DAIRY FARMING:

BEING

THE THEORY, PRACTICE, AND METHODS OF DAIRYING.

BY

J. P. SHELDON.

ASSISTED BY LEADING AUTHORITIES IN VARIOUS COUNTRIES.

With Twenty-five Coloured Plates.

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INTRODUCTION.

OR generations past, Dairy-farming in these islands has been an important branch of our national enterprise, and its importance has been steadily increasing, but it has not hitherto received the same relative amount of notice and recognition that other branches of agriculture have enjoyed. Not being the first to feel the effects of foreign competition, it seems to have gone on quietly and uneventfully, attracting but little public notice, minding its own business in its own way, and making no special and comprehensive attempt at improvement until late years, as, indeed, none seemed to be specially needed. A very few years ago no kind of foreign dairy-produce sent to us was admitted to be, in either quality or quantity, sufficiently marked to justify much uneasiness, or to demand any special exertion, on our part. Some twenty years since, our importations of foreign cheese and butter were but a tithe of what they now are in quantity, whilst their quality, generally speaking, was inferior to our home productions; their consumption, too, was limited to certain classes and to special districts. But now all this is changed, and at length British dairying seems to be waking up to the demands of the age; statistics are collected, and reports issued, and various efforts are being made to bring it into system and order, and to develop and improve its resources. About the year 1870 the factory system of cheese-making was introduced into several of our best dairying districts; a few years later the British Dairy Farmers' Association was formed; and, though last not least, the Royal Agricultural Society has now taken the subject warmly in hand, and offers prizes for a variety of new or improved implements, utensils, and machines, which the modern phases of dairy-farming have made a necessity of the day. All these are hopeful signs that at length dairy-farming is beginning to assume that comparative importance which belongs to it as the chief home source, in one way or another, of the nation's food-supply.

Breeds of Cattle.

It is not alone on account of cheese, butter, and milk—in themselves articles of the first moment—that dairy-farming is a supremely important factor in the sum of our national agriculture. It is also the indirect—in many cases the direct—source from which our home supply of beef is derived; and the raising of cattle is, consequently, an important branch of it.

A comprehensive and painstaking history of the various breeds of cattle which are found in the British Islands yet remains to be written; and it may well be doubted if such a history will ever be written, since the annals from which the earlier portions of it would have to be derived are admitted to be meagre and obscure. Be this as it may, it is not our purpose in this work to attempt any such account—first, because we have not space for it; and, secondly, we have not the requisite materials. We shall, however, endeavour to indicate
very briefly some of the outlines, giving more or less of details when dealing with special breeds, which such an account would present.

How and when the original animals from which our present breeds of cattle are descended first came to this country, it is now impossible to determine. That they have inhabited these islands for a very long period is proved by those fossiliferous remains of them which have from time to time been discovered in very ancient cave and drift deposits, which, though even approximate dates can hardly be given, were formed many thousands of years ago. More than once during these vast pre-historic periods of time, the bed of the German Ocean has been elevated so that England formed part of the Continent of Europe, and it may well be that the remote ancestors of our herds of cattle, migrating westwards, came to Britain by dry land all the way, in the period preceding the last time when the sea swept between this country and the Continent, and England again became an island.

It is probable—but this, we suspect, is a point which, like the preceding one, can never be determined with certainty—that the various types of dairy-cattle, as seen in the distinct breeds of the present day, have all come from one original and individual stock which, before the land was fenced in and cultivated, roamed at large for ages over the face of the country. Even to this day have survived, in the white cattle preserved in the parks at Chillingham, Chartley, and Lyme, the lineal descendants of the ancient roaming herds, still retaining, thoughconfined within a limited area, the wild characteristics of their remote ancestors, and but little, if at all, changed by the skill which man has brought to bear on what are properly called the “improved breeds.”

We may lay it down as a first proposition that Nature, without the interference of man, has from one original stock produced various races, or breeds, or families of animals; and it is no less true that she does not require man’s assistance to preserve these from deterioration, providing only that they are left to themselves. Her great laws of natural selection are the means by which she brings about these results. On the other hand, we also witness around us everywhere the great power which man possesses, by artificial selection and classification, and by rejection of unfit specimens, of moulding and improving the various kinds of animals which he has reduced to domestication.

The striking differences which are seen between the Longhorns and the Shorthorns, the Herefords and the Devons, the West Highlanders and the Channel Islanders, the Red Poll and the Welsh Cattle, the Galloways and the Kerrys, may have been to some extent produced by the peculiarities of soil and climate to which these breeds have been respectively subject, in the districts in which they settled down, and of which they became a special feature; and the physical development—or deterioration, as the case may be—which has taken place more or less in all of them, is, perhaps, primarily due to those influences of soil, climate, and locality, and to the law of natural selection working through these means. More recently they have been improved by domestication, and by artificial selection—principles which Man has formulated into a science during the past hundred years or so.

We may here regret that Britain did not share in the genius for arts, sciences, and literature which several thousand years ago pervaded some of the countries of Southern Europe. Had she done so, we should have had records of the cattle, and of the agriculture generally, which were found in the country at that period. Such records, besides being interesting, would have thrown a flood of light over the dark, early history of our country; and many points in the history of our native breeds of cattle, which rest now, and must ever rest, mainly on conjecture, and on chains of evidence which are more or less imperfect, would have been tolerably clear and trustworthy. Even in later times, when England began to have a written history, the dignity of our historians was more gratified in writing of wars and Court intrigues than of the arts which tend to peace—of cattle, and of pastoral husbandry. Allusion is now and then made to domestic animals, as elements of traffic and of food, but nothing is said of the different breeds, or of the excellences of any one breed.

Fossil remains, discovered in beds of silt and in cave-deposits, demonstrate the fact that the Bos primigenius, or great ox—a genus which has been extinct for ages—once existed in this
country; and though it is not absolutely proved whether or not this genus had any connection with them, it is on collateral evidence supposed that the far-away progenitors of our domesticated breeds of cattle were larger-framed animals than those of the present era.

Be this as it may, however, our different breeds of cattle of the present day have, in the course of ages, and by the influence of locality, assumed the distinct types and forms that we now see; and in some of them these specialities of form and colour are so far “fixed” and permanent that they do not appear to alter much, if at all, wherever the animals are taken. Whether bred in England, America, or Australia, Devons and Herefords remain Devons and Herefords still. This, however, is not always the case with what, for distinction’s sake, we may call “composite breeds.” Of these the Ayrshires in a limited sense, and the ordinary dairy-stock of the midland counties in a more general one, may be taken as examples. Within comparatively recent times—say in the past two centuries—these breeds have been built up, or, to say the least, very greatly improved, by intercrossing two or more distinct breeds; and they have been since, and are still being, improved by careful selection and classification. Even the modern Shorthorns—the noblest breed of cattle, so far as we know, that the world has yet produced—cannot well be called a pure breed in the sense that the Devons, the Herefords, or the Channel Islanders can, though they are more excellent than these—just in the same sense that Englishmen cannot be called a pure race, as the Chinese or Japanese can. For some of the early breeders of Shorthorns sought to improve their cattle by “stealthy crosses with other breeds,” and even the celebrated Charles Colling, of Ketton, is known to have had recourse to Kyloe and Galloway crosses. Whether any solid improvement was obtained from these crosses is and must remain a disputed point; but the fact of the crosses, not being denied by the best authorities, remains on record. When some kinds of cattle are taken to other districts and countries, their offspring not uncommonly exhibit tendencies to “throw back” more or less to their remote ancestral elements. In order to maintain the excellent quality of the Ayrshires in any other country than their own—in England, even—it is found necessary to repeatedly import fresh blood from the fountain-head. Shorthorns, too, in other climes, while increasing rather than diminishing in constitutional vigour, not infrequently show signs of considerable “rawness,” and to check this tendency it is found necessary to use great care in selection and in general treatment. Being in a sense artificial breeds, they require more or less of artificial treatment to maintain them in the high position of purity and excellence which they have attained. In course of time, if the system under which they are bred be persevered in, they may become permanent in those features which at present are more or less fugitive. These features, however, will be the longer in becoming “fixed,” because many of the best animals are continually being transported and re-transported from one district or country to another; for where there is so much migration of individuals it is difficult for a tribe to secure and to maintain fixed, uniform, and unvarying characteristics—“fixed,” that is, in the same sense as those of local and very ancient breeds appear to be.

Far more than any other breed, because the grandest and most fashionable, Shorthorns have become cosmopolitan. They are now found in every civilised portion of the world, and in some portions which can hardly be regarded as civilised. The Shorthorn seems to be the Englishman’s shadow—it follows him everywhere. In all countries, if properly cared for, Shorthorns are found to do well. Other breeds, notably the Herefords, have been introduced and extensively bred in other countries, and they too are found to prosper, without such minute care, under the new conditions; while their distinguishing characteristics, being to all intents and purposes stamped with the principle of permanence, so far as such matters can become permanent, do not change in any marked degree. Yet it is probable that foreign soils and climates will modify them somewhat in course of time. Not the least of the merits which English breeds of cattle carry with them to foreign countries is their prepotency—their ability to stamp in a marked manner their own qualities on the offspring of any of the native breeds with which they are intercrossed in such foreign countries; and in this way they are modifying the cattle of the rest of the world in a degree analogous to that in which Englishmen are modifying its manners and institutions.
This property of prepotency belongs in a marked degree to the Shorthorns, the Herefords, and the Devons; and, especially for breeding purposes, these cattle are held in high esteem in various countries of Europe, in America, and in Australia. To the Shorthorns it especially belongs; and, if such an analogy be permitted, we may assume that the physical vigour of Shorthorns, like that of the English nation, is owing in no insignificant measure to the ancient admixture of foreign blood. In order to maintain unimpaired the size and reproductive vigour of a race, Nature occasionally requires, as it would seem, either fresh soil and climate, or fresh blood. Confined exclusively to themselves and to a given district, animals of all kinds, including man himself, appear to deteriorate in size and vigour, if not in purity of type. It must always be borne in mind, in respect to the breeding of animals, that the power of prepotency—of impressing his characteristics on his offspring, whatever their mothers may be—will depend mainly on a bull’s physical vigour and soundness of constitution, and that the offspring will most resemble that parent which possesses these qualities in the highest degree.

There are very few of the breeds or tribes into which the native cattle of Britain have resolved themselves that have not been more or less improved by man’s judgment and skill in the art of breeding; and some of them, by careful selection only, and without crossing from other breeds, have been very greatly improved. The improvements consist mainly in a nearer approach to symmetry of form—so far, at all events, as our ideas of symmetry go—in earlier maturity, in aptitude to fatten quickly on a minimum quantity of food, and in the development of milking properties. Nor can it be doubted that the improvement in each of these points is real and substantial, though they are seldom found combined in a high degree in one animal or family. In the breeding of pedigree Shorthorns, milking properties have only too commonly been sacrificed to symmetry of form, early maturity, and rapidity of fattening—one or all of these. And yet it is admitted to be possible that all these properties should be secured in the breeding of animals, and we actually find certain families of Shorthorns famous alike for milk, symmetry, early maturity, and rapid fattening. Where these are all attained—and attained they undoubtedly are in some instances—nothing is left to be desired, providing only that physical vigour and fertility are maintained, for if these suffer, the rest are comparatively valueless. The breeding of cattle with a view to symmetry and beauty of form, early maturity, and rapid laying on of flesh, and treating milk as a matter of little importance, has caused many people to entertain the belief that beef and milk in the same breed are somehow incompatible; that only one of these properties can be secured in a high degree in any one animal or family; that the methods employed to produce on the one hand a race of cattle excellently adapted for beef-making, and on the other for the production in an equally high degree of milk and butter, usually result in milk being sacrificed to beef, or beef to milk; and that between these two stools either the breeder will fall to the ground, or will have to be content with sitting on one of them. This belief rests on a fallacy created by the one-sided objects aimed at, and methods employed, by certain breeders of show-cattle.

We have hitherto failed to be convinced of the soundness of this method of breeding, and we have equally failed to see that the results of it are by any means deserving of having a hard and fast theory in the art of breeding based upon them. We are well aware that high feeding for show purposes, coupled with the practice of not allowing the cow to give any milk during the greater part of the year, will soon result in dwarfing the lacteal organs; and that if persevered in for several generations, quick feeding and deficient milking properties will become marked features in the breed. It is a mere question of imperfect exercise of milking functions. Yet we know also that a diametrically opposite result may be obtained by similar methods; that beef may be sacrificed to milk just as easily as milk may to beef, by simply breeding in that direction. And it is equally true that a more excellent course than either of these may without great difficulty be followed, and cattle may be bred with both milk and beef combined. These qualities, we believe, are co-ordinate and correlated; they may and do exist normally in the same animal, and they may be developed either separately or jointly according to the direction
INTRODUCTION.

in which the breeding and treatment of the animals are made to tend. High milking as well as quick fattening properties are doubtless to some considerable extent artificial productions. Wild cattle are neither good milkers nor good feeders; and we see, in those parts of England where calves are commonly allowed to run with their mothers, that the cattle are not famous as good milkers. Milk much sooner leaves the cow when a calf sucks from her than when she is milked by hand. The Hereford cattle are a marked instance of this; and yet we find the Herefords are not by any means inferior milkers when they are treated as other dairy-cattle are—when their calves are taken away at birth, and they are milked by hand instead. In all breeds the milking properties of cows vary more or less; some cows are good, others bad, and others again indifferent milkers; but with care and judgment in selecting animals to breed from, not only may nearly all the animals be bred good milkers, but milking and feeding capacities may be combined in them in a highly satisfactory manner.

Milk.

Milk, cheese, and butter are the productions, *par excellence*, with which is associated the salient idea conveyed by the term "dairy-farming"—they are its specialities, its prominent features. But the relative prominence of these features is changing rapidly in these later days. So far as English dairy-farming is concerned, milk—for consumption as milk, and not as cheese and butter—is taking the lead as a special commercial element. The quantity of cheese, if not of butter, made in the British Islands is yearly diminishing; and it is not improbable that, in course of time, we may depend almost wholly on foreign supplies of cheese, and, to a very great extent, on foreign supplies of butter; our own dairy-farming being devoted chiefly to the milk-trade. Yet dairy-farming will not become any the less important on that account—rather the contrary; but cheese and butter making will become less important, especially in districts where railways offer facilities for the conveyance of milk to our towns and cities. At present, however, cheese-making is still a highly important branch of dairy-farming, and for some time yet will continue to be so; but it has, in some districts, already given way before the rush of the milk-trade, which has been greatly stimulated in recent years. Two principal causes have contributed to this. First, the operation of the Adulteration Acts, in the last eight or ten years, has so greatly increased the consumption of milk by all classes of our urban populations, and fast trains on the railways afford such facilities for rapid conveyance of perishable food, that a new and altogether extraordinary opening has been made for country milk in our cities and towns. Secondly, the cattle-plague of ten or twelve years ago destroyed the milch-cows in town cow-houses—particularly in London—in such a wholesale manner that, in the great bulk of cases, they have not been, and in all probability never will be, replaced; and the sources of our towns' and cities' milk-supply are now found in country villages scores of miles away.

This is a new departure which is changing the whole complexion of English dairy-farming, either directly or indirectly. In most dairying districts through which railways pass, the traveller by the morning and evening trains may see, as he passes along, a number of milk-cans standing on the station platforms, awaiting despatch to their destinations. There are but few if any stations, however small, from which no milk is sent, while from some of the larger ones very considerable quantities are sent away night and morning. The aggregate extent of this milk traffic, as will be seen from the statistics and other information relating to it, which will be found in their proper place in the body of this work, is enormous, and is yearly increasing. And when we consider that almost the whole of this vast trade has sprung up within a comparatively few years, the modern change which has come over a large portion of English dairy-farming will be plainly seen, and it is no less plain that the new order of things will go on developing. To this great feature of dairy-farming we shall devote the amount of space which its importance demands, and we hope to give to our readers an adequate presentation of its various bearings. We think it promises to become, in the not distant future, the sheet-anchor of a large section of our dairy-farmers, while it is also a question of first moment to the public at large.
DAIRY FARMING.

We need no support when we say that only a tithe of the milk is consumed by our people that ought to be, for the truth of the statement is obvious to every one. Unadulterated, undiluted, unskimmed, and properly-treated milk, taken from a healthy cow in good condition, and produced by the consumption of healthy and nutritious grasses and other kinds of food, contains within itself, in proper proportions, all the elements that are necessary to sustain human life through a considerable period of time. Scarcely any other single article of food will do this. When we eat bread and drink milk, we eat bread, butter, and cheese, and drink water—all of them in the best combination and condition to nourish the human system. All things considered, good milk is the cheapest kind of food that we have, for 3 pints of it, weighing 33 lbs., and costing 4½d., contain as much nutriment as 1 lb. of beef, which costs 9d. There is no loss in cooking the milk as there is in cooking the beef, and there is no bone in it that cannot be eaten; it is simple, palatable, nutritious, healthful, cheap, and always ready for use with or without preparation. Few kinds of food are really more nutritious and healthful—none so complete. The National Live Stock Journal tells us that the average analyses of thirty-four samples of pure milk by S. P. Sharpless, of Boston, gave the following results:—

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<td>Cream volume</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>85-83</td>
</tr>
<tr>
<td>Sugar</td>
<td>4-82</td>
</tr>
<tr>
<td>Casein</td>
<td>4-06</td>
</tr>
<tr>
<td>Fat</td>
<td>4-62</td>
</tr>
<tr>
<td>Ash</td>
<td>65</td>
</tr>
</tbody>
</table>

According to Dr. Lanester, the composition of lean beef is:—

<table>
<thead>
<tr>
<th>Water</th>
<th>50-0 per cent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat</td>
<td>30-0</td>
</tr>
<tr>
<td>Fibrin and albumen</td>
<td>8-0</td>
</tr>
<tr>
<td>Gelatine</td>
<td>7-9</td>
</tr>
<tr>
<td>Mineral</td>
<td>5-0</td>
</tr>
</tbody>
</table>

While Professor Way gives for a particularly lean sample 53-81 per cent. of water, 3-10 per cent. of fat, 24-06 per cent. of albuminous matter, and 19-3 per cent. of other substances.

If from these data we construct a table, we find that the chemical substances of 1 lb. of milk and beef have about the following relations:—

<table>
<thead>
<tr>
<th>Water</th>
<th>13-73 ozs.</th>
<th>8-9 ozs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flesh-forming constituents (nitrogenous)</td>
<td>65</td>
<td>24</td>
</tr>
<tr>
<td>Heat-producing constituents (carbo-hydrates)</td>
<td>1-51</td>
<td>4-8</td>
</tr>
<tr>
<td>Mineral matter</td>
<td>10</td>
<td>8</td>
</tr>
</tbody>
</table>

\[
\begin{align*}
\text{Water} & = 13-73 \text{ ozs.} \\
\text{Flesh-forming constituents (nitrogenous)} & = 65 \\
\text{Heat-producing constituents (carbo-hydrates)} & = 1-51 \\
\text{Mineral matter} & = 10 \\
\end{align*}
\]

This is to say that, chemically, 3.7 lbs. of milk is the equivalent of 1 lb. of beef in flesh-forming or nitrogenous constituents, and 3.17 lbs. of milk is the equivalent of 1 lb. of beef in heat-producing elements, or carbo-hydrates.

In a calculation, by Dr. Frankland, of the weight of various articles of diet required to be consumed to furnish the force requisite to raise a man of 140 lbs. weight to the height of 10,000 feet, 8 lbs. of milk and 3.5 lbs. of lean beef are given for the figures. In another table, furnished by Lethingly, the amount of food necessary to be consumed to furnish the necessary nitrogenous constituents for a day’s diet is given as 72-4 ounces for milk and 15-6 ounces for lean meat. In the table of the average daily diet required for active labour, we find 391 grains of nitrogen and 6823 grains of carbon—an amount supplied by about 11½ lbs. of milk (about 11½ lbs. to supply the carbon, only about 9 lbs. to supply the nitrogen), or about 3½ lbs. of beef
(about 3·6 lbs. to supply the carbon, and 2·1 lbs. to supply the nitrogen). The carbon and nitrogen in average milk and beef are calculated by Dr. Lankester as below:—

<table>
<thead>
<tr>
<th></th>
<th>Grains per lb.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>Carbon: 599</td>
</tr>
<tr>
<td></td>
<td>Nitrogen: 44</td>
</tr>
<tr>
<td>Beef</td>
<td>Carbon: 1834</td>
</tr>
<tr>
<td></td>
<td>Nitrogen: 184</td>
</tr>
</tbody>
</table>

We must therefore assume from the data offered, that the relative values of beef and milk as human food are as 3\(\frac{1}{2}\) are to 11\(\frac{1}{2}\), or as (in round numbers) 1 to 3\(\frac{1}{2}\). If milk is 4d. a quart, then it is the equal in food value to beef at 6\(\frac{1}{4}\)d. a pound; and, *rice versi*, when beef is 1s. 0\(\frac{1}{4}\)d. a pound, then milk should be 8d. a quart, calculated on its food value. We thus see that, at any ruling prices, milk is certainly one of the cheapest, if not the cheapest, food that can be furnished to the family, while all experience is in favour of its healthy qualities.

The production of milk in the animal economy is one of the most interesting and beautiful of the many branches of study which natural history provides. That the offspring of the order Mammalia should receive its sustenance for a time direct from the mother's body is singularly interesting, and milk is perhaps the most beautiful of Nature's provisions for the support of life. How milk is made is a subject well worth a few minutes' inquiry. A scientific journal describes the process as follows:—

"We all know that milk comes from the cow, and is derived primarily from the food that goes in at the mouth. The cow, indeed, is the machine which receives the raw material, the grass or hay or grain, and in the natural laboratory of her body produces the sweet and palatable milk, so essential to infancy, so agreeable to the adult. How it is done is a most interesting inquiry. It is not simply filtered from the blood, as water is filtered through earth or paper. It is itself an organised material, containing bodies which possess form, and which are allied to the animal which produces them."

"If we pass a bristle inward through the orifice of the teat, it traverses a duct or tube which opens into a reservoir which communicates with other reservoirs or with ducts; selecting one of these ducts and continuing, it finally arrives at a small sacular cavity, which comprises the extremity of the system. Within this cavity, the vesicle, as it has been named, the fat of milk is produced—but how? A microscopic examination shows these little cavities, but about a thirtieth of an inch, more or less, in diameter, are lined with cells of a uniform size, but if anything smaller above than below. These cells produce the milk globule by forming new cells in the following way:—A cell commences to bud at the extremity, and grows until the bud is dropped off into the cavity; and there the water, containing casein and milk-sugar in solution, and which has been transuded from the tissues, takes this young milk globule, but just now a part of the living structure of the cow, and washes it down through duct after duct, till it reaches the reservoirs and passes out through the teat. Thus the fat of milk is formed in the cow, and the process is distinctly an epithelial one, or a sort of a cell growth, as the nail cells elongate to form the nail of the hand or foot."

"Let us retrace our way with the milk. The simple cell, which but just now was part of the vesicle, or terminal acini, or ultimate follicle, has received the material for its growth from the blood which has been brought to it by the system of capillaries, which has enveloped it with an abundant network. This material, received into the cell, has become changed into fat by a species of change allied to degeneration, or the breaking up of previous compounds. This ultimate follicle is grouped with other vesicles of a like character, to form a lobule."

"This lobule is arranged with other lobules, and the combined secretions of all the lobules are passed onward to the main duct. To repeat, the vesicles secrete and pass their product, the milk globule, into the duct of the lobule, and from this duct the globule passes into others, continually more capacious, until it reaches the reservoirs, which are principally arranged about the periphery and apex of the udder-gland."
"We thus see that the milk globule is at one time a portion of the living cow; that it must partake in some measure of the character of the cow. Hence, as cows differ—we know that cows’ meat differs, formed of muscle cells as it is, one piece of beef being tender and juicy, another being dry and tough—so must there be differences in their milk."

Milk, then, is a liquid emulsion produced from the elements of blood and chyle in the mammary-gland of the female animal of the order Mammalia, after she has given birth to young. Seen under a microscope it appears as a colourless fluid, in which float innumerable little globules, which contain the fats of which butter is composed. The “shells” of these microscopic sacs or globules consist of casein or albumen, which, being white, give to milk its peculiar opacity.

Some people do not relish milk now as they did once—when their tastes were uneducated and uninitiated; it is too simple and too dilute a food to find much favour in the eyes of those who have long been accustomed to strong and concentrated meat and drink. Then, again, it is, or has been in the past, very difficult for townpeople to procure wholesome milk—milk from healthy cows that have been fed on healthy food. Too frequently milk has contained, in one form or another, germs of disease, which have caused sickness and sometimes death among the people. We say "too frequently," because we now know that such has no need to be the case at all. Assuming that the country is free from the diseases which have been repeatedly imported with Continental cattle, cows will give sound and healthy milk, providing they are fed on sound and healthy food, and are kept away from filthy water and from vitiated air. It is not our purpose here, any more than it is our wish, to advocate a milk diet in preference to any other; but we may point out the great advantage which would accrue, to producers and to consumers alike, if our citizens drank more milk than they do, and less of other things; and we may also say that if the people who use milk could always depend on getting it pure, the demand for it would increase much more rapidly than it has done. True, the milk now supplied to townsfolk is much more nearly what it ought to be than that of ten years ago, yet we still hear of frequent convictions for milk adulteration. Not only common honesty, but the health of the people demands that the law as to adulteration shall be very strict and very vigilant. Dishonest milk-salesmen must be made honest in spite of themselves—be they farmers or retailers. Farmers who adulterate the milk they sell are exceedingly stupid, for they are hindering the development of a trade which provides by far the most profitable outlet they will ever find for their produce; and retailers—well, of some of them it might be said "'tis their poverty, not their will, consents;" but they, and those who cannot plead poverty but still are dishonest, and the farmers too who water or skim their milk, must be under the surveillance of a law strictly and impartially administered. If we speak pointedly, it is because we feel strongly on this subject of milk adulteration. We know that absolutely pure milk can always be obtained from several sources in the London milk-supply; but we also know that much milk that is not genuine is still sold in the metropolis, as well as in all other cities and towns. Both these things are obvious to every one who is acquainted, however slightly, with the milk-trade; and it is no less obvious that pure milk could be supplied by every salesman to every customer, providing only that all men were honest, or that the law were strict enough. It is blind fatuity on the part of every one who sells milk, to sell an article that is not genuine; it is killing the goose that lays the golden eggs, that would never leave off laying them, that would lay more of them each following year, if properly treated. Fresh and genuine milk delivered regularly would be like a small but constant supply of fresh country air to the denizens of our crowded cities, who need it sadly; it would help Nature to fight against the influence of the vitiated atmosphere which they constantly breathe; it would restore vigour and health to those who are robbed of them by the anti-natural conditions under which they live. One of the obvious duties of a Government is to see that the people are supplied with genuine and wholesome food. Next to the protection of life and property, this protection against an unwholesome food-supply is the most important. Hence it follows that the law against adulteration must be strictly enforced whenever and wherever necessary.
INTRODUCTION.

THE MILK TRADE.

The points in the milk-trade to which we shall chiefly direct attention are:—Its control in summer and its development in winter; the best methods of cooling and aërating, so that milk may carry long distances in the hottest weather, taking no real harm by the way; and the regulation of its conveyance by rail, embodying increased facilities as to times and rates of transit. We shall also treat upon the development of the factory system in connection with the milk-trade; their partnership, so to speak, so that the one may be subservient to the other—cheese-making to the milk-trade—on the plan already in some measure successfully carried out by several of the Derbyshire factories and by the Aylesbury Dairy Company, so that when there is a plethora of milk in summer, the surplus over and above the needs of the trade may, in the manner next most profitable, be made up into cheese or butter, as the case may be, or into condensed milk. As the matter now stands, an amazing quantity of milk is handled in a wasteful and unprofitable manner, owing to a prevalent lack of knowledge as to the best manner of preparing it for transit by railway, and as to the best methods of cheese and butter making. The annual loss under these heads to individuals or companies, and through them to the nation, is immense. This loss must, as far as possible, be prevented.

Milk Production.

It is obvious that no estimate can pretend to do more than approximate to the quantity of milk produced by the cows of the British Islands; and this is all that can be done with regard not only to the quantities of cheese and butter produced in this country, but also as to the quantity of milk, of cheese, and of butter that our people consume. Such estimates may, and probably do, come very near to the truth, but of this we cannot be certain; they will, however, be sufficient for our purpose here, which is to show how vast is the importance of our dairy-farming. During the years 1876-8 the number, in the British Islands, of "cows and heifers in milk or in calf" has seriously diminished; the figures given in the agricultural returns are as follows:—

<table>
<thead>
<tr>
<th>Year</th>
<th>Cows</th>
</tr>
</thead>
<tbody>
<tr>
<td>1876</td>
<td>3,775,203</td>
</tr>
<tr>
<td>1877</td>
<td>3,744,647</td>
</tr>
<tr>
<td>1878</td>
<td>3,708,766</td>
</tr>
</tbody>
</table>

If we base our estimate on 3,700,000 cows, and assume that each of these animals produces, on the average, 440 gallons of milk per annum, we have an aggregate milk production of 1,628,000,000 gallons. Of this vast quantity it is probable that about one-eighth is used in the rearing and fattening of calves, leaving a balance of 1,424,500,000 gallons available for human consumption in the forms of milk, cheese, and butter, including what is used in cooking and what is wasted. If this balance were all made into cheese, it would produce over 500,000 tons of ripe cheese, which would be a trifle under 10 ozs. per week per head of our population. Made into butter it would produce over 230,000 tons, or nearly 5 ozs. per week per head of the population. When we come to reckon up the excess of our imports over our exports in these articles, and add to such excess the quantities produced in these islands, we find that in reality we consume cheese at a rate very little, if at all, exceeding 4 ozs. per week per capita, and butter at a rate very little, if at all, exceeding 3½ ozs. per week per capita.

But suppose we allow that each man, woman, and child in the British Islands swallows, on an average, in the forms of milk and of various cookeries, one-third of a pint per day, or 15 gallons per year—and this, we think, is under rather than over the mark, and in a short time will be considerably under it—these items of consumption dispose of some 525,000,000 gallons per annum, leaving a balance of about 900,000,000 gallons to be converted into cheese and butter. Bearing in mind that scarcely any cheese at all is made in Ireland, and in the smaller islands of the British group, and that in many parts of England cheese-making is giving way to butter-making, we are perhaps not very far wrong in assuming that some 350,000,000 gallons are devoted
Dairy Farming.

Condensed milk is now becoming an important element in dairy-farming. As one of the auxiliary products of milk it is likely to increase in importance as time rolls on. At present the manufacture of it is very limited in this country, and in comparison with certain foreign countries will probably remain so, because milk cannot in England be bought cheap enough to enable any one to compete on equal terms with manufacturers abroad. Experiments in condensing milk were begun more than thirty years ago in America, and earlier than that in Europe, but it is only a little over twenty years since the art of making it successfully was perfected. Preparations under the names of "desiccated milk," "milk powders," and "milk essence," had been on the market for some time before, but they were all more or less unsatisfactory. It had long been felt that if milk could be deprived of its water, leaving all the valuable constituents intact; if it could be made to keep in its new form for long periods, and could at will be restored to its original state by merely adding water to it; then the conditions necessary to its general acceptance by those for whose use it was designed would be successfully met. But the articles mentioned were preparations only, and could not be re-invested with the characteristics of actual milk; hence their ultimate uselessness.

The credit of being the first to produce a thoroughly successful article under the name of "condensed milk," which was, to all intents and purposes, actual milk minus the bulk of its water, is ascribed to Mr. Bowden, of White Plains, New York, America. Under his process the milk is not reduced to a solid or dry state, but at least six-sevenths of its normal percentage of water is removed, while its valuable elements remain uninjured, and it assumes a consistency somewhat resembling that of treacle. The true value of pure, fresh milk, as an article of food, is at length meeting with a more popular and general recognition; and as condensed milk of the best brands is, when re-mixed with water, very closely analogous to, nay, identical in all respects with fresh milk itself, the result naturally follows that it will soon come to be considered, especially where it is difficult to obtain milk fresh from the cow, a very tolerable and excellent substitute. For the use of sailors and soldiers, and in parts of the earth where no cows are kept, condensed milk is obviously of very great importance. Its condensed form adds greatly to its portability,
and, being in hermetically-sealed cans, it remains sound and good for an indefinite period. One of the strongest recommendations in favour of condensed milk is this: it cannot be successfully produced from milk that is not perfectly sweet and clean and of uniformly good quality. Any imperfection in the original material is more apparent in condensed milk than it is in cheese, though, perhaps, not more so than in butter. Hence it follows that manufacturers of condensed milk are extremely particular with regard to the quality, cleanliness, and soundness of the milk they buy, for success is found to be impossible without it. Hitherto it has been customary to add a given quantity of sugar, in order to give permanent keeping properties, where such properties are needed; but there is also a good deal made of what is called "plain condensed milk," to which no sugar is added; this last is preferable to the other, on account of the absence of excessive sweetness, but it is made for consumption within a reasonable time. It can hardly be expected that condensed milk will wholly take the place of fresh milk where the latter is not very difficult to procure, but it will in part supplant fresh milk in our larger cities and towns; not because it is cheaper, but for the reasons that it is more convenient of carriage from the country, and will keep good a much longer time. The conveyance of country milk by road and rail is costly and unceasing, and will not admit of delay; but the carriage of condensed milk, and its manufacture, will balance these expenses and inconveniences.

**Dairy Management and Appliances.**

Cheese and butter making will also receive the amount of attention which they merit, and this is very large. Not only the various time-honoured as well as modern systems which are found in various parts of the British Islands and Colonies, but also the many foreign methods will be described by competent writers. Comparisons will thus be suggested rather than drawn. The causes of success on the one hand, and of failure on the other, will be pointed out as far as may be. As among the latter, it may be said that sufficient attention is not paid to details of management, nor importance attached to care and cleanliness; and the scientific aspect of the case is too commonly scented as pedantic and superfluous. We must not any longer disregard these matters, if we are to meet foreign competition with success. In most other, if not all industries, whether agricultural or commercial, scientific research has done much more solid good than is commonly owned. But while it is true that several eminent men have devoted much scientific investigation to cheese and butter making, the teachings of science in these industries have not been by any means generally accepted, and the great bulk of cheese and butter makers are working still in their forefathers’ groove. They seem as if they thought they could succeed well enough by sheer physical force, without paying attention to the delicacy of details; they look upon the minute care, the unceasing attention, the scrupulous cleanliness, the almost microscopical attention to and arrangement of details—the painstaking work, and the careful study of principles—which they are told the French butter-makers and the American cheese-makers carry into their business, as being in a sense puerile, and on the whole unnecessary. The almost loving devotion which the Frenchman and the German pay to the making of their unrivalled butter, and of their many curious kinds of cheese, and the earnest, long-sustained enthusiasm which the American factory or creamery manager throws into his profession, are regarded by the average English dairy-farmer, and by British cheese and butter makers generally, as belonging to the list of amiable infatuations—useful perhaps, in some measure, but still infatuations. Herein lies at once the difference and the difficulty. So long as we content ourselves with regarding the efforts of others as unnecessary, and, worse still, if we regard them as puerile, we are very little likely either to copy or to improve upon them. But when we are being palpably left behind in the race; when we are being beaten in our own markets, and in the estimation of the judges at our own shows, by foreign productions, our eyes are opened somewhat, and we begin to admit that not only are our own methods not quite perfect, but that there must be some merit in the systems carried on in other countries. When we have arrived at this point, there is a good prospect of improvement setting in. In the year 1878, at the great Dairy Shows of London, Frome, and
Kilmarnock, and at many other shows of lesser importance, the complaint of the judges was almost universal that there was a greater proportion of inferior cheese than they had ever found before; and wherever American or Canadian cheese was brought into competition with our own, the verdict was that English cheese suffered by the comparison. Some such universal and startling verdict as this was needed, to enable our farmers to fully realise the position in which they stand as cheese-makers, and to finally convince them, in a practical sort of way, that they must take more pains and use more thought than they have been in the habit of doing, or the quick result will be disaster of a very serious and lasting kind.

The unsatisfactory state into which cheese-making in this country has drifted, is attributable to various causes. That there is a great deal of inferior cheese in the country, is a fact that he who runs may read, but the reason or reasons why it suddenly became commoner than ever, and worse, are not so easy to discover. Anyway, the year 1878 was a disastrous one for cheese-makers, and cheese was lower in price than it had been for at least twenty years. Some say it was the peculiar season that caused so much cheese to be bad; that the large rainfall and the scarcity of sun changed the character of the herbage; and that cheese-makers, not knowing this, were unable to cope with it. This conjecture is ingenious, and no doubt true in part; but we have had many equally rainy seasons without a corresponding result. Others attribute it to the use of artificial manures and feeding-stuffs; while others, again, say it is owing to the land not being improved, and that we cannot compete with Americans, because our land is so much inferior to theirs. The former of these apologists have, at all events, probability in support of their opinion; for the average quality of English cheese is declared, by those who have every means of knowing, to be worse than it was before guano and nitrates and phosphates were so commonly used for the improvement of land. But the latter, we think, are wholly wrong in both their premises. In the first place, it is not true that the dairy-lands of England and Scotland have not been improved, and many of them very greatly improved, in recent years, by draining, liming, and seeding with fresh grasses, by the application of both natural and artificial manures, and by the consumption of feeding-stuffs; and, again, whoever has travelled through the dairy regions of America, and who knows good land from bad, cannot fail to have been struck with the plentiful evidences which exist of American land, generally speaking, being inferior to our own for dairying purposes. One plain proof of this is that our land will carry more stock, and, in fact, does carry much more stock, than land in America carries. The following calculations show the number of different kinds of stock maintained per hundred acres of land under grass, in the two countries respectively, in the year 1875:

<table>
<thead>
<tr>
<th></th>
<th>America</th>
<th>England</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horses</td>
<td>7.49</td>
<td>9.26</td>
</tr>
<tr>
<td>Cattle</td>
<td>18.74</td>
<td>33.75</td>
</tr>
<tr>
<td>Sheep</td>
<td>24.16</td>
<td>111.23</td>
</tr>
</tbody>
</table>

We make these calculations from the official returns of both countries, and on the grass land only (including both natural and artificial—both permanent and temporary—grasses), excluding in both cases the arable land, which, in America, certainly bears a larger proportion towards the grass land than it does in England.

Again, it is a long-established truism amongst dairy-farmers that "the poorest land produces the best cheese, but not the most of it." These pastures are none of the richest from which are made the finest qualities of Leicester cheese, which, all things considered, is perhaps the best of our many excellent kinds of English cheese. Leaving out the famous Stilton, which, being more than a full-milk cheese, is not a fair competitor, there is no cheese made in England that fetches so high a price as the finest samples of Leicester, yet it is made from land that is admittedly inferior in quality or richness to other land from which a less excellent cheese is made. It must be borne in mind, however, that somewhat less cheese per acre is made in Leicestershire than is made in most other parts of England from land of equal richness.
INTRODUCTION.

Other people, again, attribute the prevalent badness of cheese, in the year before mentioned, to the growing carelessness and incompetency of those who make the cheese; and dairymaids and factory-managers come almost equally under the lash. It is beginning to be freely said, that if you find really good cheese in a farm-house, it has been made in nine cases out of ten by the farmer's wife or daughter; and it is freely hinted that the heedlessness and lack of skill which dairymaids have betrayed for years, are now beginning to be copied by some factory-managers. It is said that labour-saving appliances in both farm-house and factories have too commonly caused cheese-makers to become less careful; and it not uncommonly happens, we are told, that the best cheese of a given district is found where these labour-saving appliances have been but sparingly adopted.

But if this be really the result of labour-saving appliances, it certainly is not they that are to blame. Though in some, nay, even in many cases a disastrous result has, after a time, followed the introduction of those appliances, they are not by any means necessarily the cause of that result; and though they are made by some persons to bear the blame of it, it can only be so for want of thought. We have seen instances over and over again, both in England and America, where the finest cheese has been made by the aid of such appliances; and in the latter country, indeed, the wonderful improvement which has, in the past fifteen years or so, been brought about in the average quality of cheese, is on all hands believed to be due in a great measure to these very labour-saving appliances. If people really do grow careless through using them, it is the fault of the people, not of the appliances. It is said by men who are in a position to know, that cheese-making is too much slurried over now-a-days—that "there is not enough work put into it." Admitting the correctness of this statement, still the mischief does not lie at the door of the appliances. Labour-saving appliances in cheese-making were intended, not to make people careless, thoughtless, and lazy, but to enable a large amount of work to be done by fewer persons, in a shorter time, and with less discomfort than the old system admitted of; and it is mere begging the question to blame them for any misfortunes that may occur.

Yet other people say that the mischief is owing to a lack of careful and thoughtful study by cheese-makers of the principles which underlie their business, and which have been expounded over and over again by scientific men who have investigated them. This last conjecture, we think, is very near the truth; but, be that as it may, it is quite true that our cheese and butter makers do not by any means study the hidden principles of their business, nor do they attach so much importance to art in work, as the Americans and the Germans do; and hence, whilst it is a fact that cheese is becoming worse just now, and butter is not improving, in this country, American cheese and German butter have been for some years and are still improving. We believe, however, that English cheese will again come to the front in reputation, and that we are only now passing through one of those repeated periods of probation which seem to be necessary in most industries when a new step in advance of the old is required to be taken, and when there is a danger of falling into a careless state. The period of depression in the cheese-trade, which has been coming on for several years—slowly it came at first, but of late years its progress has been at an alarming rate—is also partly the result of over-production on the one hand, and of the general dulness in nearly every department of trade and commerce on the other, coupled with the feverish and unsettled condition of the political world throughout Europe and part of Asia. When the air is filled with rumours of war, the arts of peace at once become timid, and they languish until the air is clear again. After a time the clouds will have passed away, and trade will revive. But meanwhile we should put our house in order; the causes of the many failures in cheese-making should be looked into, and care must be taken to avoid disaster in the future.

There is no royal road to success in these matters; it can be attained only by patient care, sustained industry, regularity, cleanliness, and unremitting attention to details. And this scrupulous cleanliness, this painstaking care, are no less necessary in cheese-making than in butter-making. Success in cheese-making—which, moreover, is a more complicated process than butter-making—depends less on technical knowledge than on practical skill, dexterity in the work, watchful
attention, cleanly habits, and patient industry. And, we may add, even these excellent qualities will be of but small avail if due care is not taken of the milk from the onset—at milking-time and afterwards; and the kind of food from which the cows produce it is a matter of importance, involving as it does the question of its manufacture in the animal economy—a question we shall hope to touch upon in the body of this work.

Cheese.

By writers on hygiene, milk is regarded as the finest standard of human food; but it is such a quickly-perishable thing that it is necessary to place it, by artificial means, in some form in which it is not so liable to early decay. Cheese and condensed milk are the only artificial forms in which all the valuable elements of milk are retained in a form which is not quickly perishable, and, of these two, cheese is by far the more convenient and serviceable as a common article of food. The whole of the most valuable elements of milk are retained in full, or nearly so, in a well-made cheese. It is in the first place deprived of some 55 per cent. of its water, and the larger portion of its sugar is evolved in the whey, but very little of its fats and less of its casein pass away in the process. The following is an average of eight analyses of milk which were made by Dr. Voeleker:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>86.84</td>
</tr>
<tr>
<td>Butter—pure fat</td>
<td>3.30</td>
</tr>
<tr>
<td>Casein (containing Nitrogen 3.2)</td>
<td>3.95</td>
</tr>
<tr>
<td>Milk-sugar...</td>
<td>4.60</td>
</tr>
<tr>
<td>Mineral Matters, Ash</td>
<td>0.81</td>
</tr>
</tbody>
</table>

And, by the same analyst, a cheese from the Derby Cheese Factory, made in 1871, was found to be composed of the following constituents:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>31.68</td>
</tr>
<tr>
<td>Butter</td>
<td>35.20</td>
</tr>
<tr>
<td>Casein (containing Nitrogen 3.92)</td>
<td>24.30</td>
</tr>
<tr>
<td>Milk-sugar, Lactic Acid, &amp;c.</td>
<td>4.38</td>
</tr>
<tr>
<td>Mineral Matters, Ash</td>
<td>4.24</td>
</tr>
</tbody>
</table>

Cheese, then, is properly described as a concentrated essence of milk, minus the greater part of the sugar. The process of cheese-making is similar to the digestion of milk in the stomach of an animal. Before it can be assimilated by the animal economy, milk undergoes a regular succession of changes in the stomach. The process of coagulation proceeds in the same manner in both cases, and is brought about by identical agencies. The digestive principle is used by art to coagulate milk in cheese-making, and by Nature to coagulate it in the stomach; and though coagulation of milk in the former case can be brought about by various other means—by acids, and juices of plants, or by the process of natural decay—no other agent has been discovered that answers the purpose nearly so well as rennet, which is simply a solution containing the digestive essence of a calf's stomach. This essence is a ferment, and consists of minute globular bodies which float in myriads in the gastric juice, and they are the direct cause of digestion in the stomach, and of coagulation out of it, when applied to warm milk. These processes of digestion and coagulation up to a given point are identical—with these differences only: the quantity of digestive essence which a calf applies to one gallon of milk in the stomach we apply to three or four hundred gallons in the cheese-tub; and in the former case the milk is operated on by the essence at a temperature of 98° to 100°, whereas in the cheese-tub it is operated on at about 80°, consequently the one coagulates in ten minutes, and the other in an hour. In each case the curd, soft at first, gradually hardens till the whey is nearly all separated from it, and it becomes comparatively firm and solid—slowly in the one case, rapidly in the other. In the case of the curd in the stomach the after-process is equally rapid, and digestion is accelerated and completed
by the greater heat, by the peristaltic motions of the animal’s stomach, and by the greater quantity of digestive ferment which is brought to bear. In the case of the curd in the cheese the after-process is correspondingly slow; the quantity of digestive ferment still at work in it, in the same manner as in the calf’s stomach, is less in quantity; and the temperature of the room in which the ripening is carried on is some 30° lower than that of the stomach. But in a few weeks or months, as the case may be, instead of a few hours, the firm and tough curd in the cheese begins to yield to the digestive agency, and becomes less firm and tough, assumes the same salty and disintegrated appearance, and the same cheesy flavour, but not the same animal odour, as the curd in the stomach of the calf. In the stomach the entire process of digestion, from beginning to end, goes on rapidly, until the mass of curd again assumes a liquid form, and is carried away when it has served the purposes of life; in the cheese the process of ripening goes on slowly, so that it may be consumed at leisure. The coagulation of milk in the cheese-tub is exactly like, only slower than, the early stages of digestion in the stomach; and when the curd is formed into cheese the ripening is much slower still than the corresponding stages of digestion. It will now be understood that a ripe, well-made cheese not only represents very fairly and successfully the milk from which it was made, but that, containing as it does such myriads of those globular bodies, which are the principle and element of the digestive ferment, it is a most proper and excellent article of food for man.

A good, ripe cheese is, in fact, partly digested before it is eaten; but, being a most concentrated food, it does not agree with many people who lead sedentary lives, if it is partaken of too freely. Cheese alone is too concentrated a food, and it has not bulk enough to sufficiently distend the stomach and bowels, if no more of it is eaten than is necessary for the needs of the body; but its defective bulk is easily balanced by eating along with it bulkier and less nutritious kinds of food, such as bread, potatoes, or fruit. And, again, the two classes of elements into which chemistry divides our food do not exist in it in the proportion which Nature dictates in such a perfect article of food as milk. Of albuminoids, or flesh-formers, and of fat and heat producers in our food, we require the proportion of two and a quarter of the latter to one of the former. Any deviation from this proportion is so far detrimental to health, and so far a waste. In whatever proportions food may be administered, the body assimilates it according to its needs, and rejects the surplus; the injury to health, resulting from improper food and too much of it, is seen in indigestion; the waste of food is not so patent to our senses, but it just as surely takes place. The disproportion of the two classes of food-elements in cheese is owing to the loss of the milk-sugar which has been carried off by the whey; it is deficient, therefore, in heat-giving principle. The following table will show at a glance the proportions of flesh and fat formers which respectively exist in various kinds of food:—

<table>
<thead>
<tr>
<th>Food</th>
<th>Flesh-formers</th>
<th>Fat-formers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>3.8 per cent</td>
<td>8.2 per cent</td>
</tr>
<tr>
<td>Cheese</td>
<td>21.0</td>
<td>31.0</td>
</tr>
<tr>
<td>Flesh</td>
<td>11.4</td>
<td>29.0</td>
</tr>
<tr>
<td>Wheat flour</td>
<td>11.8</td>
<td>74.1</td>
</tr>
<tr>
<td>Ground wheat</td>
<td>13.0</td>
<td>67.6</td>
</tr>
<tr>
<td>Rice</td>
<td>7.5</td>
<td>76.5</td>
</tr>
<tr>
<td>Potatoes</td>
<td>2.0</td>
<td>21.0</td>
</tr>
<tr>
<td>Beans</td>
<td>22.5</td>
<td>45.5</td>
</tr>
<tr>
<td>Peas</td>
<td>22.4</td>
<td>52.5</td>
</tr>
<tr>
<td>Fruit</td>
<td>0.5</td>
<td>11.3</td>
</tr>
</tbody>
</table>

Taking milk as the standard, it will be seen that all the others, except peas and flesh, deviate more or less widely from what is considered to be a perfect article of food. Cheese has much too large a proportion of flesh-formers, or albuminoids; but this defect is easily balanced by eating with it a considerable portion of wheaten bread, which has an equally large proportion of fat-formers, or heat-givers; potatoes and rice, from their composition, are also well adapted to be eaten along with cheese. A mixed diet is generally the best, and for those who lead sedentary lives,
or are in delicate health, it is necessary to eat simple kinds of food, not as a rule concentrated, but easy of digestion and assimilation. Cheese provides the cheapest and best food for those who undergo considerable physical exercise; but it is not so well adapted for those who do not, unless a properly-made and thoroughly-ripe one could always be secured. The chief reason why cheese does not enter more largely into the diet of our people is found in the fact that a great deal of it is improperly made and immature.

Bound for pound, cheese contains more nutriment than butchers' meat, and it may with advantage be used instead of it, and especially so, as they may both be called "animal food." Flesh is, of course, more nearly than cheese a perfect article of food, though less so than milk. If it were possible that there should be no waste of food in the animal economy, a pound of flesh would produce a pound of flesh in him who ate it. More than this it could not do; but a pound of cheese, being stronger and more concentrated, would produce, by simply absorbing water, more than a pound of flesh. It is, consequently, even if they are the same price in the market, the cheaper of the two; for, still further than flesh, it adds to the value of less nutritious kinds of food with which it may be consumed. The following statement of percentages will illustrate our meaning more clearly—

<table>
<thead>
<tr>
<th></th>
<th>Flesh-formers</th>
<th>Fat-formers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 lb. of Cheese</td>
<td>24.9</td>
<td>31.0</td>
</tr>
<tr>
<td>½ lb. of Bread</td>
<td>5.9</td>
<td>57.0</td>
</tr>
<tr>
<td>2 lbs. of Flesh-meat</td>
<td>28.3</td>
<td>68.0</td>
</tr>
</tbody>
</table>

It will be seen that the pound of cheese and the half-pound of bread are actually richer in both flesh and fat formers than the two pounds of flesh-meat are, whilst the proportions of these substances are in better combination in the former than in the latter. The cheese and bread would cost not more than 9d., whilst the two pounds of meat would cost about 1s. 6d. Consumed with bread or potatoes, cheese has thus an economical value that no other animal food possesses. Flesh-meat, for instance, is so nearly perfect alone as an article of food, that it does not impart, as cheese does, an increased value to the commoner and cheaper kinds of food, and they do not serve to restore in it, as they do in cheese, the proper balance between the two classes of food-elements. Unlike cheese, beef has no surplus richness to spare for the improvement of those kinds of food that need enriching to make them fit for the sustenance of our bodies. So, when bread and potatoes are eaten with flesh-meat, their surplus elements of heat and respiration—starch and sugar—are wasted, and the only service they can perform in this connection is to supply the deficient bulk in the meat. Generally speaking, and especially in summer, we live too much on food which contains an excess of the elements that produce fat and support respiration, the surplus of which contributes nothing to the support of life; and an article of food that will restore to such other food the missing flesh-formers ought to be better appreciated and more plentifully consumed. Cheese will do this more cheaply and effectually than anything else that is equally available, and we therefore advance its claims with confidence to the notice of our readers.

In one respect cheese is unique among our many kinds of food. We have spoken before of the singular agent by which milk is coagulated, both in digestion and in cheese-making. This agent consists, as we have said, of infinitesimal globules, so minute that a single drop of rennet liquid contains hundreds of thousands of them. These organisms remain in the coagulum they have produced from the milk, and they are present in the cheese as it ripens, and until it is consumed, retaining their vitality till the last, but it has not yet been determined whether or not they increase in number in the cheese. When cheese is undergoing digestion in the stomach, the globules are set at liberty, their former condition of warmth being restored to them they at once resume their natural activity, and become valuable in assisting to digest other food as well as the cheese that contained them. That ripe cheese does really contain these globules or organisms is proved by dissolving a piece of it in tepid water; the solution will coagulate milk just in the same
INTRODUCTION.

way that the original rennet did, if it is applied to new sweet milk at the usual temperature of 80° Fahr.; and that it will really assist in the digestion of other food is equally true, though not so easy of demonstration. Scientific truths have often been hit upon and practised for centuries before the why and wherefore of them have been made plain. In many cases science does not so much invent as explain what has been invented long before by instinct and necessity. Thus it is that the practice of eating a morsel of ripe old Stilton after a heavy dinner, long established and almost universal in society, has only in recent years been proved by science to be based on sound dietetic principles—the cheese aids the digestion of the other food. The pungent taste which is generally found in over-ripe cheese is owing to the presence of ammoniacal salts. During the ripening of the cheese a portion of the casein undergoes decomposition, and is partially changed into ammonia; the ammonia, though an extremely volatile essence, does not escape, but combines with several fatty acids which are formed from the butter in the cheese. The longer the cheese is kept, within reasonable limits, the riper it gets, and the greater is the accumulation of these peculiar ammoniacal salts. In a thoroughly ripe, well-kept, and sound old cheese, the ammonia is not in a free state, but exists in the form of salts, of which the base is ammonia in combination with butyric, caprinic, caprylic, and other acids produced from the fats of which the butter is composed.

The milk of sheep and goats and cows has been, from the earliest times that have bequeathed a history to us, a favourite article of food for man, and the oldest extant writings make not infrequent mention of cheese, though, perhaps, nothing more than mention. It was a common article of food among the ancient Greeks, Romans, and Jews. The oldest poet-historian of the world, Homer, sings of the virtues of milk and cheese, in connection with the feasts of the warriors of Troy:

"There thrice within the year the flocks produce,
Nor master there nor shepherd ever feels
A dearth of cheese, of flesh, or of sweet milk
Delicious drawn from udders never dry."

Odyssey (Cowper’s Translation), Book 4

In the Bible it is stated that Jesse commanded his son David to “carry these ten cheeses unto the captain of their thousand, and look how thy brethren fare.” And, again, they brought “honey, and butter, and sheep, and cheese of kine for David, and for the people that were with him, to eat.” In the extreme north of the world the Laplanders from an early period have made cheese of the milk of the reindeer, and used it not only as an important article of food, but a medical remedy applied to a frozen limb—the cheese is melted and the limb anointed with it. These primitive people coagulate the milk with the sap of the plant butterwort (Pinguicular vulgaris). In Stephens’ “Book of the Farm,” pigs’ stomachs are recommended for the purpose of coagulating milk in cheese-making, and it is said that some persons believe they will make stronger rennet than the ordinary kind. Lambs’ stomachs, and, in fact, the stomach of any young animal of the order Mammalia, will also coagulate milk. But calves’ stomachs are the only ones that are at all generally used for that purpose; and all other kinds, if used at all, are used only in special districts, or for the purposes of experiment.

OLEOMARGARINE CHEESE.

Oleomargarine cheese is one of the many singular productions of modern times. The high price of butter in late years has led to its introduction. When fresh-milk butter fetches thrice as much per pound as cheese does in the market, there is great inducement for cheese-makers to take, at all events, a portion of the cream off the evening’s milk; and cheese deprived of its fats is not only less valuable in proportion to the quantity of them that has been removed, but it will not ripen properly unless some special provision is made to help it. To remedy the defective ripening of skim-milk cheese, Mr. H. O. Freeman, of Sherburne, N.Y., devised the plan of restoring, by artificial means, the fatty element of which the cheese had been deprived by skimming the cream off the milk. His plan is to mix with the skim-milk, just before adding the rennet to it, some clean cheap fat, such as rancid butter that has been purified, or oleomargarine derived from beef.
suet. We are not aware that oleomargarine cheese has ever been made in England; but in America it has been made in considerable quantities, and some of it is so close an imitation of full-milk cheese in quality, texture, appearance, and even in flavour, that only an expert can at once tell one from the other. There has been much discussion and controversy among cheese authorities on the other side of the Atlantic as to the merits of this oleomargarine cheese. It has its friends and its enemies. It has been vigorously attacked, and as vigorously defended; and now awaits the decision of that final court of appeal in such cases—public opinion! We think there is no need for controversy as to its merits or demerits—discussion ought to suffice; for, after all has been said and done, this kind of cheese is a perfectly wholesome article of food, and, so long as it is honestly made and as honestly sold, it is a legitimate addition to our food—supply that may justly claim to stand or fall on its merits. But if it comes to be palmed off on the public as pure-milk cheese, it at once forfeits its claim to be treated with fair-play; and we are afraid that some injudicious makers of it will endeavour to pass it off under a designation which is not correct.

Butter.

By all civilised nations butter is now used very extensively as an article of food, and wherever refined taste exists it is held in high estimation as one of the chief delicacies of the age. It is always found on the tables of the wealthy and refined, the peer and the peasant alike are familiar with it, and if we were deprived of it, its absence would create a void that could not be filled. Used in a great variety of forms, it has long been indispensable in the art of cookery. It is employed in some shape or form in almost every kind of prepared food, and there are few dietetic luxuries that are not more or less indebted to it. Everyone knows that butter is obtained from milk, or the cream of milk, by means of violent agitation in a churn. The end and aim of this violent agitation are to break the casein-shells of the minute milk or cream globules which contain the mixture of fatty matters that go to make up butter. These globules are a trifle lighter than the liquid portion of the milk, and they consequently—the larger and better part of them, that is—rise to the surface if the milk is allowed to remain at rest for some hours, and having so risen they are called "cream." The cream being skimmed off the milk, leaves the latter poorer in quality and less opaque in colour, for the colour of milk is owing in part to the cream globules it contains, as its chief richness is owing to the fats they contain.

We are told by Dr. Voeleker that "butter consists mainly of a mixture of several fats, amongst which palmatin, a solid crystallisable substance, is the most important. Palmatin, with a little stearine, constitutes about 65 per cent. of pure butter. Mixed with these solid fats are about 30 per cent. of olein, a liquid fatty matter, and about 2 per cent. of odoriferous oils. The peculiar flavour and odour of butter are owing to the presence of this small proportion of these peculiar oils—viz., butyrin, caproin, and caprylin. In butter, as it comes to our table, we find, besides these fatty matters, about 16 to 18 per cent. of water, 1 to 2 per cent. of salt, and variable small quantities of fragments of casein-shells. The more perfectly the latter are removed by kneading under water, the better butter keeps; for casein, on exposure to air in a moist state, especially in warm weather, becomes rapidly changed into a ferment, which, acting on the last-named volatile fatty matters of butter, resolves them into glycerine and butyric acid, $C_8H_{16}O_4$; caproic acid, $C_{12}H_{22}O_3$; and caprylic acid, $C_{16}H_{32}O_4$. The occurrence of these volatile, uncombined fatty acids in rancid butter not only spoils the flavour, but renders it more or less unwholesome."*

The demand for butter will always be great, and if the public could always procure sweet-flavoured, pure, firm, and well-made butter, the consumption per capita would be much larger than it is. As in milk and cheese, so in butter, a pure and genuine article always secures a large

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* Journal of the Royal Agricultural Society, First Series, 1863, p. 201. It will be seen that the composition of these acids is identical, though the proportions are different. The meaning of the above symbols is that butyric acid consists of 8 atoms or parts of carbon ($\text{C}$), 8 of hydrogen ($\text{H}$), and 4 of oxygen ($\text{O}$). Caproic acid is formed by the addition of 4 atoms of carbon and hydrogen to the same quantity of oxygen; and caprylic acid absorbs yet an additional 4 atoms of the same substances.
INTRODUCTION.

and unflagging demand. And butter is so delicate a production that it is easily spoiled in the making, if great care, method, and cleanliness are not observed.

Some years ago we knew a widow lady whose butter, especially with respect to flavour, was always of a very superior kind. We asked her what her secret was, for we had never tasted such butter in a farm-house. "I have no secret," she said, "butter-tower,"—I am always very particular about keeping thoroughly clean every vessel with which the milk and cream come in contact. I frequently have them well scalded with boiling water, well scrubbed with a hard brush, and well rinsed in clear, cold water; and I am also careful to keep the milk-room clean and dry, and well supplied with fresh air. I am not aware that I have any secret beyond this—in fact, there is no secret in the matter." True, no secret this, yet it is the whole secret of the matter! We may add that this lady had only for a short time been used to such matters; she was only for the time being taking charge of the household of her bachelor son, who had taken to dairy-farming as a pursuit in life.

That butter was known to the ancients is proved by the frequent references to it which are found in the oldest writers, but how the production of it was first discovered is a problem that will never be solved. It is, however, probable that the discovery was accidentally made—in the carrying of milk in skins slung over horses' backs or otherwise. By the Arabs in Barbary, and by the natives of Caffraria, butter is to this day churned in goat-skins, which are suspended by the legs from boughs of trees, and swung backwards and forwards until the butter comes. In the Levant it is produced by securing the cream in skins, and then treading on them with the feet; and in India by simply turning a stick round in the milk.

The principal use of butter among the ancient Greeks and Romans was as an ointment and a medicine. The latter anointed the bodies of their children with it to make them pliable, and it was commonly used in many countries in those early times as hair-oil. The Greeks are said to have been made acquainted with it by the Scythians, Thracians, and Phrygians, and the Romans by the Germans. Noble ladies in the olden times used it as a dressing for the hair, for Plutarch relates that a Spartan lady paid a visit to Berenice, the wife of Dejotarus, and that the former smelled so much of sweet ointment, and the latter of butter, that neither of them could endure the other. It was, in fact, seldom used as food in the old countries of Southern Europe, olive-oil being used in place of it; and even in the present day it is but sparingly used as food in Italy, Spain, Portugal, and the southern parts of France.

The ancient Christians are said to have burnt butter in their lamps, instead of oil; and in later times it was used for the same purpose in the Catholic churches of France, in order to lessen the consumption of olive-oil. There is a tower on the Cathedral of Rouen called the "butter-tower," from the fact that the Archbishop of Rouen, in A.D. 1500, finding the supply of oil to fail during Lent, permitted the use of butter in lamps, on condition that each inhabitant should pay six deniers, with which money the tower was built. There are other "butter-towers," at Notre Dame, Bourges, &c.*

Oleomargarine Butter.

Oleomargarine butter is now extensively made in America and on the continent of Europe. Not cheese only, but butter is now produced in part in an artificial manner, and by aid of a substance which, though not foreign, is still an adulteration. Several years ago, M. Mége Mouriez made many experiments in the attempt to find a substitute for butter, which might be used in the French army and navy. He came to the conclusion that the butter in milk was elaborated from the fat of the animal that gave the milk, and that by melting beef fat at a moderate temperature, an oil almost identical with the fats of butter would be produced. Pursuing his experiments, his expectations were so far realized that this oil of fat, when churned along with some milk, yielded a product that was accepted by the French authorities as a substitute for butter. Some years ago the manufacture of this artificial butter had made considerable progress both in France and Germany. It grew into general use on European coasting steamers, and was

* Scientific American, Oct. 25, 1873.
DAIRY FARMING.

exclusively used in the French navy, notwithstanding occasional protests. About 1874 the United States Dairy Company purchased the right of its manufacture, and a very large quantity of it is being made in factories in New York and New Jersey. As in the case of artificial cheese, it has been the cause of a great deal of discussion, some of which has not been of a very friendly kind, but its merits have been to a certain extent recognised, and its consumption has increased. Mr. L. S. Hardin, who is an authority on American dairying, says of it:—“It has one quality that will make it a dangerous rival with even the highest grades of butter, and that is its keeping quality. Being only tallow to begin with, after the severest test it remains only tallow, while even the best butter rapidly changes its chemical nature after it has once entered the field of dissolution. In texture, colour, and quality, aside from its excellent keeping quality, this oleomargarine butter is not only a dangerous rival for the higher grades of butter, but I am most seriously alarmed lest it should supersede our farm-butter altogether.”

There is a greater quantity of this butter, made principally on the Continent, and sold in the English market, than people generally are aware of. We do not consider this in itself an evil, because it becomes each year more difficult to produce real butter in quantity sufficient to meet the public demand; but we must record a strong protest against the gross commercial immorality which is involved, not in the manufacture of this artificial butter, but in palming it off on the public as genuine milk butter. The manufacture of this butter, and the sale of it, under existing conditions of demand, are equally justifiable; what is not justifiable is the sale of it under a false and deceptive designation. Artificial butter as such, and when sold as such, is a perfectly legitimate element of commerce, and when made by a sound and careful process may be credited with being an honest supplement to the list of our pre-existing foods; but there is much of it now in the market that is not so manufactured, and that is quite unfit to be considered a fair article of food.

Artificial butter, made from good beef or mutton fat, and by a careful and correct method, whether sold to be eaten as it is, or to be used by pastry-cooks, is a product for which there is an opening that is likely to become larger each year; but it will be incumbent on those who are on the look-out for adulterations to narrowly watch the artificial butter market. The method of its production is one that admits of, and induces, the employment of improper and dangerous material; and if watered milk brings the lash of the law on those who water it, we may reasonably expect that they shall not escape who make or sell artificial butter that is not what it ought to be. At the same time, the production of a genuine article—an article, that is, made from sound materials—may very properly be encouraged, providing always that it is not sold under false pretences. Such an article as this may fill most of the purposes to which inferior milk-butter has been applied; and in that event, which we think is most likely to happen—which has already happened to some not inconsiderable extent—it will be necessary that those who make milk-butter should in all cases take the pains that are necessary to the production of a first-class article. Longer marches than ever are now-a-days being stolen on those who, from good raw materials, produce inferior manufactured goods. What were formerly waste, or next to waste, materials are now utilised and made to serve important ends. This is the case now in oleomargarine cheese and butter; in metallurgy, and in the manufacturing arts generally, it has been the case for a long time.

IMPORTATIONS OF DAIRY PRODUCE.

A good many years have passed since cheese was first imported into this country from America, the first shipment coming to us in the year 1830. In less than twenty years the quantity imported per annum had risen to about 15,000,000 lbs.; in ten years more it had fallen back to some 5,000,000 lbs.—this was in 1858. Since that period the factory system of cheese-making has grown up in America; the quantity of cheese made has greatly increased, while its quality has no less greatly improved; and we are now importing American cheese to the extent of 115,000,000 to 120,000,000 lbs., or about fifty-three thousand tons, per annum. There can be no doubt that to the factory system is wholly due the marked improvement in quality, and
INTRODUCTION.

in a great measure the increase in quantity, which have taken place in both American and Canadian cheese in late years. It was in the year 1851 that Jesse Williams built the first cheese-factory in the United States, near Rome, Oneida County, N.Y.; and in less than ten years afterwards factories had begun to multiply rapidly in the States. Seven or eight years later the first Canadian factory was built, at Ingersoll, Ontario. These times mark the period from which dates the rapid increase in the exports of cheese from the two countries respectively. The importation of cheese from Canada is hence much more recent than from the States; in 1864 it had barely commenced, even if it had commenced at all, and five years later it had only risen to some 4,000,000 lbs.; but since that date Canada has been coming rapidly to the front in many ways with respect to the amount of her exports, and we are now receiving from her more than 30,000,000 lbs. of cheese, or over sixteen thousand tons, per annum. From European countries we are importing about 64,000,000 lbs., making a grand total, from all sources, of nearly 220,000,000 lbs., or ninety-eight thousand three hundred tons, per annum. Our annual home production of cheese we have estimated at one hundred and twenty-six thousand tons, which is about one and a quarter times the amount of our importations. The total quantities of cheese, and their value, imported annually into this country, for a period of sixteen years, and from all sources, are given in the following table:—

<table>
<thead>
<tr>
<th>Year</th>
<th>Quantity</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1863</td>
<td>756,285 cwt.</td>
<td>£1,866,887</td>
</tr>
<tr>
<td>1864</td>
<td>834,844</td>
<td>2,176,248</td>
</tr>
<tr>
<td>1865</td>
<td>833,277</td>
<td>2,463,299</td>
</tr>
<tr>
<td>1866</td>
<td>872,342</td>
<td>2,801,579</td>
</tr>
<tr>
<td>1867</td>
<td>905,476</td>
<td>2,555,265</td>
</tr>
<tr>
<td>1868</td>
<td>875,287</td>
<td>2,565,213</td>
</tr>
<tr>
<td>1869</td>
<td>978,189</td>
<td>3,083,850</td>
</tr>
<tr>
<td>1870</td>
<td>1,041,281</td>
<td>3,274,331</td>
</tr>
<tr>
<td>1871</td>
<td>1,216,400 cwt.</td>
<td>£3,341,496</td>
</tr>
<tr>
<td>1872</td>
<td>1,057,883</td>
<td>3,031,977</td>
</tr>
<tr>
<td>1873</td>
<td>1,256,728</td>
<td>4,001,456</td>
</tr>
<tr>
<td>1874</td>
<td>1,485,265</td>
<td>4,483,927</td>
</tr>
<tr>
<td>1875</td>
<td>1,627,748</td>
<td>4,709,508</td>
</tr>
<tr>
<td>1876</td>
<td>1,591,201</td>
<td>4,237,763</td>
</tr>
<tr>
<td>1877</td>
<td>1,651,088</td>
<td>4,703,053</td>
</tr>
<tr>
<td>1878</td>
<td>1,965,949</td>
<td>4,939,009</td>
</tr>
</tbody>
</table>

And the quantities and values of butter importations through a corresponding period are similarly given in the subjoined statement:—

<table>
<thead>
<tr>
<th>Year</th>
<th>Quantity</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1863</td>
<td>864,708 cwt.</td>
<td>£1,537,157</td>
</tr>
<tr>
<td>1864</td>
<td>1,034,617</td>
<td>5,622,704</td>
</tr>
<tr>
<td>1865</td>
<td>1,093,717</td>
<td>5,943,884</td>
</tr>
<tr>
<td>1866</td>
<td>1,165,081</td>
<td>5,962,455</td>
</tr>
<tr>
<td>1867</td>
<td>1,142,262</td>
<td>5,841,271</td>
</tr>
<tr>
<td>1868</td>
<td>1,097,549</td>
<td>3,640,718</td>
</tr>
<tr>
<td>1869</td>
<td>1,159,089</td>
<td>6,023,210</td>
</tr>
<tr>
<td>1870</td>
<td>1,159,210</td>
<td>6,793,877</td>
</tr>
<tr>
<td>1871</td>
<td>1,334,783 cwt.</td>
<td>£6,839,040</td>
</tr>
<tr>
<td>1872</td>
<td>1,138,081</td>
<td>6,928,474</td>
</tr>
<tr>
<td>1873</td>
<td>1,279,506</td>
<td>6,956,594</td>
</tr>
<tr>
<td>1874</td>
<td>1,619,508</td>
<td>9,050,025</td>
</tr>
<tr>
<td>1875</td>
<td>1,467,870</td>
<td>8,502,048</td>
</tr>
<tr>
<td>1876</td>
<td>1,659,492</td>
<td>9,718,226</td>
</tr>
<tr>
<td>1877</td>
<td>1,637,939</td>
<td>9,583,305</td>
</tr>
<tr>
<td>1878</td>
<td>1,795,413</td>
<td>9,940,412</td>
</tr>
</tbody>
</table>

It will be seen in the foregoing tables that our importations of butter approach those of cheese in actual weight, while their value is nearly twice that of the cheese. Our exports of cheese and butter are comparatively insignificant. For the year 1878 our exports of cheese were 16,522 cwt., valued at £66,001; and of butter 36,520 cwt., valued at £243,032.

In 1862 our importations of bacon and hams amounted to 1,345,694 cwt., the value of which was £2,477,005; in 1878 they had risen to 4,263,901 cwt., the value of which was £5,611,500. In 1862 our importations of pork were 227,758 cwt., the value of which was £499,018; in 1878 they had risen to 369,500 cwt., the value of which was £611,024. In 1862 our importations of lard were 530,090 cwt., of the value of £1,121,059; in 1878 they had risen to 908,157 cwt., of the value of £1,756,925. In 1862 our importations of eggs amounted in number to 232,321,200, and in value to £533,813; in 1878 they had risen to 783,484,320, the value of which was declared to be £2,511,922; and the value of poultry has increased so rapidly even of late years, as to have risen from £72,426 in 1876 to £125,521 in 1878.

A short inquiry into the origin of soils cannot fail to be both instructive and interesting, and our work will therefore treat of their formation and distribution, explaining their properties
and peculiarities. We shall speak of the soils and climates that are best adapted to dairying, and of the methods of increasing the adaptation of those to which Nature has not given the best properties for the purpose; the exhaustion and improvement of soils will also engage our attention, along with the best methods of cultivation and treatment employed on dairy-farms, and including the application and treatment of manures both natural and artificial; and, lying at the foundation of all good husbandry on wet soils, we shall devote considerable space to the subject of draining, describing its methods and explaining its principles. So far the soil. The various cultivated crops found in the best dairying districts, including roots, artificial grasses, leguminous plants, cereals, &c., and also weeds and worthless grasses, will receive due attention; while the botanical aspects of this section, so far as they are useful to the agriculturist, will be handled in a manner at once scientific and popular. Dairy-homesteads, farm-buildings, fences, shelter, the supply of water, &c., will be illustrated and described. The various races, breeding, and selection of cows for dairy purposes, with their feeding and treatment through the different parts of the year, will be fully explained in the letterpress, and by the aid of illustrations supplementary to the text. Milking, the rearing and feeding of calves, and the general treatment of stock both young and old, will receive the amount of attention they merit. The various purposes to which dairy products are devoted, the ways in which they are disposed of, and the commercial aspects of dairy-farming in its different branches, will be fully explained; and, lastly, the supplementary stock appertaining more or less specially to dairy-farming will be dealt with in as liberal a manner as our space may be found to admit of. We trust on these bases to present to our readers a comprehensive and painstaking work descriptive not only of the duties and conditions, the benefits and the drawbacks, but also of the elements of success, as well as the causes of failure that, separately and jointly, fill in and rule the life of a dairy-farmer. We are assisted in these matters by eminent authorities in various countries, each of whom writes on the subject with which he is specially acquainted; and, for ourselves, our part has lain in arranging the matter we have had contributed by others, and in writing on the several topics with which we happen to be familiar. The object we have in view is to promote the lively interest which, in places, has begun to attach to dairy-farming; to keep alive the spirit of improvement which is manifesting itself in various ways; to place before the public an account of the various methods of making cheese and butter in different countries, as well as in different parts of our own country, describing all the modern features and improvements, and illustrating the best of the various improved and newly-invented machines, implements, and utensils which find favour with the more advanced dairy-farmers of the present day; to trace out the "new departures" into which dairy-farming has developed, or is developing; and to give a general presentation of the whole subject in such a manner that those interested may derive from our work instruction and assistance.

J. P. S.
Dairy Farming.

Chapter 1.

Breeding and Selection of Dairy Cattle.

The Practical Difference between Good and Bad Stock—Illustrated by Cases—Importance of Breeding for Milk in Pedigree Stock—Examples—Pedigree Breeding an Art—Main Principles of Breeding—All Animals tend to Produce their Like—Breeding Consists of Accumulating the Tendencies of Successive Generations in One Direction—In-Breeding and Crossing—Evils of Both—Means of Avoiding them, by Crossing Families—Effects of a "Raw" Cross—These Principles Applicable to the Breeding of Dairy Stock—Directions for the First Selection—Practical Remarks.

Several things contribute more to a dairy-farmer's success than skill in selecting and breeding his dairy-stock. Some men possess this skill in a high degree intuitively; others acquire it by careful observation and long-continued experience; others, again, never can or do attain it; but, however it may come into a man's possession, it is no mean element in his success. We may lay it down as a first principle that a farmer may just as well have a good class of stock as a poor one. The land that will maintain twenty common-bred cows will maintain twenty well-bred ones, and the annual profit from the latter will be considerably more than from the former. It is, in fact, a dead loss to keep common, weedy animals in the place of good ones; and the sum of that loss is just the difference in the net profit which the two kinds respectively give to their owners. As this difference is a serious one, let us see in what it consists.

It is a fact, so well ascertained as to be no longer disputed, that some cows will yield more milk than others will on a given quantity and quality of food; and it is no less true that they will yield more beef under like conditions. This superiority consists in the greater ability of the one than the other to convert the food she eats into milk or meat, or both these, for some animals possess a high order of merit in both departments. It does not matter what kind and quantity of food you give to some cows, they will neither milk nor fatten satisfactorily on it; while others will do both in a high degree. It is the same with an animal as with a steam-boiler—the more complete the combustion of the food or fuel it gets, the more satisfactory will be the result, because there is less waste. And animals can be bred up to this just as surely as steam-boilers can be constructed up to it; it is a mere question of skill in breeding on the one part, and of construction on the other.

Again: dairy-cows are essentially food-consumers and food-producers, and the more food an animal can consume in a given time, providing she produces a relatively large proportion of milk or beef in return for it, the more profitable will she be to her owner. This is mainly a question of soundness of constitution and strength of digestion. And, further than this, it is an easy matter to reach the limit of production that an inferior animal is capable of. She can only take a given quantity of food, making an inferior use even of that; while a really good animal will not only eat more food, but will put what she eats to a more profitable purpose. An ill-bred one will not take much more food than is required to make good the wear and tear of her body, and it is only from the food over and above this that
the farmer derives his profit. All cows have to live, first of all, from the food they eat; and, when the requirements of life are met, the rest of the food consumed goes, or should go, to the production of milk or of beef. The object is to secure such animals as will not be content with merely living, but will put in plenty of overtime for the benefit of their owners; in other words, cows that will consume food enough to make a profit, turning that food to the best possible use, and not make a beggarly return for the advantages placed before them.

To illustrate the difference between a good dairy-cow and a poor one, we will state two cases in which both animals are fed up to their capacity, showing the difference in result:—

<table>
<thead>
<tr>
<th>Cow No. 1</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr.—To ordinary keep, ad. lib., for one year</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>14</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>To extra food, corn, &amp;c.</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cr.—By one calf</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>By 400 gallons of milk, at 8d.</td>
<td>13</td>
<td>6</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit</td>
<td>14</td>
<td>6</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cow No. 2</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr.—To ordinary keep, ad. lib., for one year</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>17</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>To extra food, corn, &amp;c.</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cr.—By one calf</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>By 700 gallons of milk, at 8d.</td>
<td>23</td>
<td>6</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit</td>
<td>25</td>
<td>6</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These are not by any means extreme cases, though imaginary ones; for many cows give less than 400 gallons of milk, whilst others give more than 700 gallons in a season. Instances are on record where cows have produced each 500 lbs. of butter in one year; and as a pound of butter requires from two to three gallons of milk on the average, it is evident that these cows must either have given much more than 700 gallons of milk, or that the milk was of unusual quality.

In the breeding of pedigree cattle of any kind, particularly Shorthorns, the milking property has been too much sacrificed to beauty and symmetry of form. The fabulous prices which animals of certain tribes commonly fetch have made the question of milk appear one of small importance, and the consequence is that not only are these animals not bred to milk, but their properties as milkers are seldom if ever inquired into by those who buy them. This neglect of breeding for milk, and the breeding instead for heavy flesh, light bone, symmetry of form, beauty of expression and skin, and early maturity, has been carried to such a length that many of our pedigree Shorthorns have not milk enough to rear their own offspring, and foster-mothers have to be provided for the calves. It is a question worthy of investigation how far the milk of a foster-mother, especially if she is a common-bred cow, influences the purity of breed in the calf that is reared upon it, and we are not aware that it has as yet had much attention, if any, devoted to it. Be this as it may, however, it is none the less a pity that the question of milk has been so far ignored in the breeding of pedigree stock; not alone because certain families of pedigree Shorthorns are still remarkable for the quantity of milk which some of the cows give, but also because pedigree blood is now being largely introduced into the general dairy-herds of the country, which it cannot fail to injure in the milk department whenever it comes from a poor milking family. Three-quarters of a century ago the Durham cows, from which all our Shorthorns have descended, were celebrated as much for the quantity of milk they gave as for their capacity to fatten quickly; and as some of their descendants still possess both these properties, in addition to beauty and symmetry of form, there would seem to be no reason to doubt the possibility of breeding for milk, in addition to the other excellences for which Shorthorns are so deservedly famous.

There are, however, among our most famous breeds of dairy-cows, two conspicuous exceptions to this rule of not breeding for milk in pedigree stock. The Ayrshires and Channel Islanders have many pedigree families among them, and great attention has been paid for a long period to purity of blood. But in all cases milk has been placed first in the list of the merits for which these cattle are distinguished, and the result is that we have in the two breeds, though they differ widely from each other, the highest embodiment of what dairy-cows ought to be according to British and American notions. Nor has symmetry of form been lost sight of in the breeding of these cattle, yet the standard of
symmetry differs very widely from that of the Shorthorns. Milk is the chief object, form next; but the form is specially adapted to milk, differing in this from the Shorthorns, whose form is specially adapted to beef. In each case the object to aim at is well understood, and in each case perfection has been attained—so far, at all events, as the model is concerned.

The breeding of pedigree stock is an art, and a high form of art too; it is the guiding, controlling, and developing of some of the hidden principles of nature, so as to produce animal forms that are as nearly as possible perfect; it is an art, to succeed in which in a high degree needs much thought and experience. Nothing short of a careful study of pedigree, and of the laws which govern the economy of animal reproduction, will enable a man to tell, with anything approaching to accuracy, what will be the result of a cross between two animals of different families which are distinctly or not at all related. Sometimes the most promising and likely mating of two animals will turn out in the offspring to have been a misfit, while in other instances the results will be more satisfactory than could have been expected. We cannot pretend here to give more than an outline of the leading principles involved in the breeding of pedigree cattle, and we should not have done even this were it not the fact that many dairy-farmers now-a-days breed their stock on recognised principles and with almost as much care as pedigree Shorthorns; in fact, there are many carefully-bred herds of dairy-cows with long and respectable pedigrees in their owners' herd-books, though perhaps they have no place in the official herd-book of the breed.

From a letter addressed by Sir John Saunders Sebright to the Right Hon. Sir Joseph Banks, under date August 1st, 1809, we take the following extracts:—“Were I to define what is called the ‘Art of Breeding,’ I should say that it consisted in the selection of males and females intended to breed together, in reference to each other's merits and defects. It is not always by putting the best male to the best female that the best produce will be obtained, for should they both have a tendency to the same defect, although in ever so slight a degree, it will generally preponderate so much in the produce as to render it of little value.

“A breed of animals may be said to be improved when any desired quality has been increased by art beyond what that quality was in the same breed in a state of nature. What has been produced by art must be continued by the same means, for the most improved breeds will soon return to a state of nature, or perhaps defects will arise which did not exist when the breed was in its natural state, unless the greatest attention is paid to the selection of the individuals who are to breed together.

“We must observe the smallest tendency to imperfection in our stock the moment it appears, so as to be able to counteract it before it becomes a defect; as a rope-dancer, to preserve his equilibrium, must correct the balance before it is gone too far, and then not by such a motion as will incline it too much to the opposite side. The breeder's success will depend entirely upon the degree in which he may happen to possess this particular talent.

“Regard should not only be paid to the qualities apparent in animals selected for breeding, but to those which have prevailed in the race from which they are descended, as they will always show themselves sooner or later in the progeny. It is for this reason that we should not breed from an animal, however excellent, unless we can ascertain it to be what is called ‘well-bred,’ that is, descended from a race of ancestors who have through several generations possessed in a high degree the properties which it is our object to attain.

“The offspring of some animals is very unlike themselves; it is, therefore, a good precaution to try the young males with a few females the quality of whose produce has been already ascertained; by this means we shall know the sort of stock they get and the description of females to which they are best adapted.”

The Theory of Breeding.

It must always be borne in mind that “like produces like”—that is, some influence is always exerted by the parents on the offspring. But this is much stronger in some cases than in others. In some instances the influence of the parents is so strong that they produce an almost exact likeness of themselves, or of one of them. In other cases the immediate influence of the parents in stamping their own individual peculiarities on their offspring is smaller than some dormant influences which, though unperceived in themselves, they
have inherited from their ancestors. Thus the offspring are liable to inherit not only the evident peculiarities of their parents, but also the dormant properties which come from ancestors ten or twenty generations back. Still, however, it is not often, except in the case of parents whose own influence is not vigorous, that these ancestral traits appear in any marked degree through more than four generations.

The capability of a bull to transmit to his offspring his own peculiar properties, or mould, or excellences of any kind, depends on his having inherited them from a succession of ancestors endowed with similar characteristics. Thus it follows that the older the pedigree of any tribe or family of animals which have been carefully bred with a view to the development of certain superiorities and to the eradication of certain inferiorities, the less likely will any of the offspring of that tribe or family be to go back to remote ancestors for certain peculiarities which are rightly supposed to be dormant or dead. And thus "careful breeding" consists in not breeding from any animals which exhibit tendencies to "throw back," as it is termed, to original imperfections—to breed from those only in whom the various excellences we are trying to establish and secure are most strongly marked, and in whom the deficiencies we are aiming to eradicate do not reappear. By this system only can "pure blood" be attained; and by "pure blood" is meant a sure succession of a combination of excellences, accompanied by no deficiencies of importance.

The task of the breeder would be a simple one if he wished to secure only one point of excellence in his cattle; but as no beast is perfect by the possession of one excellent point only, so it is necessary in breeding to aim to secure the many and various points, each and all of which are indispensable to the perfect animal. So in mating a male and a female animal together, it is necessary that the ancestry of each should be thoroughly known for at least four generations. It is not enough to know that the two animals themselves possess certain combinations of characteristics which would seem to fit them to produce superior offspring; it is not enough that one of them is especially excellent in certain points in which the other is deficient, and vice versa; but it is also necessary to ascertain how far, by previous careful breeding, the various excellences they possess deserve to be regarded as fixed. It is also expedient to know for how many generations the deficiencies which were common to the remote ancestry of the tribe have been practically obliterated, have been dormant—dead.

"Distinctness of type" is secured by the same means as "pure blood," but it cannot be regarded as fixed until several generations have shown no tendency to depart from it. Both these mean a concentration of excellences and an exclusion of imperfections, made permanent, or fixed, by careful and exclusive breeding up to a given ideal.

In any case, it is a mistake to breed from weakly or delicate animals, for diseases and deficiencies lurk in them. Strong and vigorous animals, on the other hand, if well bred, are capable of very strongly impressing on their offspring those characteristics and qualities toward which their own breeding has been made to tend. This is very striking at times when a strong and well-bred bull has been mated with a common-bred and not too vigorous cow; the offspring often has all, or nearly all, the characteristics of the well-bred sire. But these characteristics in the offspring cannot be regarded as fixed in the sense they are in the sire, for it is only the first cross; and to obtain fixity of type in this new cross would require several more crosses through as many generations with pure-bred bulls. One of the chief disadvantages of close-breeding is that the animals lose more or less of vigour, and it is commonly found that the offspring of a cross between two animals not at all related to each other is more vigorous than either of the parents.

"In-breeding," as it is termed—that is, the breeding for a time amongst near relations—generally results mischievously on the systems and on the fertility of stock. Consanguinity of blood, though valuable in the formation of pure-bred types, and up to a given point, is a great evil if carried too far. The effects of too close in-breeding are most commonly tuberculosis, infertility, and general debility; and what is only a slight and transient form of disease in the first parents of that family may, and often does, become a fixed and severe form in succeeding generations—indeed, the same result may be developed from what at first is not a disease but only a weakened function. If the family is kept exclusively to itself in the breeding, this evil intensifies; if it is bred into other families, the evil tends to decrease.
It is an established fact that the breeding together of parent and progeny is almost always less injurious than that of brother and sister. This is easy to understand, for the evil results of in-breeding have not advanced so far in that case as in this—at all events, on one side. The evil effects of too close in-breeding are with difficulty postponed by killing off all the animals which exhibit any of them; they are only postponed, not eradicated—and you may go on weeding out till none are left.

The only method of obtaining pure blood, and at the same time of avoiding the evils of in-breeding, is to establish several families of the same tribe, or several branches of the same family, breeding them all carefully to one ideal or model, weeding out all animals which are delicate or which show a tendency to revert to original imperfections, and breeding only from the true and vigorous ones. These different branches of the same family having been kept apart, though bred to the same models, do well for crossing—or rather, for getting a little fresh blood from time to time of the same kind. But one great hindrance to this lies in the different ideals which different men set up, and the different methods by which they seek to attain them. If there were uniformity of taste, judgment, and method among breeders, there would soon be uniformity of result.

It will thus be seen that families proceeding from the same original stock—descending in parallel lines from common ancestors—being practically, and to all intents and purposes, of the same blood and breed, are most valuable for subsequent inter-mixing, with the view of maintaining the vigour without impairing the purity of the breed. This system, of course, confined as it is to the members of one family or of one tribe which are more or less closely related to each other, cannot strictly be called "crossing;" and yet by means of this system most of the benefits of crossing are secured, whilst its evils are avoided. By "evils" is here meant impurity of blood or breed.

In all breeding it is necessary to introduce fresh blood at times; and the skill of the breeder lies in his ability to select and introduce this fresh blood in such a manner that the vigour of the animals is increased, whilst their symmetry, if interfered with at all, is improved. And to this end animals are selected from other branches of the same family, or from a distinct though similar family, distantly or not at all related. These different branches of a family are sometimes produced for a deliberate purpose, with the view of subsequent re-intermingling of the blood.

One of the effects of introducing wholly fresh blood into a family is very curious, and it demands to be taken notice of by the breeder. In most cases, certain ancient characteristics of the breed are lying latent; they have been laid to rest by careful breeding against them. Mr. Darwin has established the important fact that crossing itself does undoubtedly give a more or less definite impulse towards characters long lost, but which were present in far back ancestry. Thus the tendency of introducing fresh blood, especially if it be a distinct cross and entirely unrelated, is to cause the offspring to "throw back," as practical breeders term it, to an earlier and unimproved type; and the consequence usually is that the first cross exhibits considerable "rawness," though it is as commonly greatly increased in vigour.

Thus, continual and rigorous in-breeding, on the one hand, produces, or rather develops, the inevitable "weak spot;" and, on the other hand, "raw crossing" causes the stock to revert back to the original condition of the breed. The breeder has to use all the acumen of which he is possessed in order to steer as clear as possible of both these evils, and he therefore avoids in-breeding too closely on the one hand, and too distinct crossing on the other. This is not difficult to accomplish in Shorthorn breeding, for as all the families are more or less related to each other, or are at all events bred up to one common model of perfection, crosses can be obtained, or rather fresh blood, without interfering in the least with the purity of the blood and breed.

The "principles of breeding," as here laid down, refer more particularly to pedigree stock, which must needs be bred with the greatest care and judgment to avoid disaster; but they are also generally applicable to the breeding of dairy-cows. It is the aim—not impossible of attainment—of our dairy-farmers, to produce dairy-cows that will possess both milking and fattening properties in a high degree—the highest attainable. Whilst a cow is kept in the dairy herd it is important that she should be a "deep milker;" and it is a matter only second in importance that she should be a good fatter when she goes barren, or when she is past the best as a dairy-cow. A dairy-cow is now no longer valuable on account of milk alone,
but also on account of beef; hence it follows that practical dairy-farmers must develop in the animals they breed not only good milking but good fattening properties. And it is not by any means impossible or even very difficult to do this; but it requires skill, judgment, and care, almost to the extent they are necessary in Shorthorn breeding. Pedigree breeding is a pursuit in which only the wealthy can engage; but there is room for the exercise of great skill in the breeding of ordinary dairy-stock.

Selection of Dairy Cows.

The first thing a young beginner must do is to select a number of good young dairy-cows, full of quality but not too full of condition. Good store condition is better than move—it enables the buyer to see what the animal really is. "Fat hides a many faults," and it is no good to pay dearly for superfluous condition in animals that are wanted for breeding purposes, especially when that surplus condition is detrimental to the object in view—viz., breeding. But the animals should come of a good stock, and should have plenty of quality. He should be careful to ascertain, if he does not already know, the "lines" on which, and the kind of stock from which, they have been bred, and he will then have a correct notion as to how far their qualities may be regarded as fixed and transmissible. The next thing to do is to select a bull from a still better family than the cows, for in this way the herd may be improved by the introduction of superior blood through the agency of one animal only. The first male will have a most important influence on the herd, and it is "penny wise and pound foolish" not to get a really good and suitable one, even though he costs fifty or sixty guineas; for if there are twenty-five or thirty cows to put him to, it will be only two guineas per cow, and will generally be repaid in the first crop of calves.

The cows selected should have well-rounded, robust-looking frames, indicating a strong and vigorous constitution; the back and loins should be level and wide; the legs moderately short, with a fair amount of bone; the fore-quarters should be deep, wide, and finely moulded; the hind-quarters massive, well filled in with flesh, wide, and deep; the tail set on squarely, and the flanks well let down; the neck should be fine, fairly long, and elegant; and the face should have a distinctly feminine appearance, for a masculine-looking cow, with a heavy muscular neck and a massive clumpish head, is never a good milker, however well she may lay on flesh. And last, though not least, the udder should be well formed and the teats squarely set on.

The bull selected should be symmetrical, vigorous, fleshy, of good girth, strong in his loins, of good constitution, well developed in his quarters, and stout and strong on his legs; his head and neck should be massive and masculine-looking, and he should come of a good milking family. In cows and bulls alike a good constitution is indicated by a well-rounded form, the lustre and oiliness of the hair, and the prominence and brilliancy of the eyes; and quality is ascertained by the general appearance of the animal, and the softness and mellowness of the skin under the hand.

A great deal of discussion has been raised in recent years, particularly in America and France, on the "milk mirror," or "escutecheon" theory of M. Guenon, as indicating the milking capacity of a cow. It relates to the various appearances of the hair on the thighs and udder. In Fig. 1 (taken from Arnold's "American Dairying") it will be seen that a considerable portion of the hair on the udder and thighs lies differently from what might be expected; the slope of it, instead of downward, is upward and outward. This reversed hair is the so-called "escutecheon." If the space covered by the reversed hair, especially in the portion above the udder, be large and broad, so that it extends far outward on the thighs, the cow is said to be a good milker; and if the upper part is broad and smooth, she will give a good flow of milk prolonged late on in the season. If, on the contrary, the reversed hair occupies but a small space below, and is narrow and irregular above, it is said the cow will not give a large flow of milk, either for a short or a prolonged period. Professor L. B. Arnold says:—"The connection of the 'escutecheon' with the flow of milk is accounted for by Magne, who says that the hair turns in the direction in which the arteries ramify, and that the reversed hair on the udder and adjacent parts indicates the termination of the arteries which supply the udder with blood. When these arteries are large they are not confined to the udder, but extend down through it and upward and outward, ramifying on the skin beyond the
udder, giving the hair the peculiar appearance which distinguishes it from the rest of the surface. If the arteries supplying the udder with blood are very small, they are not likely to extend much beyond the udder, and hence form a small escutcheon. Hence a small escutcheon indicates a feeble supply of blood to the udder, and consequently but little material to make milk of, and hence a small flow of milk. Guenon studied and explained these marks only as they appear on the hind part of the bag, and the marks noticed by him were supposed to apply to the whole udder. This could not well be true. Each quarter of the udder is supplied with blood by a distinct and separate arterial branch, and they may, and often do, vary considerably in size in the respective quarters of the bag. Those supplying the two hind quarters of the bag are usually larger than those which supply the front part; but sometimes the reverse is true, in which case the marks on the back part of the bag would not be a correct indication of the front part, and so with other inequalities. Each quarter of the bag has an escutcheon for itself, made by the ramification of the arterial branch supplying it with blood, and which serves as an index only to that division of the udder. These 'mirrors' blend in the middle and appear as one, but the outside of the reversed hair varies for each quarter according to the size of the arterial branch by which it is supported. If there is more escutcheon on one side or one quarter of the bag, it indicates a flow from that side or quarter corresponding to the excess of the development.

"The size of the escutcheon is regarded as the measure of the quantity of blood supplied to the milk-producing vessels, and is evidence of their capability of elaborating milk. In the same way, the veins take up the blood and carry it back in the milk-veins, which pass through the bag and along the belly, and enter the body through one or more holes on their way to the heart. The size of these milk-veins and the holes where they enter the body vary with the escutcheon, and, like it, give evidence of the quantity of venous blood passing away from and through the udder; and they have the same significance with reference to quantity as the supply of arterial blood and the size of the escutcheon.

"But none of these indications, taken singly, is an infallible evidence of a large yield of milk. They must be considered together. A large escutcheon and milk-veins, coupled with a small stomach, would be marked down at least one-half of what they might otherwise signify; and a large digestive apparatus, coupled with small milk-veins and escutcheon, should be marked down in the same way. Keeping the leading indications in view, observation will soon enable one to make close estimates."

This milk escutcheon, or shield, then, is one of those theories of which all that can be said is that they have more or less of truth in them. Their correctness is sometimes startling — like fortune-telling; but they are so frequently incorrect — also like fortune-telling — that none but dreamers attach more than an occasional and passing importance to them. The escutcheon theory, therefore, is one which we must neither unreservedly accept nor lightly throw aside. A wide-spreading escutcheon may be looked for as one of the points which go to make up a first-class dairy-cow; but it is only one point, and it cannot be regarded as being so important as some of the others that we have mentioned, simply because it is not so reliable as they are.

A smooth skin, with soft fine hair, is commonly thought to be an indication of richness of milk;
DAIRY FARMING.

but this is not a sure and unvarying guide, for some cows, whose hair is neither soft nor fine, and whose skin is not smooth, give very rich milk; whilst some of the smooth and fine-skinned ones give milk which contains a low percentage of cream. But it is the rule that smooth-skinned and soft-haired cows should give rich milk, and it is therefore one of the points to be attended to in the selection of dairy-cows. If a cow is delicate-looking, and has a pale, dry, sickly sort of skin, she will always give milk of a poor quality, and generally small in quantity; while, on the other hand, a cow whose skin is a rich yellow colour, showing a tendency to accumulation of fat in the cellular tissue beneath—whose hair has a lustre and glossiness, as if it had been cleaned with an oily brush, and whose general appearance shows healthiness and vigour—will commonly give rich milk, and plenty of it. On animals that are well adapted for both milk and beef there will always be a soft, velvety skin, which will feel mellow to the touch, as if it rested on a second under-skin like a cushion. This "under-skin" consists of a network of cells, called "cellular tissue," and when a cow is not in milk, fat soon accumulates in it, and forms the "quality" or "handling" which indicates the extent to which she may be considered fit for the butcher. If the cow is in milk this fatty accumulation in the cellular tissue goes instead to form cream in the milk. An abundance of cellular tissue not only indicates quality and strength of constitution, but is always associated with a tendency and ability to form fat to fill it with. A poor supply of cellular tissue is indicated by a thin skin, which seems to fit very tightly on the bones. A cow of this description will generally give milk of poor quality, though she may for a time give a fair quantity of it; and she will be a poor fattener.

The breed of cows to be selected will depend very much on taste, kind of land, locality, and climate. The Ayrshire breed is becoming very popular and general in dairying districts, not in Scotland only, but in England and Ireland, not to mention the United States and Canada. They are deep milkers—wonderfully deep for such small cows; they will do fairly well on land which is unfit to carry large cattle, and on good land they are said to milk as well as any other kind; but they are not so well adapted for fattening. As a rule, the better breed of the general dairy-cows of the country, which are mostly Shorthorn crosses on old Longhorn stock, showing much more of the former than of the latter, will be found to be as profitable as most other kinds, especially on strong sappy land. Where grass is abundant, and cows have not to travel far to satisfy their appetites, heavy massive cattle may be kept with advantage, especially if the land is sound and firm. To be milked for a few years, and then turned into beef, is a double purpose which commends itself to the rent-paying dairy-farmer of the present day; and for this end Shorthorns and Shorthorn crosses are well adapted. It is, however, doubtful if, in the country of the Herefords, the Sussex, the Norfolk and Suffolk Polled, the Channel Islanders, and Ayrshires, a dairy-farmer can do better, generally speaking, than to select a herd composed of good specimens of the breed which is peculiar to the district. There are, no doubt, exceptions to this rule, and Shorthorns have proved themselves to be possessed in a high degree of the power of adapting themselves to almost any soil and climate; but, generally speaking, it will be found that the breed peculiar to the district has become endowed with properties which fit it pre-eminently for that district. On this basis improvements may be made by careful classing and selection; or, if purity of breed is not desired, crossing with other breeds may in some cases be tried with success. In some districts, the dairy-stock of which have been built up from Longhorn and Shorthorn foundations, it is the practice to get a little pure Longhorn blood among them occasionally, when it is thought they have become too closely allied to the Shorthorn side of the cross. Giving these grade Shorthorns a dash of original Longhorn blood now and then, is supposed to result in an increase of milk and of physical vigour. Shorthorn crosses on native breeds of cattle have commonly produced a great improvement; on Ayrshires, for instance, the cross results in a considerable increase of size, coupled with earlier maturity and an increased aptitude to fatten, but generally with a decrease in milk; this last, however, is, we think, hardly an unavoidable result, and it ought to be possible to improve the Ayrshires in other respects without sacrificing their milking properties. Many native breeds of cattle have been improved in all respects, including milk, by Shorthorn crosses; but the Ayrshires are, for the size of them, such extra-
ordinary milkers, that all we can expect to attain in that respect by crossing them is to maintain, and not sacrifice, their milking properties.

With dairy-farmers, milk must always be a matter of the first importance. Where cheese and butter making are carried on, both quantity and quality of milk are required; but where the milk trade is the opening toward which farmers devote their energies, quantity is of more moment than quality. Cows may be bred up to either of these objects, and the method of feeding influences them also. The breeding for milk seems to be opposed to the breeding for fattening and for early maturity, and these two latter qualities are more artificial than the first. A large and long-sustained flow of milk is the result of domestication, and of selection of animals to breed from whose milking powers have become hereditary; and the conditions under which our dairy-cows exist have given permanence of character to what was at first only an unusual development of a natural function. In crossing two breeds of animals together, one of which is celebrated for meat and the other for milk, the properties of both are commonly found in a high degree in the offspring; but a real difficulty is generally found when we try to maintain this double character in the next generation—the second generation of the cross is commonly found to throw back specially toward one or other of the two properties which were combined in the first. But as highly developed milking properties, early maturity, and aptitude to fatten are all more or less the result of artificial treatment and breeding, it will follow that they ought, without very great difficulty, to be successfully combined in the same animal; and the way to attain this desired end is to make an intelligent use of the principles of breeding, by repeatedly crossing animals together, both male and female of which come of families in whom all these desired properties are known to be present in a satisfactory degree. A farmer will, of course, breed from all his cows, but he will keep for his own use in the herd the offspring only of those whose superior qualities he desires to perpetuate—the rest should go early to the shambles, and not to the milk-pail.

If cows are kept constantly in-doors, not only their own milking properties, but also those of their offspring will be likely to suffer; a sluggish life tends to fatness rather than to milk, and the properties which are promoted by habit at the outset soon become prominent and hereditary. Instead of keeping dairy-cows under constant restraint and confinement, they should have a reasonable amount of exercise, if they are to transmit unimpaired to their offspring the milking properties and the vigour which are so desirable in dairy-stock. Treatment not too far removed from nature, and a liberal supply of succulent and nutritious food, will tend best of all to the highest development of the milking properties; and careful selection of animals to breed from will soon give those or any other properties a fixed and permanent character.
CHAPTER II.

BREEDS OF CATTLE: SHORTHORNS, AYRSHIRES.


IKE the rest of our native and distinct breeds of cattle, Shorthorns owe, in no small measure, their special features and characteristics to the influence of soil and climate in that part of the country which may be regarded as their original home. Nowadays their home is everywhere; but the counties of Durham, York, Westmorland, and Northumberland claim the proud distinction of having produced them as a breed, and for a long time they bore the name of "Durham cattle." By the climatic and geological influences, whatever they may be, of the district covered by those counties they were originally moulded; yet, more than most of our other breeds, they are supposed to be indebted to long bygone crosses with foreign cattle. "Saxon, and Norman, and Dane are we," and in a limited sense the same may almost be said of Shorthorn cattle; for the old Scandinavian conquerors of Britain, coming from the west and north of Europe, not only mingled their own blood with ours, but, it is supposed, brought some of their large, raw-boned, coarse-fleshed, short-horned, heavy-milking, strong and hardy cattle, and grafted them on the native cattle of the north-eastern counties of England, where they landed on our shores. But still we have no definite reason to believe, but only to conjecture, that these foreign cattle actually did come with the invaders to whom they belonged; nor, while admitting the probability that they did so come, have we any better reason either to believe or conjecture that they were brought with a view of improving the native breeds of cattle in this country. We have no evidence that the art of breeding was either understood or valued in those days; but in the early part of the last century there was a tradition floating among the Shorthorn breeders of the Teeswater district that a breed of cattle, much resembling in size, shape, and colour the cattle of North-western Europe—of Holland, Holstein, and Denmark—had existed many centuries before in Yorkshire, chiefly in the district of Holderness. Yet nothing was certainly known as to the people by whom, or the period when, they were introduced into Britain. They were, however, popularly supposed to have been brought by the warlike and adventurous natives of Denmark, Sweden, and Norway, who repeatedly invaded this country, settling in portions of it, many centuries before the Norman Conquest.

We are equally in the dark as to whether the Saxons and Normans contributed anything to the improvement of cattle in this country.

Whatever amount of influence we may accord to the soil and climate of Northumbria, it is not to be supposed—though we have no records bearing on the subject—that no one, during those long dreary centuries preceding and following the Norman Conquest, had consciously or unconsciously tried to improve the quality and build of these cattle. The spirit of agricultural progress existed in the northern counties long enough before it was either publicly recognised or reduced to anything like order or system; and we are therefore justified, by the ancient excellence of Shorthorns,
in presuming that many breeders, whose names unfortunately have not been handed down to us, greatly assisted nature in the improvement and development of this noble race of cattle. Be this as it may, however, we have no clear records of any systematic attempts at improvement having been made earlier than the eighteenth century. Yet the country was not wholly asleep in those days that seem now to us so torpid; progress, or the foundation for it, was being surely though slowly and obscurely made.

Whether by art or nature, or both these combined, the Teeswater cattle were celebrated many centuries ago as yielding, under generous treatment, larger quantities of milk than any other breed of cattle yet known in these islands. Though late to mature, they afterwards laid on flesh rapidly, and fattened into heavy weights of coarse-grained, dark-coloured flesh, whose flavour was inferior to that of the smaller breeds of cattle. They had coarse heads, with short stubby horns, heavy masculine necks, high coarse shoulders, flat sides, wide hips, long rumps, and thick thighs loaded with flesh. They were, as now, of various colours—deep red, pure white, red and white, roan, and not uncommonly light dun and yellow-red.

An ancient record, which is said to be still preserved in Durham, states that cattle of great excellence existed in that county so long ago as the middle of the fifteenth century. And a tradition was current a hundred years ago among the breeders of Durham and Yorkshire that a superior race of Shorthorns had existed on the estates of the earls and dukes of Northumberland since the latter part of the sixteenth century. It is very much to be regretted that the early history of Shorthorns rests on nothing more solid than tradition. Sir Hugh Smithson, who had married the heiress of that great family, and was raised to the dukedom of Northumberland in 1766, was a great breeder of Shorthorns. He was in the habit of weighing his cattle and the food they ate, so as to ascertain the improvement they made for the food consumed; and so fond was he of his Shorthorns that his peers jokingly dubbed him "the Yorkshire grazier." A century earlier than the time of Sir Hugh, the Aislabies of Studley Park, and the Blacketts of Newby Hall, had very fine Shorthorn cattle, and had paid great attention to their breeding. Even at that early day portraits of these cattle adorned the entrance halls of their owners' residences.

There had existed time out of mind on both sides of the river Tees, from Barnard Castle downwards to Yarm, a peculiar breed of cattle—the Teeswater, or old-fashioned Durham Shorthorns. And long before the names of the Messrs. Colling had been heard, those of the following breeders and improvers of them had obtained celebrity—namely, Millbank, St. Quintin, Pennyman, Brown, Hill, Wright, Charge, Maynard, Jolly, Hutchinson, Sharer, and others. Long also before Ketton or Barnton were known as Shorthorn localities, the following places were in repute—namely, Barningham, Aldborough, Barton, Cleasby, Manfield, Stapleton, Dalton, Newton, Morrell, Blackwell, Oxenfield, Hurworth, Eryholme, Worsell, Sockburn, &c., so that even in the beginning of the eighteenth century Shorthorns had already attained notoriety, and landowners as well as farmers were alive to the expediency of improving their cattle.

The year 1780 is usually considered to mark the beginning of a new era in the history of Shorthorns. At this period, as it would seem, a fresh impetus was given, and a new interest added, to the pursuit of breeding these already famous cattle. Many causes, no doubt, contributed to this, some of which are more or less obscure. The country was advancing in prosperity, and population was increasing; Shorthorn interests, previously
more or less scattered, were becoming numerous and important enough to command a sort of systematic unity and recognition. The celebrated Robert Bakewell of Dishley, in his management of Leicester sheep, had reduced the art of breeding to a system in which the results could be predicted with moderate certainty, and his genius was attracting many followers and admirers. His principles, so far as he allowed them to be known, were applied not to sheep only, but to horses and cattle, and in each case with marked success. It was evident that man had secured the secret of moulding and improving domestic animals almost at will, as a potter moulds his clay. They improved visibly in each successive generation, until, in a comparatively short space of time, animal forms were built up possessing such beauty, symmetry, and general excellence, that they have not easily been surpassed in more modern times. Bakewell's system was the creation of his own genius, and differed widely from the usual practice of English stock-breeders of his day. He dissected some of the carcases of his cattle and sheep, minutely examined the flesh, bones, and sinews, and so obtained a sound and practical knowledge of animal physiology. He put his anatomical specimens in pickle, and afterwards hung them up in his hall for subsequent reference. From this scientific investigation he deduced a system of the laws of animal nutrition and economy at once sound, accurate, and practical. His method in breeding was to select animals, wherever he could find them, of the best blood, and possessing as nearly as possible the form he needed for the objects he had in view; he then bred them strictly in their own family only, only going out of it when he found specimens elsewhere which he considered would still further improve his stock. His judgment was sound, clear, accurate, and penetrating; and he was at once a profound scholar and master of the principles which, far more than any other man, he had studied and formulated into a system. In the strictest sense of the word he was a man of "genius;" and, more than to any other man, England owes to him the marvellous improvements in her cattle and sheep which have been made in the past hundred years. He was eminently a public man, much given to hospitality, and though he made a great deal of money—for a farmer—he is said not to have been rich when he died. The old farm at Dishley, which his commanding genius consecrated into a shrine, has passed into the hands of a stranger, but, like that of its old tenant, its name is immortal. "Bakewell of Dishley" is known wherever the science of agriculture is studied, and his name is, and ever will be, revered by those who take a delight in the improvement of cattle, sheep, and horses. He died in 1795, at the age of sixty-nine.

Some little time—about the year 1780—after Bakewell's fame had reached a high position, two young men, Robert and Charles Colling, the sons of a substantial Teeswater farmer, were about starting business on their own account. These young men had heard of Bakewell's extraordinary genius as a breeder; they paid him repeated visits, carefully examined his stock—the Leicester sheep and the Longhorn cattle—noticed the improvements he had effected in them, gathered all the knowledge they could of his system, bought some of his improved sheep, and continued breeding them to his model, and applied his principles of breeding to Shorthorn cattle. Their success was complete; their names are known in Shorthorn circles all over the world, and the farms at Barmpton and Ketton, on which they subsequently settled, are almost as celebrated as Bakewell's old farm at Dishley. Though Bakewell never took in hand the breeding of Shorthorns, the principles he had previously applied to the Leicester sheep and the Longhorn cattle were found to be equally successful with other breeds and kinds of animals, and it was reserved to the brothers Colling to apply them to the breed of cattle which has since become the most famous the world has yet known. And to Bakewell's transcendent genius this is the strongest testimony—the universal success which has followed the application of his principles. Under the management of Charles and Robert Colling, Shorthorn cattle soon attained a popularity they had not previously enjoyed, and that popularity has gone on increasing till the present day. The system still pursued is identical with that which the Collings established on Bakewell's principles—viz., breeding "in-and-in," so long as constitution, size, vigour, quality, health, and fecundity are not injured by it. This appears to be the surest way of raising superior stock—the breeding together of animals of the same strain of blood. Attention to pedigree is found to be more effective than attention to form without pedigree.
this fact, coupled with fashion and high prices, has a strong tendency to perpetuate "pure blood," and to prevent the ill-effects which follow "raw crossing;" while on the other hand it has, no doubt, the effect of causing far too little weeding out to be done of unfit specimens.

The practice of close in-and-in breeding has in some cases produced extraordinary results, and it is, no doubt, strictly true that uniformity of type and quality may be sooner and more certainly attained by this system than any other; but experience has proved that the number of families on which the system can be long practised with safety and success is very limited, and that in the majority of cases it has resulted in more or less of disaster and disappointment. The effects of it are seen in weakened constitutions, in liability to disease, and in frequent barrenness. The practice of systematically using sires of the same line of descent—of the same family, though not of the same household—preserving the purity of blood and a sufficiently close relationship, appears to be most in favour; it is called "line breeding," and by means of it, though perhaps more slowly, most of the desirable effects of in-and-in breeding are attained, whilst its evils are to a great extent avoided. It is, however, only by the establishment of several parallel lines of the same strain of blood, keeping them for a time apart, and breeding them all to the same model, that this system can be thoroughly carried out; but it is not very difficult now-a-days, for these parallel lines in many families have been long established. The practice of "cross breeding," by mating a female of one strain of blood with a male of another, the families of both being of the first respectability, is productive of more flesh, fecundity, health, and vigour of constitution; but sires so bred rarely fetch prices equal to those commanded by sires who have been carefully bred from one direct line of ancestry, either by "in-and-in" or by "line breeding."

**Remarkable Shorthorn Sales.**

Scientific and elaborate principles of breeding have been more extensively employed on Shorthorn cattle than on any other kind or breed of animals, and the money value attached to the best specimens of the most fashionable families has of late years become fabulous. At Mr. Charles Colling's sale, on the 11th of October, 1810, seventeen cows fetched 2,669 guineas, or an average of 157 guineas; eleven bulls fetched 2,249 guineas, or an average of 204½ guineas nearly; seven heifers fetched 808 guineas, or an average of 115½ guineas nearly; twelve heifer and bull calves, under one year old, fetched 961 guineas, or an average of 80 guineas. Among these animals the highest-priced ones were the bull Comet, 1,000 guineas; the bull Petrareh, 365 guineas; the cow Lily, 410 guineas; the cow Countess, 400 guineas; the heifer Young Countess, 206 guineas; and the bull-calf Young Favourite, 140 guineas. In all, forty-seven animals fetched £7,115 17s., or an average of £151 8s. These prices were in those days considered to be enormous, and they were not sustained at Mr. Robert Colling's sale, on the 29th of September, 1818, where sixty-one animals fetched 7,484 guineas, or an average of £128 16s. 6d. nearly. Since those early days of Shorthorn popularity prices have been continuously advancing, and for a long time past it has been no uncommon occurrence for pure specimen bulls and heifers of the best strains of blood to fetch from 1,000 to 1,500 guineas, and later on the prices have risen into several thousands for a single animal.

In September, 1873, the bucolic world was startled by the results of a sale of Mr. Campbell's Shorthorns, at New York Mills, near Utica, New York, America. At this sale six females of the "Oxford" tribe averaged £1,087 10s., and the bull-calves £396 16s. 8d. Eleven females of the "Duchess" tribe made the prodigious average of £4,322 14s. 2d., one cow fetching the unparalleled sum of 40,600 dollars, or, in our money, £8,158 6s. 8d.

On the 4th of September, 1877, Mr. Thornton sold, at Bowness, forty-five Shorthorns which Mr. Cochrane, of Canada, had sent over to this country for sale. The sum-total of the sale amounted to £17,150, or an average of £381 2s. 2d. per animal. The average price of thirty-seven cows, heifers, and calves was over £120, and of eight bulls over £300. The "Third Duchess of Hillhurst," red, calved December 25th, 1875, and consequently only twenty months old, was sold to Mr. Loder, of Towcester, for 4,100 guineas; and the "Fifth Duchess of Hillhurst," red, calved May 1st, 1876, and consequently only sixteen months old, was bought by Lord Bective for the still larger sum of 4,300 guineas!
On the 19th of September, 1878, the Duke of Devonshire's periodical sale of draft Shorthorns was held at Holker Hall, Lancashire. Mr. Strafford was the auctioneer. In all there were thirty animals sold; and the sum-total realised was £19,922 11s. 9d. or an average of £664 1s. 9d. per head. Eighteen cows made £11,302 1s., or an average of £794 11s. 2d.; and twelve bulls made £5,620, or an average of £468 6s. 8d. Though trade in the country was then in a depressed condition, and Shorthorn sales during the year had shown a marked decline in prices, the sale at Holker was a great success, proving that unlimited capital and sound judgment applied to the art of Shorthorn breeding still reap a rich reward. Mr. Drewry, agent to the Duke, had managed His Grace's herd of Shorthorns for many years.

Points of Shorthorns.

Mr. John Thornton, the celebrated auctioneer, describes Shorthorn cattle as follows:—"The breed is distinguished by its symmetrical proportions, and by its great bulk on a comparatively small structure, the offal being very light, and the limbs small and fine. The head is expressive, being rather broad across the forehead, tapering gracefully below the eyes to the open nostrils and fine flesh-coloured muzzle. The eyes are bright, prominent, and of a particularly placid, sweet expression, the whole countenance being remarkably gentle. The horns (whence comes the name) are usually short, springing well from the head, with a graceful downward curl, and of a creamy white or yellowish colour, the ears being fine, erect, and hairy. The neck moderately thick (muscular in the male), and set straight and well into the shoulders, which when viewed in front are wide, showing thickness through the heart, the breast coming well forward, and the fore-legs standing short and wide apart. The back, among the higher-bred animals, is remarkably broad and flat, the ribs springing well out of it barrel-like, and with little space between them and the hip-bones, which are soft and well covered. The hind-quarters are long and well filled in, the tail being set square on to them; the thighs meet low down, forming the full and deep twist; the udder not too large, but placed forward, the teats being well formed and of a medium size; and the hind-legs standing short and straight to the ground. The general appearance should show even outlines. The whole body is covered with long soft hair, there frequently being a fine undercoat, and this hair is of the most pleasing variety of colour, from the soft white to the full deep red. Occasionally the animal is red and white, the white being found principally on the forehead, underneath the belly, and a few spots on the hind quarters and legs; often the whole body is white, with the neck and head partially covered with roan, while again the entire body is most beautifully variegated, of a rich deep purple or plum-coloured hue. On touching the points, the skin is found to be soft and mellow, as if lying on a soft cushion. In animals thin in condition a kind of inner skin is felt, which is the 'quality' or 'handling,' indicative of those great fattening propensities for which the breed is so famous."

The Alloy.

We stated in the Introduction that Charles Colling had recourse to Kyloe and Galloway crosses in the breeding of his Shorthorns. These crosses, having introduced a new blood element, were called "the alloy," and this alloy has been the cause of interminable discussion and controversy; for which, if for no other reason, it is a matter of regret that it was ever introduced. Speaking of the Galloway cross, the late Mr. Willoughby Wood says:—"I proceed now to address myself to the subject of 'the alloy.' It originated from what has been unceremoniously
called O'Callaghan's polled Galloway. Now this same O'Callaghan was Colonel James O'Callaghan, of the noble house of Lismore, and a great friend of the late Duke of Cleveland, one of whose boroughs he represented for many years in the House of Commons. The duke, as Lord Lieutenant, also made him Colonel of the Durham militia. Having pitched his tent, in the decline of life, at Heighington, in that county, he there ended his days as he had lived, a very popular character. Having bought a couple of polled Galloway cows, he had no difficulty in getting Mr. C. Colling, his near neighbour, to allow him to send one of them to his bull Bolingbroke. She produced a bull-calf. It was a roan, in due time had horns, and showed all the other indica of a true-bred Shorthorn. Such was 'Son of Bolingbroke.' Mr. C. Colling bought him and his dam of Colonel O'Callaghan, and put his cow, old Johanna, to this son of Bolingbroke. She produced a red and white bull-calf, who, like his father, took in all respects after the Shorthorns. He was yelept 'Grandson of Bolingbroke.' (208). To him Mr. C. Colling put Phoenix, daughter, as we have seen, of 'Old Favourite,' and she produced 'Lady,' as she had before done, by Bolingbroke, the bull 'Favourite,' the father of Comet; and also (by her own son, Favourite) Young Phoenix, the mother of Comet. Lady was the dam of Washington (674), Major (397), George (276), and Mr. Wright's Sir Charles (592), and also of Countess and Laura. At Mr. C. Colling's sale, in 1810, this alloy stock sold at very high prices—Major for 200 guineas; George for 130 guineas; Lady herself, at 14 years old, for 206 guineas; Laura, her daughter, for 210 guineas; Laura's daughter, Young Laura, at 2 years old, for 101 guineas; and Countess, the other daughter of Lady, was bought of Major Rudd, of Morton, for 400 guineas. When we meet, therefore, with descendants of 'Grandson of Bolingbroke,' or of Major, George, or Sir Charles, such as 'Western Comet' (689), Frederick (267), Keswick (153 and 1266), or of Countess or Laura, we encounter the alloy. But what do we therein encounter that is base or injurious? What is the meaning of alloy? Here we have a cross with a breed of cattle of first-rate character and quality, and polled Galloway breeders might equally say they had been alloyed by the Shorthorn cross. We are satisfied, however, that in fact 'the alloy' never took—that it was utterly and speedily thrown out—and that, as did the son of the polled Galloway by Bolingbroke, so did all his descendants adhere to the Shorthorn side of the house. I have never heard that any of them were without horns, or exhibited the least trait of the polled Galloway, except, it may be, in the analogous good qualities of that breed. I incline to think there is truth in the theory that in crossing distinct breeds the offspring does take exclusively at once, or very shortly, to one or other side of the house.

"We appear then to have, in the instance of the alloy, an illustration of M. Malinie Nonet's ingenious theory of the difficulty of changing the type or characteristics of a long-established breed, and that this difficulty is in proportion to its purity of blood, or, in other words, to its antiquity.*

"If this be true, the non-infection of Shorthorns by the alloy affords an additional argument in favour of the ancient and indigenous character of the breed. But had the first offspring of this cross partaken equally of the bloods of its different parents, in what proportion would the Galloway blood exist in any modern Shorthorn? Seeing how early capability of procreation exists and is called into operation in that breed, and also how rapidly generations of cattle pass away, I do not

* See vol. xiv., p. 214, of the Royal Agricultural Society's Journal, First Series, 1853.
believe there is an extant Shorthorn which has an appreciable particle of the Galloway blood in its veins. I must say I think this kind of crossing, or perhaps, rather, attempted crossing, a mistake—a mere waste of time.

"Take the case, well known to greyhound coursers, of Mr. Goolake's bull-dog cross. Considering the position the dogs thus 'alloyed' hold as to their 'public performance,' does any one think this cross has been injurious, or can any one from their appearance discern it? Yet I think it was a mistake.

"Being of opinion, then, that the alloy has done neither good nor harm directly, I am not so sure that indirectly it may not have done good. Those who had it in their stock became less scrupulous on the score of pedigree, and, unlike pedigree martinet, looked less to that than to the good qualities of a bull. It may be thus, perhaps, explained how it has come to pass that many animals having in them this once dreaded bugbear, the alloy, have taken the highest places in the showyard. I do not allude more particularly to these animals, lest I should revive against them this stupid prejudice of 'the alloy,' and a more stupid prejudice, a more complete phantom, cannot exist. Breeders, however, will understand my allusion. We maintain it then to have been established by this narration that the Collings in general, notwithstanding what Mr. Charles Colling did in a particular instance, formed the improved Shorthorns by careful selection from the local breed, which had already attained considerable perfection; that such is the antiquity and indigenous character of the old-fashioned Shorthorns, such its native purity, that even should any commixture of ingredients of another kind have taken place, yet, like an infusion of the same sort with the waters of father Tees, it has been speedily thrown off without affecting its perennial purity.

"The owners of our native Shorthorns, therefore, may snap their fingers at the ancient myths as to 'wild cattle from Chillingham Park,' and 'Dutch or Holstein cattle from across the German Ocean.' Those who have seen the wild cattle at Chillingham will bear me out in saying there is not a single characteristic or point of resemblance exhibited by them which is possessed by the Shorthorns, except that Shorthorns are occasionally white; but they are also sometimes red, yet no one has ever ventured on that score to point to the Devon or Sussex breeds as their original. As to the Dutch or Holstein importation, of which one used to hear so much, the writer happened some years ago to stumble on a fact tending to turn the tables on the Holsteiners. It seems, according to Anderson (in his treatise on Commerce), who quotes from Rymer's Federa, that Edward IV. allowed a favourite sister, Margaret, Duchess Dowager of Holstein, to export from this country annually, and for many years, into Holstein and the Low Countries, great numbers of cattle and sheep, for the purpose of improving the breeds of them in those countries. Whence is it so likely they were exported as from the ports of Hull and Newcastle across the German Ocean? And if it be true, as has been said, that some centuries after a herd of cattle was found there greatly resembling our native Shorthorns, whence may it not fairly be assumed the originals came? And when, as it is said—for it rests only on tradition—some of these were brought into this country, what was this but a re-importation? what was it but that England had her own again?"

The foregoing is a clever argument in favour of the purity of Shorthorn blood, and however we may reserve our opinion as to its absolute, we may freely admit its practical, correctness. Whatever may have been the visible or invisible effect of the foreign blood at the period of its introduction, it is now substantially correct to say that the effect of it will, under ordinary conditions, never again be seen in pure-bred Shorthorns, though it is still possible that it may now and again crop out in raw crosses of Shorthorns with other breeds. It has not yet been determined how long a period of pure breeding is required to so thoroughly eradicate the alien blood of a previous cross that it will not, under any conditions whatever, betray itself in the future.

**Qualities of Shorthorns.**

One of the chief merits of Shorthorns—perhaps the most striking and practical merit—is their power of improving in a marvellous manner, and in a very short time, most other breeds of cattle with which they are allowed to mingle their blood. But qualities recently acquired are soon lost if there is a lack of physical vigour in the breeding animals. The qualities of the more vigorous male—or female, as the case may be—will be found in the offspring, for when health and vital force are
full to overflowing, individual characteristics of whatever kind are most surely transmitted; but if the vital force diminishes, and the animal becomes weak and delicate, the qualities last acquired will be the first to disappear—so important are strength and soundness of constitution. Leaving out the Devons, Herefords, Channel Islanders, and one or two other breeds which still remain distinct, Shorthorns have greatly improved, and are still greatly improving, the whole of the cattle of these islands. In Ireland and Wales and Scotland their influence is seen almost everywhere. In the Isle of Man and in the Orkneys and Shetlands they are found. In America and Canada their influence has been very marked on the old breeds of the country, and there are many pure-bred herds existing from which young bulls are drafted for use in continuing the improvement of the “grade cattle” of the country. In Australia and New Zealand they have been long established, and are doing remarkably well. Even in Russia and Japan they have made their home; and indeed they are strangers in no country which can lay the smallest claim to civilisation.

It is to be regretted that in the breeding of some families of pedigree Shorthorns, milking properties have been sacrificed to early maturity and aptitude to fatten, for the reputation of the breed as milk-producers has suffered somewhat in consequence. To such a length has this tendency been carried that it is well known to be a fact, in many cases, that “wet nurses” have had to be employed to help the pedigree mothers to rear their offspring, and in some cases to rear it wholly without that help from the mother which she ought to have been able to give, but could not. Now a cow that cannot support her own calf forfeits, in the economy of nature, her claim to existence, though her form and symmetry may be perfect, and her pedigree as long as one’s arm. In order to restore to the Shorthorn breed the lost portion of their reputation as deep milkers, it is only necessary that breeders should retrace their steps with regard to milk, and make this chief use of a cow one of their chief considerations in breeding; for a cow that is a poor milker fails to give to her owner that larger portion of profit which, under proper conditions, she is specially designed to yield. There is no reason why the Shorthorn breed should not acquire that superior reputation for both beef and milk of which we know the breed is capable. There are instances on record of Shorthorn cows giving thirty or more quarts of milk per day for a length of time, and being at the same time possessed of superior fattening properties. And it is no disparagement to any other breed that Shorthorns should take high rank in both these departments of usefulness and profit, for they have a place to fill which no other breed could fill so well, and the other breeds, on their part, are well suited to many districts, and purposes for which Shorthorns could not be kept with profit.

One of the chief sources of profit to a Shorthorn breeder lies in the sale of his young bulls at good round prices, and the experience of the past few years amply proves that he depends each year more than before on finding among bona fide dairy-farmers the great bulk of his customers for such young bulls. It also proves that as the market is now well filled with good pedigree stock, the supply having so far overtaken the demand that the price of well-descended bulls is now within the reach of even small dairy-farmers, it is more than ever necessary that breeders should make their stock popular with practical, rent-paying dairy-farmers. This can only be done by cultivating the too much neglected milking properties, so that Shorthorns may everywhere be regarded as thorough-going dairy as well as grazing stock; and it will only be done when breeders clearly discern in the signs of the times the fact that the most profitable market will be that, in which the demand is for animals descended from herds which are noted as being not only good grazers but deep milkers. Many families of pure-bred Shorthorns are known to be deep milkers, and though their milk is less rich than that of the Alderneys, both in colour and quality, the milk globules are of a good size, so that the cream rises quickly.

The main objections urged against Shorthorns are, that many of them tend to convert the food they eat into fat and flesh rather than into milk, and that they are not so well adapted as the smaller breeds—the Ayrshires, for example—for hilly districts, for cold climates, and for poor land. Their size, delicate constitution, and generally tender nature unfit them for withstanding the hardships incidental to low temperatures and exposed situations; and their most suitable habitat is in warm, low-lying districts, where level or
slightly undulating land of exceptionally good quality prevails.

The animals given in the foreground of the coloured plate are Mr. B. St. John Ackers' "Sir Roland," Lord Fitzhardinge's "Rugia Niblett," Mr. Richard Stratton's "Fairy Queen," and Mr. W. T. Carrington's "Charmer." The first-mentioned cow is red, with white on thigh; the second roan; and the third red, with little white. The last one, though not entered in the herd-book, is one of the three capital dairy-cows to which was awarded the 100-guinea prize at the first Dairy Show in London, in 1870. Other types are shown in the engravings.

**Ayrshires.**

Mr. James Buchanan writes as follows concerning this breed of cattle:

"This heavy-milking and hardy breed of dairy-cattle is well suited to the soil and climate of Scotland, where it has been long established and is highly valued. Small in size, short in the legs, and with fine clean bones, Ayrshires thrive and give a fair share of milk where large and less hardy cows would scarcely live. In the south and west of Scotland, where large cheese-dairies are kept, it is a rare thing to find any other breed of cows used, and the knowledge of this fact enables us to appreciate the justice of Mr. Scott Burn's remark, in one of his books on the Dairy, &c.,* where he says: 'For dairy purposes, in cheese districts, the Ayrshires are justly celebrated; indeed, they seem to possess the power of converting the elements of food more completely than any other breed into cheese and butter.'

"Little is known as to the manner in which this favourite breed was first brought into or bred in Scotland, but it is generally believed that the cows from which both they and Shorthorns are descended were the country cows belonging to the district lying between the Wear and the Tees; and it is probable that some of these cows—which were famous for being good milkers more than a hundred years ago—were bought by Scotch dealers, or drovers, when returning to their own country, after disposing of their 'drives' of black cattle in England. The mothers of the milky herd being thus introduced into Scotland, there is good reason to believe that bulls of the West Highland breed were used for crossing; for West Highland cows are to the present day good milkers, and we often see a brindled bull or cow of the Ayrshire breed; but, above all, in the size and shape of the horns of a true Ayrshire there is clear evidence of West Highland blood. Another—not very pleasant—trait of character might also be mentioned, which still further confirms this supposition: both breeds are of spiteful and pugnacious dispositions, and always ready to gore or rip up each other when a fair chance offers. Ayrshires, although bred together, will do this, and it is safest to screw wooden or iron knobs on their sharp horns, which prevent their injuring each other.

"Great attention and care have been bestowed on the improvement and development of this valuable breed of dairy-cattle, during the last thirty years, in Scotland. An Ayrshire Herd-book has been established, milking competitions, and of late years an annual exhibition of cows, called the 'Ayrshire Derby.' This has brought large numbers to the county from which these cattle take their name; and the competition for the thirty-five prizes offered in the 'Derby' is very keen indeed.

"Large numbers of Ayrshire cows are annually bought, and sent to England, Ireland, and the United States of America, and the breed is rapidly rising in favour in all those countries, for although

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* "Outlines of Modern Farming," By Mr. Scott Burn. Lockwood & Co., 1875.
they are profitable on poor and inferior pastures, they are much more profitable where grass is rich and plentiful. The return from individual cows, and from whole dairies of this breed, have frequently been published in the agricultural papers, and from these statistics it is easy to understand why many tenant-farmers and dairymen are anxious to obtain cows of so profitable a kind. The first cost being much less than what is paid for large cows, and the fact that a considerably larger number of the small cattle can be kept on a given acreage, induce many men to give the northern breed a trial, especially where milk is the chief desideratum.

"Any one who remembers seeing Ayrshire cows exhibited at a Scotch show, thirty years ago, will notice the difference between the appearance of the prize-takers now and then. At that time judges of Ayrshires looked chiefly to very fine bones, thin soft skins, small deer-like heads and necks, narrow muzzles, and prominent eyes; and these points, with large well-shaped udders (about which the same opinions still hold), were, and are, sure indications of great milking powers. But it began to be felt that more stamina and stronger constitution were desirable, and therefore, at the present time, a cow is thought more of for having a thicker skin, if soft and flexible, stronger bones, and the horns need not now be so thin and fine; and if a cow has a light fore-end, with a clean well-veined neck, judges like to see her with a good covering of flesh, believing that although such a one will probably give no more—if as much—milk as her prototype of thirty years ago, yet the thicker and stronger cow is to be preferred, because her appearance indicates strength and hardiness, with a proportionate capacity for resisting sickness, and an improved aptitude to fatten.

"In Cork and Kerry, the Agricultural Societies have endeavoured to promote the importation and breeding of Ayrshire cattle by offering special prizes for them. In Kerry, particularly, the Agricultural Society there (which is one of the most flourishing of the kind in Ireland) fully recognises the importance of the breed. One of its members, an extensive land agent, has lately imported a number of Ayrshire bulls for the use of the tenantry on a number of the estates for which he is agent. Lord Ventris has also imported and bred some excellent specimens of the breed; while an extensive farmer has informed me that he intends keeping no other breed of dairy-cows on the two farms he occupies in that county; on the one farm he is to breed Ayrshires, on the other he keeps a Shorthorned bull, and rears crosses for fattening.

"When the Royal Agricultural Society of Ireland visited Tralee, in 1870, there was a fine show of Ayrshire cattle, and although the competition in the cow class was very strong, the cow which was awarded the first prize had been bred and reared in the county.

"The numbers of good milk cows brought to a large show are seldom very great, and they mostly belong to gentlemen who wish to sell them or their produce. There are few dairymen, or others, who keep cows for the milk alone, who will send away a number of their best cows in the middle of the milking season to a showyard, where they will be kept for nearly a week in an unnatural—or, at any rate, unusual—way for them, and all for the chance of a small money prize. Cows so exhibited, when they return to their own stalls, are seen to have fallen off a good deal in the yield of milk, and are otherwise no better for their trip. It is quite different with large cows, which are valued chiefly for the calf they are to produce, and which are seldom overburdened with milk at any time; hence we see many of the latter exhibited, but comparatively few of the former, and no doubt for the reasons I have stated."

Ayrshires as Butchers' Beasts.

"It was no uncommon thing in Scotland, at the time to which I have referred, for breeders of Ayrshires to systematically under-feed their young heifer-calves and yearlings, in order to get the points developed which were then in most request, and this could not be continued without weakening and injuring the constitutions of the animals to some extent. Many people, seeing the stunted appearance of these half-starved Ayrshires, naturally concluded that, whatever their value might be for milk, they would never do for butchers' beasts. But this foolish and hurtful fashion has happily passed away, and with it the prejudice against Ayrshires as fattening beasts is fast disappearing also, as feeders have opportunities of testing the breed alongside of others.

"Mr. William McLaren, Herrington Hill,
Sunderland, who has for a number of years fattened cattle extensively, says in a letter dated 26th April, 1878:—'I bought four Ayrshire calves in June and July, 1876, from Mr. J. McLaren, Red House, Sunderland. They were very small and poor-looking, and, indeed, hardly seemed worth rearing at all, but we let them run about with the others, and gave them very little milk or attention; however, they seemed to freshen up wonderfully last summer, except one, which was lame nearly all summer—caused by "foul" in the foot. They were put into boxes at Martinmas, and got good feeding, and I sold three of them last month (March) at 10s. 3d. per stone of 14 lbs.; they weighed 47, 47, and 43 stones respectively. The one which was lame I have still, and he is now about as good as the others were when they were sold. They were very little to look at, and probably would not have sold for more than 40 stones in a market (they were all bullocks, and as nice as heifers), but I sold them to weigh, as I knew they generally weighed much more than any one would call them.' Mr. McLaren gives a number of other instances of Ayrshires which he has fed, and for which he realised very satisfactory prices, and he concludes by saying, 'I wish I could buy more of them to feed; if I have an opportunity I shall not miss it.'

'Now those four calves were out of cows I had sold to Mr. J. McLaren in the beginning of March, 1876—cows which were all in call to an Ayrshire bull, so that the calves were certainly pure Ayrshires. Mr. J. McLaren sends his new milk into Sunderland, and probably those four bullock-calves got very little of it during the two months or so he kept them before selling—hence their small size; but when sold fat they could not have been above two years old, and yet the two best ones realised over £24 each, and the other, sold at the same time, over £22.

'From these statistics in fattening Ayrshires we may conclude that there is not nearly so great a difference in the fattening qualities of the different breeds of cattle as is generally supposed; and when we speak of the lean, lanky, ill-shaped bullocks of sixty years ago, and contrast them with the handsome Shorthorn or Hereford which is prime fat at two years of age, we ought to remember that the breeding and treatment of the two animals have been as different as their appearance, and that the fat and handsome young animal we so admire has probably cost more to his owner during the last year of his life than the other cost his owner during the whole of the four or five years during which he found his food in the fields, with perhaps the addition of a little hay or straw during a severe storm, or if kept in a yard in winter, with no other food but straw.

'When estimating the value of any breed of cows for the dairy, we naturally look first to the quantity of milk they yield, but we ought also to take into consideration their aptitude to fatten; and if Ayrshires were as unsuitable as some people think them for the stall, it might well be doubted whether men farming prime land should keep them, notwithstanding their admitted merits as milk cattle.

'As cows or heifers can be bought at moderate prices at any time of the year in Scotland, farmers who wish to keep Ayrshires on good land in England should replenish their stock from the north when required, and they should buy a strong-boned, heavy-coated, masculine-looking Shorthorned bull for crossing with their Ayrshire cows. These crosses pay as well for fattening as any breed. Like the pure Ayrshires, they kill, when fat, considerably heavier than they appear to be; their flesh is of a peculiarly firm texture and of excellent quality.

'Having a dairy, and selling the milk to a dairyman, my calves are reared on as little milk as possible, and soon sent away to find their food in the fields, where they get a small allowance of cake for a few months; after then they get no more cake at all, but about the 1st of November, when they are a little over 2½ years old, they are put into boxes, and fattened with roots, meal, and a little hay. For a number of years I have sold nearly all of my own rearing of cattle to a butcher by weight, and in 1877 the average weight of these bullocks was 77½ lbs. each, or nearly seven cwt's. The first one was killed on the 10th January, the last on April 4th, and their ages would be, on an average, about thirty-four months. These figures were commented on by several persons, and one gentleman thought the cross would not fetch the highest price of beef per pound. This drew a reply from Mr. Morris, the butcher to whom I have referred, in which he said, 'I may say that I consider the cross admirably adapted for the trade (particularly now, as customers have
become so fastidious as to what they eat); they have an abundance of good flesh, without the large quantity of fat common to Shorthorns and some other breeds, and are light in the bone.' Further on he continues:—'Let half a dozen half-breds be bought, with the same number of pure-breds (Shorthorns), and fed together, I think the result would dispel a little prejudice that exists as to the merits of this cross.' Mr. Morris had previously said, in reply to a question from me, as to whether he thought the cross-bred Ayrshires as good butchers' beasts as the Shorthorn, 'They are better beasts, both for the butcher and the consumer,' and as he has bought nearly all my winter-fed beasts of this breed for the last four years, his opinion is entitled to respect, especially as he is a farmer himself, and fattens a number of good beasts.

"In this year (1878) my cross-bred bullocks have weighed from a little over six to nine cwt., each killed between February 13th and end of April, fed in the usual way, ages about thirty-five months on an average. I have no trouble in getting the top price per pound for them. For years they have paid me better than the larger cattle which I have bought in, and I have no doubt that a cross with a Hereford bull would yield equally satisfactory results.

"In the United States of America the Ayrshire cows have long been prime favourites, in those districts especially where cheese is the chief product of the dairies. American farmers have found out, by very close and accurate investigation, that they are almost, if not quite, superior to every other breed known on that continent for cheese-making."

Ayrshire Points.

"The favourite colour of the Ayrshire is a light brown or brown and white; some few are found black and white (a notable bull, belonging to the Duke of Buccleuch, of this colour won many prizes two or three years ago), and now and then even a pure white one is seen; but, so far as I have seen or heard, they are never roan-coloured. Some years ago an Ayrshire was hardly considered pure unless it had a black nose, but a white nose is not looked upon as any drawback to a good cow at the present time. When a cow or bull is slightly brindled it is pretty sure to have a black nose, or if the prevailing colour is dark brown, the nose and some other points are likely to be black; this is merely an indication that the West Highland blood is re-appearing. Some people think if a cow shows a ‘notch’ in each of the ears it is a sign of a pure Ayrshire, but this is a mistake; it belongs, nevertheless, to some families, and is regularly transmitted, but it is no particular advantage, and an Ayrshire cow is just as well without the notch. Nor do I attach any importance to the ‘escutcheon,’ never having observed that a cow was better or worse for having a large one.

"The udder is the chief point from which we can infer the milking capabilities of a cow of any sort, and especially of an Ayrshire. Take the following description of what good judges esteem the best shape and appearance:—‘It should, in form, be long from front to back, stretching well forward on the belly, broad behind, filling up well the space between the legs, but should not be too deep vertically—that is, hang too far down—space being obtained in it rather through length and breadth.’ I may add to this description that some cows, even with large well-shaped ‘bags,’ are not nearly so good as they look, on account of their bags being fleshy; and it is sometimes hard to tell, from their appearance, whether they have been milked or not. A cow having a far less udder, but which can be emptied, or ‘milked down’ as it is called, is of more value, and will probably keep on milking fairly well for a much longer time than the former will do; it is always satisfactory to see the large veins on the belly full and prominent, with a good large cavity at the upper end of each. When well-fed, a good Ayrshire cow will give milk up to within two or three weeks of calving, but she ought never to be allowed to do so, as it injures her considerably for the following season; milking once a day should be begun about ten weeks before the cow is due to calve, and she ought to be quite dry at least eight weeks before calving. There is often considerable difficulty in doing this, but the animal should be kept on straw and water until the milk leaves, if found necessary.

"As young Ayrshire heifers and cows have generally very small teats, inexperienced or heedless milkers should not be employed to milk them; after they have had one or two calves, their teats get larger, and they are as easily milked as cows of any other breed. As these cows are of lively
and active dispositions, it is very seldom indeed they require any help when calving, unless they have been allowed to get too fat; this sometimes happens when they have run on to Midsummer before calving, and when they have had very good pasture. The best way is to turn a cow, when she is about to calve, into a roomy loose box or yard, and leave her alone; it is very seldom that interference with her on these occasions does anything but mischief. When any unusual symptoms are observed, she may be looked to occasionally, and assisted if really necessary.

"A few words may here be added as to the best times and ages at which Ayrshires should be purchased in Scotland by farmers who wish to try the breed in England or Ireland. Those who wish to keep up a supply of milk in winter as well as in summer, and who have small farms, must doubt buy cows near calving or already calved, but there are serious risks in conveying them a long distance by rail. If the cows are calved, they are very liable to catch colds at draughty stations; they cannot be regularly milked on the journey, and consequently we often hear of such taking milk-fever after arriving at their destination. If, on the other hand, the cows purchased are very near calving, there are obvious risks of their calving in trucks, in which case I have found they do not recover from it during the whole season. Perhaps the best way for those to do who cannot keep heifers for a few months is to employ a cattle agent, in a district where many of the breed are kept, to go to the farmers' houses who have cows to sell, and to buy them when they are only beginning to 'spring,' and these may be conveyed with comparative safety by rail. To the English or Irish farmer, however, who has a good outlet for cattle through the winter, I recommend him to buy at some of the Scotch fairs in October or November; he will get good heifers, rising three years old, warranted in calf, from £12 to £14 each: these will thrive on grass fields through the winter, and they do not require anything extra until snow or frost comes, when a little chaff daily will keep them well enough until they can get a sufficient supply of rough grass again. I purchased twelve such heifers in Lanarkshire last year (1877), and now, at the beginning of May, those dropping their calves are in very high condition; some of them are actually too fresh, having had a month's good pasture. Good cows, from four to six years old, will cost, at calving, from £16 to £22 each, according to size and appearance, and such cattle imported in February or March will, in all probability, leave the first cost of themselves to the owner before Christmas following, provided he can sell all their milk for the very moderate price of 6½d. per gallon.

"It may be convenient here to give a few well-authenticated cases of the quantities of milk given, or weight of butter produced, by some good specimens of this breed:—

"Mr. Burn tells us, in the book previously quoted from, that the Duke of Athole bought an Ayrshire cow from Mr. Wallace, of Kirklandholm, which produced 1,305 gallons of milk from 11th April, 1860, to 11th April, 1861, or about 17 quarts daily for forty-four weeks. He estimates the value of the new milk at 9d. per gallon, and that would give £48 18s. 9d. in a year.

"In June, 1865, I set aside the milk of a number of my best cows, in order to try how much butter they would each yield in seven days, with the following results:—The best cow produced 14 lbs. of butter, and the worst very nearly 12 lbs., in the same time; these cows were all pure Ayrshires, bred from stock which I had imported from Scotland. The pasture they had was first year's clover seeds, and they had no other food whatever; the quantity of milk required for each pound of butter was nearly 12 quarts. The experiment was made on the farm of Saekville, near Tralee, Ireland, and was conducted with great care and exactness.

"In County Durham there are many farmers who keep Ayrshire cows. In July, 1876, one of those farmers showed me his dairy-books, from which it appeared that in 1875 the gross returns from his thirty-six cows were over £25 each cow; and he assured me that he thought it a very bad year indeed when they produced less than that figure each. This gentleman had carried on his dairy for nearly thirty years in that neighbourhood, and had always, up to that date, bought cows as he required them in Scotland. This seems the best plan for English farmers to follow; for whether it is due to the climate, food, or their management, it seems certain that those bred and reared in England seldom prove as good milkers as those which are brought from the north; the latter are always much harder also, and in the midland and southern counties they thrive very
well, with little or no shelter, even in winter time, if only they have a fair bite of grass on the pasture."

At a recent meeting of the New York Dairymen's Association, Mr. Robert M'Adam read a paper, giving the results of his experience of Shorthorns and Ayrshires in the dairy. He said he began dairying in 1843 in Scotland, and followed it till 1869; that he had studied the two breeds carefully on the farm and at fairs; that he had known many large milkers among the Shorthorns. He thinks the preference given by the best Scotch dairymen to the Ayrshire over the Shorthorn, where either could be easily obtained, ought to go a good way in deciding the question between the two; that a few great milkers are not evidence of the general quality of a breed, but rather the average produced by large numbers. In 1863 he purchased the milk from a neighbouring Shorthorn herd, and mixed it with that of an Ayrshire herd, and found that the mixed milk was poorer than that of his own herd had been before. He made a comparative test next season (1864), and for the month of June found the following result:—

**Ayrshires** — 66 cows — 65,380 lbs. of milk; cheese, 6,424 lbs.; ratio, 10:17; daily average of milk per cow, 33 lbs.; cheese, 3½ lbs.

**Shorthorns** — 66 cows — 52,680 lbs. of milk; cheese, 4,797 lbs.; ratio, 10:98; daily average of milk per cow, 27 lbs.; cheese, 2 7-15 lbs.

He says both herds were pastured in adjoining fields, on land of similar quality. Both herds were esteemed first-class of their respective breeds. He for some years was an instructor in cheesemaking, and made cheese in a hundred different places, and had opportunities of examining a great number of herds; took notes of the yields of various dairies, and the general results were in favour of Ayrshires. He thinks that land which will maintain nine Shorthorns will keep ten Ayrshires, and that the latter will yield more and richer milk, and are harder and more prolific. For a period of twenty-five years the average yield of his own dairy was 500 lbs. of cheese per cow.

**Qualities of Ayrshire Cattle.**

Under the microscope the milk of the Ayrshire is found to be well stocked with nitrogenous matter, or casein, and the cream globules are numerous, but very unequal in size. This defect tells against the Ayrshire as a butter-cow, for the cream does not rise well when the globules are unequal in size, nor is all the butter got out of it except by skilful churning.

Mr. Allsebrook, of Wollaton, Nottingham, writes to us as follows on Ayrshire cows in the Midlands:—

"During the last ten years I have had Ayrshire cows in my dairies in Warwickshire and Nottinghamshire, and where a large quantity of milk is desired I consider they are more valuable than any other breed. They are specially valuable where the pasture-land is not of a first-class quality, for their mouths seem to be harder than those of Shorthorns, and they do well on dry wiry pastures that would starve cattle of more aristocratic blood. On second or third rate land, heavy costly cattle require much extra care and artificial food, or they will be sure to lose money, but Ayrshires on such land thrive and do well.

"One of the objections urged against Ayrshires is that they will not feed—they are bad grazers. Doubtless some are; but some of all breeds are bad ones for that purpose. I have had many that would get fat as readily as cattle of other breeds, and if such are selected as appear likely to feed there will be little disappointment in that direction. Still, if we get a little cow that eats but little, and did not cost much; that will yield some four or five gallons of milk per day for months together, year after year, we may well forgive her if she is not easy to feed afterwards. If breeders of these very useful animals would pay more attention to the point indicated, it would doubtless be an advantage, and if dams that are good milkers and also flesh-carriers are selected, the objection would cease to be valid.

"Milk from Ayrshire cows is of a good quality, though not so rich as that from Channel Island cows. I have found, from repeated tests, that where Ayrshire cows were fairly matched against graded Shorthorns, ordinary Derbyshire cows, or good Irish cows, the Ayrshires had the best of it, their milk yielding about two per cent. more cream than the others.

"More Ayrshires can be kept on the same quantity of food. Three Ayrshires usually eat about as much as two ordinary Derbyshire cows, and three of the former will give more milk than three of the latter. Then they cost less to begin
with, fully one-third less, so the eggs are put into more baskets.

"Therefore, in comparing other dairy-cows with Ayrshires, we get these results:—They cost less to buy; they cost less to keep; the capital risked in one animal is smaller; the quality of the milk produced is better; the quantity is greater per head, and much greater for the outlay. Here is the evidence; can the verdict be doubtful?"

The great points of an Ayrshire cow are her udder and teats. The udder must reach well forward, and be firmly attached up to the body, not coming out behind or hanging loosely down; the quarters alike in size, and the teats set on widely and equally apart, neat, and not very large, square at top like a cork, not hanging together like a bunch of parsnips under a loose flabby bag. For breeding, milking, and ultimate fattening combined, the first place must be assigned to the Shorthorns, but for milk alone that place may probably be assigned to the Ayrshires. They are especially hardy and vigorous in constitution; and their superiority over many other breeds is most apparent under adverse circumstances—hilly land, with scant pasturage, and a climate subject to sudden and extreme changes of temperature. The cheerful look, the earnestness of manner, and the great physical activity of the Ayrshires stamp them at once as being valuable and trustworthy cattle; and these qualities, combined with those previously mentioned, are a strong recommendation to farmers in districts to which nature has not been kind, as well as in those which are favourably situated. Dairying districts, as a rule, are those in which the climate is more or less variable, where the atmosphere is cool and showers of rain are frequent, favouring the growth of pasture-grasses; where the winters are not infrequently severe and the springs and autumns treacherous; where the general conditions of weather and soil are adapted to the growth of green rather than grain crops. To such conditions, particularly in more extreme cases, Ayrshires appear to be specially well adapted, so far as physical fitness is concerned; while, as regards their milking properties, there is hardly room for two opinions. On wet, clayey, or heavy soils of any kind, on which heavy breeds of cattle do much harm in a "dropping season," the lighter Ayrshires are an advantage, because they do not tread up the ground so much, and so destroy less of the grass. The Ayrshires possess, of course, a few undesirable qualities, but the only ones worth mentioning are their somewhat deficient aptitude to fatten, the shortness of their teats, and their sleepless pugnacity of disposition toward each other.

The Ayrshire cows given in the Plate are His Grace the Duke of Buccleuch's "Lady Kilburnie," winner of the "Ayrshire Derby" in 1877, Mr. Cassel's "Jeanie," and Mr. Dunlop's "Daisy." The first is red with but little white, the second has many small spots of colour, and the last a few and larger spots.
CHAPTER III.


Channel Island Cattle—Probable Origin—Qualities—Great Milking Powers—Longhorns—Bakewell’s Herd—Not as a rule Remarkable for Milk—But Capable of Improvement in this Respect—Instances—Herefords—Recently Modified in Colour—Characteristics—Devons—Two Types—Richness of the Milk—Sussex Cattle—Probably an Offshoot from the Devons—An Improving Breed—Polled Breeds—Galloways—Angus or Aberdeen Cattle—Norfolks and Suffolks—West Highland Cattle—Kerries—Their many Good Qualities—Irish Cattle Generally—Welsh Cattle.

The source from which the Channel Island cattle originally sprang is not known with anything like certainty; presumptive evidence, however, points to Normandy and to Brittany, on account of their nearness to the islands. But as these island cattle are now totally different in type from those of the adjacent mainland, it is probable that if they ever came from there at all they must have come many hundreds of years ago. The Brittanies are mostly black-and-white in colour, and the Channel Islanders never so. This striking difference between them removes to a very distant point the probability that they have had a common origin. An island home for cattle is, of course, highly favourable for the formation of a type differing from the original stock, providing the natural influences of soil and climate are sufficiently marked to bring about the change; and in this case we may infer that identity would not be maintained by repeated importations from the mainland, for the inhabitants of the islands have long been jealous, and have prided themselves in their jealousy, of the purity of the breed of their beautiful cattle—and, indeed, a most excellent jealousy it is. The radical differences which exist between these island cattle and their neighbours on the mainland, providing the remote origin of both is identical, are so marked, that it must have taken ages almost to bring them about; and, besides this, the type of the former is so “fixed,” that we have no room to doubt its great antiquity.

Be their origin what it may, however, these Channel Island cattle are, and long have been,
famous for the quantity and richness of their milk, and for their surpassing excellence as “butter-cows.” The Brittanies are smaller in size, but with this exception the Channel Islanders are less fleshy, physically weaker, lighter boned, and generally smaller than the cattle of the adjoining districts of France. These differences are accounted for by difference of soil, of climate, and of treatment. The mainland cattle generally are stronger, robust, and harder than those of the islands, because they live in a less genial climate, have less affectionate care bestowed upon them, and roam at large on the pastures; and the Brittanies are smaller and harder on account of a poorer soil and a severer climate. The climate of Jersey is remarkably genial, and its soil is fertile; on the north and west the island is fringed by a high rocky shore, which secures to the southern-sloping land a grateful shelter against the cold and boisterous winds of winter. The breezes of the Atlantic that sweep over it, and the strong tides that wash its rocky beach, are greatly tempered by the warm and softening influence of that Gulf Stream to which the west coast of Ireland owes its adventitious mildness and fertility. The grass is green and nutritious, and the japonica blooms throughout the winter; so that the winters and summers of Jersey are not in violent contrast, and all its seasons are mild and uniform. So far the influence of climate on the type of cattle.

The agriculture of Jersey is gardening rather than farming, so thrifty and industrious are the people. The farms are usually very small—say twenty acres or less on the average; the cultivated crops are to a great extent raised by spade-husbandry and hand cultivation, and the abundant seaweed provides a cheap and valuable manure; the fields are very small, and their productive capacity is raised to a high position. When deep ploughing is needed for the growth of root crops, the farmers join their teams and help each other, turn and turn about, because on one of these small farms the horses kept are not alone sufficient for the purpose; and high farming on a small scale is carried out to a degree scarcely to be found anywhere else, out of China and Japan. The pastures on which the cattle graze in summer are orchards or small crofts, and from their birth none of the animals are allowed to ram at will, even in those small enclosures, but they are always either tended by children or tethered.

A convenient and effectual tether-peg is made from a bar of iron three-quarters of an inch in diameter (if of steel, half an inch is sufficient), by twisting it into the form of a corkscrew, bending it at the top into a ring, to which the rope is attached. Such an implement is shown at Fig. 6, and when screwed into the ground will hold an animal very securely, and sometimes be found very handy for other purposes. Another excellent iron tether-peg has been patented in America, and is shown in Fig. 7. In this form the top is hollowed out, and the rope secured by a large knot. Such a peg cannot possibly be pulled out of the ground, neither can the rope get twisted or caught round the top.

This method of treatment, and the great care bestowed upon them at all times and seasons, have made the Channel Island cows very docile and gentle, though at the same time less hardy and vigorous than they otherwise would have been. The comparative want of exercise has, however, done more than affect the character and physique of the breed—it has influenced it also with regard to the exceptional richness of the milk.

Fig. 6.—Iron Tether-peg.

Fig. 7.—Improved American Tether-peg.
Where there is little or no exercise there is no hard breathing, and consequently only a moderate degree of oxidation or combustion of carbon in the animal economy; and as the hydrocarbons of the food the animal eats are converted into butter, the less exercise an animal takes the richer the milk will be in the fats of which butter is composed. On the other hand, physical exercise tends to the formation of muscle or flesh rather than of milk—that is, the food of the animal is in part diverted away from the production of milk, and especially of rich milk.

Such being the case, it naturally follows that animals treated and bred in the way the Jerseys have been for generations will acquire, as one of their marked features, the capacity to produce milk very rich in quality; and this feature is transmitted from parent to offspring just as surely as any other quality that has been acquired by breeding in a given direction.

Bred on islands limited in size, whose inhabitants for generations past have been most particular not to admit the cattle of other countries, and in this way have constantly aimed at maintaining the purity of their own stock, the blood of the Channel Island cattle has become more nearly thorough in its concentration, prettiteny, and refinement, than that of most other breeds of the bovine race. In the island of Guernsey, for instance, stringent local laws were enforced long before the present century; and when an attempt was made to have them repealed, on the plea of cheapening butchers' meat, a counter-petition was presented to the Crown not to allow the repeal, and after the arguments on both sides had been heard and discussed, an Act was passed strengthening the time-honoured customs of the island. Similar laws apply to the island of Jersey. But though to the purity of the breed of these cattle such uncommon value was attached a century or more ago, they have in modern times been very greatly improved by careful selection in breeding, and the Channel Islanders of to-day are very superior to those of seventy years ago. Yet, writing even in 1834, Youatt says* "they fatten with a rapidity that would be scarcely thought possible" when not in milk. Under the fostering influence of a genial climate, a fertile soil, kind and generous treatment, and a jealous watchful-

* "Cattle: Their Breeds, Management, and Diseases," p. 268.

ness as to purity of blood, the Jersey cow has ripened into what she is—a small, gentle, and exceedingly useful animal, famous alike for meekness and for milk, for butter and for beauty! The uncommon richness of the milk she gives, and the quantity and quality of the butter it will yield, are characteristics acquired by careful breeding through a long period of time. Butter made from her milk is a higher colour than that from the milk of perhaps any other breed, and it has the advantage of being more easily worked, and of being firmer and more wax-like in texture. The cream globules are larger in size, and this accounts for the cream rising so readily and thoroughly on the milk; the envelope of casein seems thinner and weaker, and to this may be ascribed the ease with which the butter comes out of the cream in churning; while the unusual firmness, richness, and flavour of the butter are due to qualities not yet determined.

The cream globules of milk are in all cases infinitesimally small, but they differ in size in the milk of different breeds. The globules in Ayrshire milk are intermediate between those of Dutch and Jersey, and the following figures illustrate the difference between those in Jersey and in Ayrshire milk:—

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In England, Jerseys are not much used as ordinary dairy-stock, but they are in great demand for family use where only one or two are kept. In America many large herds of them are kept for purely dairy purposes, where clotted cream and finest quality butter are in demand; and it is no uncommon thing in the latter country, where results are carefully noted, for cows of this breed to produce an average of upwards of 300 lbs., and in some cases 400 lbs., of butter in a year. Instances are on record where single cows have yielded even upwards of 500 lbs. in the same period.

A curious experiment was recently made by General W. S. Tilton at the National Soldiers' Home, near Augusta, Minnesota.† The herd consisted of Dutch cattle, grades, and Jerseys. The average of milk per day for the whole year, as

† "Prize Essay on Jersey Cattle." By George E. Waring, Junior.
compared with the average weight of the cows of each class, was:—

Dutch ... 31 1/10 4 lbs. ... 1 3/10 per cent. of live weight.
Grades ... 3 3/10 " 5,849 lbs. ... 1 3/10 " "
Jerseys ... 3 7/10 " 5,876 lbs. ... 1 3/10 " "

The proportion of cream was as follows:—

Of Dutch, it took ... 3.7 lbs. live weight to produce 1 quart.
Of Grades " 3.8 lbs. " " "
Of Jerseys " 3.8 lbs. " " "

So that if an animal (other things being equal) consumes food in proportion to its weight, then, in order to make as much cream from the other breeds as can be made by a Jersey consuming 2,649 lbs. of hay, we must feed a Dutch cow 2,649 lbs., or a grade 2,402 lbs. As the cream of Jersey milk produces more butter per quart than that from the other sorts of cattle, the advantage in butter-making is still more in favour of the Jerseys.

All the animals in the Jersey plate, except the one on the left, are the property of Mr. Simpson, of Wray Park, Reigate, to whose courtesy we are indebted for the photographs from which the portraits were painted. Their names are—the bull Prince Albert Victor; Jersey Lily next to him; Luna in the foreground; Alice Grey close behind; and Her Majesty farther off on the right. The cow on the left of the plate is an excellent specimen of a Jersey, named "Young Panzy," now in America, and exported to that country from the island. The cow Luna has been three seasons in milk, with the following record:—

1876 ... ... ... 876 galls.
1877 ... ... ... 808 "
1878 ... ... ... 816 "

This is a return rarely surpassed by cows of equal size of Luna, and is a powerful testimony to the extraordinary ability which, under generous treatment, the Jerseys possess for the production of a very large quantity of milk, the quality of which is also superior to that of most other breeds of cattle. We have known the milk of a Jersey cow throw up 25 per cent. of good firm cream.

LONGHORN CATTLE.

Yorkshire is a famous county! To have produced, or at all events to have greatly helped in producing, the noblest breed of cattle the world has yet seen—the Shorthorns—were enough to lend to the county a lustre which time will not efface. But this is not all, for the Longhorns, too, sprang from "the district of Craven, a fertile corner of the West Riding of Yorkshire, bordering on Lancashire," while their great rivals and supplaters came from the other side of the county. The Ayrshires, too, are said to owe a great deal of their blood to Yorkshire. We may again regret that nothing more definite than tradition exists to supply us with a record of the early doings of these Yorkshire cattle. It is not known whether the Longhorns were imported into Yorkshire from some foreign country, or whether to the peculiarities of the soil and climate of the Craven district we are to give the credit of developing them out of the ancient roaming cattle of the north of England. One thing, we think, is circumstantially clear, viz., that the farmers of Yorkshire, two or three centuries ago, were ahead of those of the rest of the country in their ideas as to the improvement of the bovine race; for, however much soil and climate may have had to do in the matter, it is not to be supposed that only in these two limited districts were the natural influences so active as to produce, unaided by man, two of the most famous breeds of cattle that have yet been known. Be these things as they may, however, the Longhorns had spread over most of the midland counties, and had become the prevailing stock in them, long before the Shorthorns had begun to migrate far from their original home. Looking at the stock which now prevails in those counties, it is difficult to realise that Longhorns were universal in them less than a century ago. But it is a fact, nevertheless; and the great change that has taken place in the short space of a single century speaks volumes in favour of the prepotency of the Shorthorns.

The earliest record we have of a systematic attempt to improve Longhorns relates to that of Sir Thomas Gresley, of Drakelow House, Burton-on-Trent, and dates back to the early years of the eighteenth century. The next relates to a farmer and farrier named Welby, also a Derbyshire man, who had obtained his "valuable breed of cows" from Sir Thomas, and took a pride in "improving them and keeping the breed pure." The next improver of the breed, so far as we know, was a Mr. Webster, of Canley, near Coventry; he, too, had some of the stock of Sir Thomas Gresley, and was at great pains to procure bulls from
Lancashire and Westmoreland. His success was so marked that he is said to have had the best cattle then known; and one of his admirers says "he possessed the best stock, especially of \textit{beace}, that ever were, or ever will be, bred in the kingdom." It may be interesting to relate that the word "\textit{beace}," meaning dairy-cattle, is still used in some parts of the midland counties.

We come next to the greatest of all breeders, the famous Robert Bakewell, of Dishley, who was himself born, in 1725, at the place whose name, along with his own, will never be forgotten. It is not to Longhorn cattle, however, so much as to Leicester sheep, that Bakewell's fame attaches; yet he did so much even for the cattle that posterity have awarded to him the merit of having created, as it were, a new breed. He took in hand the Longhorns, because the Shorthorns were then but little known; and we can but regret not only that he did not try his hand on the Shorthorns as well, but that he left behind him no record of the eminently sound principles which guided him in his selection and classification of animals in breeding. The results he attained we know—they were, a small proportion of bone and offal and a large one of meat, utility and beauty of form, superior quality of flesh, early maturity, and aptitude to fatten—but of his own unique system we know nothing, or next to nothing, except from conjecture. He made excursions into various parts of England, inspecting celebrated herds of different breeds, but less to buy stock than to ascertain the highest possibilities of breeding. He thus formed in his own mind a sort of eclectic model of what an animal ought to be, and, under his perfect skill in classing the animals together, the various excellences he sought to attain soon fell into the one mould he had made for them. His Longhorns trace back to those of Sir Thomas Gresley, for he bought two heifers from Mr. Webster, of Canley, and procured a promising bull of the same breed from Westmoreland. To these and their offspring he chiefly confined himself, so mating them together as to develop and establish the desired points of excellence, and as his stock increased in number he was able to do this without too close in-breeding. In a very few years his stock were unapproachable for fineness of bone, smallness of offal, quality of flesh, and symmetry and beauty of form, but—not for milk. And yet Longhorns are not inferior milkers, but, as in too many Shorthorn families of the present day, milk was sacrificed to other qualities in the famous herd of Longhorns at Dishley. The farms of Drakelow, Canley, and Dishley stand in relation to Longhorns much in the same way that those of Ketton, Kirklevington, and Waraby do to Shorthorns; but the influence of the former has not radiated so far as that of the latter trio of bovine shrines, though these have borrowed their light from the former.

Mr. Bakewell was a man of surpassing kindness. His servants remained with him twenty, thirty, and even forty years, and his treatment of the cattle is described by Arthur Young in these terms:—"Another peculiarity is the amazing gentleness in which he brings up these animals. All his bulls stand still in the field to be examined; the way of driving them from one field to another, or home, is by a little switch; he or his men walk by their side, and guide them with the stick wherever they please, and they are accustomed to this method from being calves. A lad, with a stick three feet long and as big as his finger, will conduct a bull away from other bulls, and his cows, from one end of the farm to the other. All this gentleness is merely the effect of management; and the mischief often done by bulls is undoubtedly owing to practices very contrary, or else to a total neglect." To this we may add that a good deal depends on the natural disposition of the bull.

We have said that the prevailing stock in the midland counties less than a hundred years ago were Longhorns, and that they have been displaced by Shorthorns. Writing in 1809, William Pitt says,\textsuperscript{*} "The natural breed of cattle in Leicestershire is now the Longhorns." He also makes similar statements with regard to Derbyshire and Staffordshire. The change from Longhorns has been effected by repeatedly crossing with Shorthorn bulls the ordinary dairy-cattle of the country, and now the prevailing type is Shorthorn. It is thought by some that the Shorthorn element predominates too much, and that a dash of Longhorn blood now and then would be beneficial. In some districts this has been tried, but, we believe, with indifferent success. The offspring are found to be very raw; yet we think if the system were fairly tried through several generations, the two elements would be found to blend together, to the advantage of the stock as dairy.

\textsuperscript{*} "A General View of the Agriculture of the County of Leicester," 1809, p. 216.
cattle and as beef-producers. The home of the Longhorns is still in the midland counties, but there are not very many pure-bred herds; we are, however, glad to know that these grand old cattle are coming once more into favour, and a herd-book has recently been established to promote and systematise the breeding of pedigree Longhorns. A well-written account of the breed, by the Hon. Secretary, Mr. Lythall, appears in the first volume of the herd-book, and there are 286 bulls and a still larger number of cows entered in that volume. These form nuclei from which the Longhorns may again be disseminated throughout the country, though we can hardly expect they will again occupy the relative position they once did. Among the leading breeders whose names are given in the first volume of the herd-book we find His Grace the Duke of Buckingham; Sir John Harpur Crewe, Bart.; Major-General Sir F. W. Fitzwygram, Bart.; Colonel Inge, Tamworth; the Hon. M. W. B. Nugent, Hinckley; Messrs. R. H. Chapman, St. Asaph; W. S. Shaw, Lichfield; R. Brown, Lichfield; J. H. Burbery, Kenilworth; John Godfrey, Hinckley; and nearly seventy others—enough, in fact, to guarantee that the old breed of the midlands still retains its hold, and that it will not be lost sight of.

Among the folk-lore of the midland counties it is not uncommon to find traditions to the effect that the old cattle of the district were very good milkers and beef-makers. As to the former qualification, it is stated by Mr. Pitt, from whom we have previously quoted, that in the Vale of Belvoir "the cows are in part Holderness or Shorthorn; these eat the most food and give the most milk, but the milk of the Longhorn is richer, and will produce more cheese or butter." And as to the latter breed, he tells of two oxen, bred by Mr. Princep, of Croxhall, Derbyshire, and fattened in 1791 by the Marquis of Donegal at Fisherwick. "These oxen," he says, "I saw a short time before they were slaughtered; they were much alike in size and condition. One of them was carefully weighed by Mr. Bowman, his lordship's steward; the four quarters weighed 1,988 lbs., the tallow was 200 lbs., and the hide 177 lbs.; this ox, at the common price of beef in the country, was worth £60, or guineas." At the sale of Mr. Paget's Longhorns, November 14th, 1793, the bull Shakspeare fetched 400 guineas, "and afterwards served cows at 25 guineas each. I saw him at Mr. Stone's, Quordon, W. P."

Many Longhorn cows have been famous for giving very large quantities of milk, but the breed, generally speaking, is more celebrated for the quality than for the quantity of it. Mr. R. H. Chapman, of St. Asaph, a famous breeder of Longhorns, informs us of a herd of twenty of these cattle, belonging to Mr. Taverner, of Upton, making 1½ tons of cheese in the season without any extra keep, and of one cow that gave 16 quarts of milk at a meal.

The Longhorns whose portraits are given in the plate are the property of, and were bred by, Sir John Harpur Crewe, Bart., of Calke Abbey, near Derby, by whose courtesy we are enabled to present our readers with good typical specimens of the breed. Their names are "The Abbot of Calke," "Canley 2nd," in the foreground of the plate; "Lofty 2nd," the middle one of the three cows farther off; "Tulip 10th," on the left; and "Beauty 4th," on the right of the picture.

**Herefords.**

The Herefords are said to be an aboriginal race of cattle, bred for ages in the county from whose name their own name is derived. Very little that is trustworthy is known of their history earlier than the present century, but they are commonly
admitted to be one of our oldest breeds. The Hereford breeders of a century or two ago, content with their hardy, superior, meat-producing breed of cattle, were not careful to leave us any of the information which, familiar enough to themselves, is now lost to us for ever. This absence of definite knowledge has led to many conjectural statements and to much conflicting argument concerning this fine old race of cattle. Some writers have contended that they were originally "self-coloured," like the Sussex and Devon cattle; others that they are in part descended from a very ancient race of white cattle, having red ears, which existed a thousand years ago in the counties of Brecknock and Radnor; and one writer* went so far as to say that, more than two centuries ago, Lord Scudamore had imported from Flanders cows of the "red and white face" breed. Mr. Rowlandson says,† "the old Herefords are said to have been brown or reddish-brown, and it is only within the last eighty or ninety years that it has been the fashion to breed for white faces;" and he tells the story of the supposed origin of white faces, which is said to have been purely accidental, or a mere freak of nature, as owing to a favourite cow, belonging to an ancestor of Mr. Tully, who lived at Huntington, having produced a white-faced bull-calf—an instance, he says, that had "never been known to have occurred before." But Mr. Smith writes,‡ in direct contradiction to this, "that the race was originally red with a white face is clearly indicated by the almost perfect uniformity of colour which the breed of the county now presents."

In the presence of such conflicting testimony, and in the absence of any that is more authoritative, it is not easy to come to any satisfactory conclusion as to what the ancient Herefords really were in colour. That they have not always been so uniform in colour as they now are is evident from the fact that Mr. Eyton, on issuing in 1845 the first volume of the Hereford Herd-book, found it expedient to divide them into four classes—viz., mottle-faced, light grey, dark grey, and red with white face. The first three varieties are now nearly extinct. Writing in 1805, Mr. Duneumb says:§ "The cattle of Herefordshire have long been esteemed superior to most, if not all, the breeds in the island. Those of Devonshire and Sussex approach nearest to them in general appearance. Large size, an athletic form, and unusual neatness characterise the true sort; the prevailing colour is a reddish-brown, with white faces." And Mr. Youatt, writing thirty years later, says:|| "They are principally distinguished by their white faces, throats, and bellies. In a few the white extends to the shoulders. The old Herefords were brown or red-brown, with not a spot of white about them. It is only within the last fifty or sixty years that it has been the fashion to breed for white faces." Rowlandson's statement respecting colour is evidently a transcript of Youatt's. It is probable that the red with white face is, and always has been, the true Hereford colour, and that any deviations from it are the results of various haphazard crosses with other and adjoining breeds of cattle; for, as Mr. Duckham well observes,¶ "had the previous tale of the bull-calf been true, his progeny could not possibly have given the prevailing character to the breed of the county in so short a space of time." Even if it had been possible that one animal, born five quarters of a century ago, should have given to an entire breed a new and distinct character, so

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* Mr. J. A. Knight, of Downton Castle, 1809.
† Journal of the Royal Agricultural Society, 1853, p. 450.
‡ Journal of the Royal Agricultural Society, 1858, p. 366.
|| "Cattle: Their Breeds, Management, and Diseases," 1834, p. 31.
far as colour is concerned, there would still be numerous instances of departure from it, and not that striking uniformity that we see. It is, however, possible that in the far-away past, before the breed became domesticated, the progenitors of the Hereford cattle were, as most animals in a state of nature are, self-coloured; and it is also possible that the white portion in the colour of the present representatives of the race may be due to an ancient cross with the wild white cattle of Wales.

But however many differences in colour there may have been among Herefords in the past, the form and build of the different sorts were much the same. They were, as they are, noble-looking, having a free and easy gait, heavy-necked, strong-boned, deep in the fore-quarters and rather light in the hind. The characteristics of the red and white faces are stated by Mr. Duckham in the following terms:—"The face, throat, chest, lower part of the body and legs, together with the crest or mane, and the tip of the tail, a beautifully clear white; a small red spot on the eye, and a round red spot in the middle of the white on the throat, are distinctive marks that have many admirers. The countenance is at once pleasant, cheerful, and open, denoting good temper and that quietude of disposition which is so essential to the successful grazing of all ruminating animals; yet the eye is full and lively; the head small in comparison to the substance of the body; the chest deep and full, the bosom sufficiently prominent, the shoulder-blades thin, flat, and sloping towards the chine, and well covered on the outside with mellow flesh; and so beautifully do the blades blend into the body, that it is difficult to tell, in a well-fed animal, where they are set on; the chine and loin broad, hips long and moderately broad, legs straight and small, the rump forming a straight line with the back; thighs full of flesh to the hocks, a well-sprung rib and deep flank; the whole carcase well and evenly covered with rich mellow flesh; the hide thick, yet mellow, well covered with soft glossy hair, having a tendency to curl." So far as horns are concerned, they belong to what is called the "middle horn" class.

Hereford steers are still extensively used in some of the south-western counties for work on the farm; and after working for a few years they are fed for the butcher. The beef of this race of cattle is held in high estimation on account of the pleasant admixture of fat and lean and the excellent flavour; and male and female alike are said to be second to no other breed in rapid fattening on a given quantity of food. Though not so hardy as the Devons, they are active in search of food, doing well in districts not suitable to Shorthorns.

Hereford cows, as a rule, are not good milkers. Having in the past been only required to rear their own offspring, as the custom of their native district is, they have in this respect been left almost wholly in a state of nature. Hence their milking properties have been left to take care of themselves, aptitude to fatten having been cultivated instead. It is probable that no equally capable milkers have been allowed to acquire so poor a reputation as dairy-cattle. When the requirements of the offspring are the sole medium by which the parent's milk is regulated, it follows that no great quantity of milk will be given, and the period of its flow will be of limited duration—this is what nature dictates. And deep-milking characteristics are the result of treatment tending that way, of breeding for that object, and of domestication generally. These kinds of treatment and breeding have not been applied to the Herefords in times gone by. But in many parts they are now being bred with a view to the dairy, and their milking properties are being specially developed; their calves are not allowed to suck from them, and they are being hand-milked instead; and they are already, under training in the right direction, rapidly gaining favour as dairy-cows, and are proving themselves to be well qualified for the production of cheese and butter, for their milk, though not very great in quantity, is rich in quality. So far, good.

Mr. Duckham says:—"The Hereford is peculiarly a flesh-producing animal, displaying great aptitude to fatten, and unsurpassed for early maturity. The soil of the county, the home of the breed, is not adapted for dairy purposes; thus the general system of calf-rearing is to allow it to run with its dam during the summer months, weaning it when the cow is brought to the straw-yard for the winter. In all well-cared for herds the calf is never allowed to lose the flesh it has thus acquired, but during the winter months it is fed upon hay, roots, and a small allowance of linseed cake. Whether steer or heifer, it pays for a fairly liberal treatment, that it may go out to grass in the spring in fine condition. The steers so managed
will, at eighteen months old, realise £1 per month on their age."

It is claimed for the Herefords that they will fatten on less food than the Shorthorns, that they mature as early, that their flesh provides us with better beef, and that they are harder and more active. It is not, of course, claimed that they are as good, or nearly as good, dairy-cows; but that they are in most other, if not in all other, respects the equal of their great rival, and that in some of them they are decidedly superior. But if their milk is smaller in quantity than that of the Shorthorns, it is richer in quality. Whoever visits the Bath and West of England Society's Show will find Herefords so superbly well-proportioned that no kind of animals, be they Shorthorns or any other, can be found to surpass them. For a long time they have been in great demand for grazing purposes in the counties adjoining the metropolis, and perhaps for a still longer time they have been highly esteemed on account of the fine quality of beef they yield, which, "by the intermixture of fat and lean, presents that marbled appearance so much prized by the epicure, and commands the top price in the market."

In parts of the United States, in Canada, in New Zealand, and in Australia, the Herefords are great favourites. In the two former countries the breeding of these cattle will probably be stimulated by the fat cattle and fresh meat trade which has been established quite recently, because they are specially well adapted for meat production. In those foreign countries to which they have been sent already, they are found to readily acclimise and adapt themselves to new conditions, retaining all the while their character, form, and quality. These facts go far to prove antiquity of type, for recently-acquired qualities do not stand the test of other countries and climates. They are a noble race of cattle, handsome and picturesque, docile and profitable; and now that they are turning out to be reasonably good milkers, we may expect them to multiply in number among the dairy-farms of Britain. Public attention is being turned toward them, and they have been and are being greatly improved by careful selection in breeding.

THE DEVONS.

The northern part of the county of Devon has long possessed a breed of cattle, whose compactness and general beauty, activity as workers, and aptitude to fatten have made the county and the cattle alike famous. In the southern part of the county a similar race of cattle prevails, possessing the same general characteristics of form and colour as those of the northern part, but somewhat larger and coarser. The difference is chiefly caused by the difference in soil and climate. In the north there is much poor, very poor land, which is bleak, wet, and exposed, and it is here that the North Devons have acquired their compactness, hardiness, and activity. In the southern and western counties of England it is still quite common to use steers for draught purposes both on the road and in the fields, though not so much on the former; and for this purpose the North Devon steers are said to be unequaled by those of any other breed.

If it be true that what is called "self-colour"—that is, the same colour throughout—is a proof of the antiquity of breed, then the Devons may fairly be regarded as one of our aboriginal breeds of cattle. Red is the true Devon colour, though the red varies as to shades from a rich dark red to an almost pale chestnut; still, the colour prevails all over the animal, and no other colour is found among it in patches, as the case is with most of the northern breeds of cattle—to wit, the Shorthorns, the Longhorns, and the Ayrshires. Some animals have patches of white among the red, but these are regarded as not true Devons. Domestication has not at present, whatever crossing may have done, caused much, if any, deviation from the true original colour. At the famous Smithfield Show the place of honour in the catalogue is always given to the Devons, and their singular neatness, compactness, and symmetry always command the admiration of the visitors who come to the show. They have also a gentle and placid look which is very attractive; and while their hardiness enables them to withstand a cold climate, and to thrive on a herbage where the larger Hereford and Short-horn would starve, they always do remarkably well when removed to a warmer climate and a richer soil. The North Devons, too, may be regarded as the true Devons, for while the larger and coarser cattle of the south of the county owe their differences of type chiefly to a richer soil and a warmer climate, they are said to owe them also in some measure to crosses with the old Somerset and Cornish cattle; the South Devons are, in fact, an offshoot of the North Devons, more or less altered by the conditions under which they have been bred.
The Devons are the prevailing cattle in several districts in the southern counties. Though evidently related, the cattle of these districts are found to vary in size, the Somersetshire variety being larger than the North Devons, and those of South Hams larger still. The last mentioned are locally known as the "Southampton breed," and are said to be a very good variety both for beef and milk. These several varieties, indeed, form by easy gradations the connecting links by which the relationship between the Sussex and Devon cattle is inferentially established. Naturalists trace in the Highland Kyles, one or two of the Welsh breeds, and the Devons, the descendants, more or less altered by crossing, by soil, and by climate, of the Bos longifrons, the small Celtic breed, which, was supplanted by the Bos urus (antiquorum), or Bos primigenius (recentiorum), varieties of which, it is supposed, were introduced by the Teutonic alloy-conquerors of Britain, and to which it is thought our different varieties of cattle are traceable.

The Devons are not celebrated for giving large quantities of milk, but their milk is rich in quality, and Devonshire cream is known far and wide. A large quantity of milk is indeed scarcely compatible with very good quality; but with regard to this matter there is a great difference among breeds of cows. The size of the cow, again, is, or ought to be, taken into consideration with respect to quantity of milk, and as the Devon cows are rather small it is not to be expected that they should give large quantities of milk, and particularly so when they have not been specially bred for that purpose, as, for instance, the Ayrshires have. In times past the Devons, like the Herefords, have been bred chiefly with a view to the development of the male rather than the female animal, because of the value of the steers for draught purposes; the cow, consequently, is as a rule much smaller than the ox. Now, however, the case is being altered, and the cows themselves are being greatly improved, while they are becoming more valuable as dairy-cattle. As beef-makers the Devons are not easily excelled by any breed whatever, and comparisons have been made which prove that on a given quantity and quality of food they will make more beef than almost any other breed, while the beef itself is of excellent quality, compact, sweet, and juicy. The North Devons commonly have a beautiful curly coat of hair, whilst that of the South Devons is usually straight and less pleasing. The skin is mellow and elastic, handling well. The bone is usually very fine, and the offal generally is small in proportion to the meat. The horns are of the middle size. The countenance is cheerful and pleasing, and presents a deer-like appearance that establishes its beauty and refinement. The eye is full, round, and clear, and has a pale, golden-coloured circle around it, which adds to its expression. A well-bred fat Devon presents a form whose symmetry and compactness are as nearly faultless as anything we can hope to attain, and it may, in fact, be taken as a model in the breeding of bovine stock.

Sussex Cattle.

Leaving out the question of size, the resemblance between the Sussex and the Devon cattle is striking. They are of the same colour, a rich red throughout; and they are much the same in form, except that the former are larger, coarser, and somewhat less proportionate. The Sussex more nearly resemble the Herefords with regard to having strongly-developed fore-quarters, giving an undue proportion of less valuable meat. The resemblance between the two former breeds is, however, so great that, taking into consideration the effect of locality, it is obvious they have at some period been one and the same breed. It is probable that the Sussex cattle are an offshoot of the aboriginal Devons, though of this we have no proof. Like the Devons, they have in the past been bred chiefly with a view to draught purposes, but now the breeding is tending in the direction of beef and milk. They are not now, and have not been in the past, celebrated for milking properties; and in this respect they partake of the general character of the breeds of cattle in the southern counties, for, while cattle have been largely bred in the north for milk and beef, they have been bred in the south for work and beef. The direction in which the breeding of the northern animals has been made to tend is the one which is now most in favour and most useful; for though steers are still used extensively in the cultivation of the soil in the southern and western counties, they are yearly becoming less valuable for this purpose; and, on the other hand, milk is in great demand for consumption in towns and cities. Youatt says:

"The Sussex cow does not answer for the dairy. Although her milk is of very good quality, it is so inferior in quantity to that of the Holderness or"
Suffolk, that she is little regarded for the making of butter or cheese. Almost every mongrel breed finds its way into the dairy in preference to her."

Great pains are now being taken to breed the Sussex cattle without the large and heavy bone which is no longer necessary, and the model aimed at is the smallest bone with the largest quantity of flesh. In the past there have been very large Sussex oxen. One fattened many years ago at Burton Park was a huge animal: his height was 5 ft. 6 in.; his length, from the back of the horns to the tail, 8 ft.; width from hip-bone to hip-bone, 2 ft. 8 in.; depth of shoulder, 4 ft. 7 in.; girth behind the shoulder, 10 ft.; and his weight, 257 st. 4 lbs. This animal was of course a wonder, but he had an immense quantity of bone, and he was generally coarse and uneven—not in any sense a profitable butchers' beast. Yet, as a rule, the Sussex oxen are favourites with butcher and consumer alike, and mature in good time, making great weights at an early age. At the Smithfield Show the fat Sussex steers usually form a prominent and even handsome exhibition in themselves; and whilst some breeds are said to be stationary so far as improvement goes, the Sussex cattle are said to be improving year by year in form and in quality. The Sussex breed has not at present been able to win the Blue Riband of the Smithfield Show, but it may do yet. We think it will one of these days.

**Polled Breeds.**

The different breeds of polled cattle have never yet, in our opinion, met with the amount of favour that they really merit. Apart from the fact of their not being disfigured by those ugly and dangerous excrescences called "horns"—a most benevolent omission by nature in their case—they are really a superior type of cattle. Some of them are celebrated for milking properties, and all of them for the quality of their beef, while many of them come to early maturity and attain considerable weights at a youthful age. But the absence of horns is their chief merit over the other breeds, and it is no small merit. It is not claimed for them that they are superior to some of our other breeds in the various qualities for which cattle are most valuable; but that they are capital feeders is proved by the fact that the champion prize of the Smithfield Show has on three occasions in the past twelve years been awarded to them—in each case, however, to Scotch polled cattle. Yet the mere fact that they have no horns is a most valuable recommendation of these cattle. Nature gave horns to cattle for purposes of defence and attack, and in a wild state the animals no doubt required them at times; but in a state of domestication horns are not only useless, but a source of danger, mischief, and inconvenience. If, in the breeding of all kinds of cattle, horns could be abolished, the gain would be great. The Americans are turning their eyes wistfully in the direction of hornless cattle, because of their superior handiness for the cattle trade to England; and, indeed, there can be no question that in no single instance would the absence of horns be anything but an unmixed good. The cattle would be less spiteful toward each other if they had no weapons wherewith to put their spite into practice, and very little harm could be done by bare heads only. There has been an outcry against the cruelty involved in the practice of dishorning cattle—that is, cutting off the horns close to the head—but in some circumstances there may be less of cruelty in that than in leaving them in possession of weapons with which to rip each other up when they get a chance to do so. We do not, however, advocate cutting off the horns of cattle, but we do recommend the breeding of animals to whom a beneficent nature has denied those terrible weapons.

**Galloways.**

The Scotch Galloways are, and long have been, a noted breed of cattle. Centuries back they were sent in numbers to be fattened in England; and writing nearly half a century ago, Youatt tells us "the polled beasts were always favourites with the English farmers." Long before the railways were dreamt of, Youatt says, "for more than 150 years," very large numbers of these cattle were sent to be fed on the rich pastures of Leicestershire and the Eastern counties. Mr. Gilbert Murray tells us that as many as 25,000 to 30,000 head were thus sent away from Dumfries alone, the journey occupying several weeks, and he assumes, we think on fairly good grounds, that the polled cattle of Norfolk and Suffolk are descended from these Scotch migrants. Youatt stated long since that "the Suffolk, like the Norfolk beast, undoubtedly sprung from the Galloway." The Galloways were liked in England because "they fattened as kindly as
the others, they attained a larger size, their flesh lost none of its firmness of grain, and they exhibited no trace of the wildness and dangerous ferocity which were sometimes serious objections to the Highland breed."

The distinguishing feature of the race is the hornless head, both in the male and female; the colour of the animals is mostly black, though some true-bred ones are red or brown, or even dun, and others, again, have white faces, and sometimes are marked with white in other parts. They are symmetrical and compact in form; the skin, though thick, is soft and mellow to the touch, and is covered with a wealth of long silky hair; the flesh is well and evenly distributed over the frame, coming well down to the knees and hocks; the shoulders are well thrown back, giving width to the chine and expansive prominence to the chest; they have long sides, with well-sprung ribs and well-rounded hips; are straight and broad in the back, short in the leg, and exhibit every symptom of soundness and hardiness of constitution. But they are not good milkers, and for this reason they have been supplanted in some districts by the Ayrshires. Youatt tells us that a Galloway cow, giving 12 to 16 quarts of milk per day, is considered a very superior milker. The milk, however, is very rich in fats, and for this reason the Galloways are good butter-cows; but it is as butchers’ animals that they have chiefly won the good opinion of those who know them well. They would greatly improve as milkers if they were bred and trained in that direction.

The counties of Wigton, Dumfries, and Kirkcudbright form the original home of the Galloways; and though they now occupy a less area in these counties, or at all events are not so numerous as they formerly were, they are still held in high esteem in many parts.

**Polled Angus or Aberdeenshire Cattle.**

There are many points of resemblance between these cattle and the Galloways, but they are usually larger, flatter in the side, thinner in the shoulder, and longer in the leg, so that their deviations from the Galloway type can hardly be regarded as improvements on it. Nevertheless, they are fine, noble cattle, and in the hands of such breeders as Sir George Macpherson Grant, Mr. M’Combie, of Tillyfour, &c. &c., they have attained considerable celebrity, and are still gaining ground.

At the Paris Exhibition of 1878 these cattle won the prize for the best group of foreign cattle. They are very hardy, good breeders, little liable to disease, arrive early at maturity, fatten quickly, and thrive well on a moderate quantity of meat. The prevailing colour is black, sometimes with a few spots; but some are a kind of yellow of various shades, or a dun, and they have a thinner skin and a smoother coat than the Galloways. Nothing whatever is known of the origin of either of these breeds of cattle, but they are regarded as distinct from each other, though it is more than probable that they were once the same. Like the Galloways, the Angus cattle are not good milkers when compared with Ayrshires or Jerseys—not good, that is, for the size of them; but this fault is attributable to the long-established practice of allowing the calves to suck from their dams. There are, however, many excellent milkers among the Aberdeens, and it is safe to assume from these instances that the breed is not by any means destitute of the qualities which go to make up a first-class dairy-breed; the one thing needful is to cultivate, as has been done in other breeds, the development of the lacteal organs. Were they treated as the Ayrshires or the Shorthorns have been, there can be little doubt of their improving in milking properties. When regularly milked by hand they are commonly found to give a very fair quantity, and under this training, and careful breeding in the same direction, these polled cattle would, after a time, be found equal to some of the more widely-established dairy-breeds. Deep milking, like any other physical property or quality, is a question of breeding and training. By Mr. M’Combie’s courtesy we are enabled to place before our readers, in the plate of Polled Aberdeens, the group of animals to which were awarded, as the best animals for breeding and for beef-producing purposes, the Grand Prize of the Paris Exhibition of 1878. Their names are—Gaily, Sybil 2nd, Pride of Aberdeen 9th, Halt 2nd, Witch of Endor, and the young bull Paris.

**Norfolk and Suffolk Polls.**

"Until the beginning of last century," says Youatt, writing in 1834, "and for some years afterwards, the native breed of Norfolk belonged to the middle horns. Their colour was usually red, or sometimes black; they possessed
many of the characters of the Devon as on a smaller scale, with their pointed, turned-up horns. A few of them are yet occasionally seen in the less cultivated parts of the country, and in the possession of the small farmer or the cottager. They have, however, been almost superseded by a polled breed." And he goes on to state that the farmers of Norfolk selected some of the imported Galloways, probably on account of their superior form and quality, and bred from them a race of cattle superior to their own—a race they had long been in the habit of procuring from Scotland; and the polled cattle gradually so gained on the horned ones that they came after a time to be regarded as the peculiar and native breed of the county. "They retain much of the general form of their ancestors, the Galloways, but not all their excellences," says he; "they have been enlarged but not improved by a southern climate and a richer soil."

It is very interesting to read, in a valuable work* recently published, of the existence in Norfolk of a race of white polled cattle which, springing directly from the ancient wild cattle of the country, had become more or less domesticated, and were excellent milkers. The Norfolk branch of this race was brought by the first Lord Suffolk from Middleton Park, in Lancashire, to Gunton Park, in Norfolk. The Gunton Park herd no longer exists, but we are told, in the work above alluded to, that "it had, however, while it existed, a great effect upon the cattle of the district." It is probable, therefore, that the cattle now known as the Norfolk polled have other polled blood in their veins than that of the Scotch Galloways, and it would be interesting to ascertain the process, with its variations, by means of which the two became merged together. The Norfolk polled cattle of to-day bear, it is true, no resemblance in colour to the white polled cattle of Gunton Park; but as colour is a property which undergoes great modifications in the domestication of cattle, the difference is no proof of non-relationship between the two.

The Suffolk cattle are, according to the oldest records, said to have been polled, and they were originally described as being dun in colour, but later on as red, red and white, and brindled. Like the Norfolk, the Suffolk polled cattle are possibly descended from the Galloways, and perchance from some of the Angus blood. The dun-coloured not infrequently found among the last mentioned would seem to establish some connection between them and the old Suffolk. Two or three centuries of life under a warmer climate and a richer soil have caused both the Norfolk and Suffolk cattle to deviate more or less from the type of their far-away ancestors. The colour of both is now chiefly red, and they are specifically known as "red-polled" cattle. But in other respects the Suffolk may be said to have deviated less widely than the Norfolk from the Galloway type. They are, for instance, somewhat lower in stature and finer than the Norfolk, shorter in the leg, broader and rounder, and have a greater propensity to fatten, often attaining greater weights. The old Suffolk cows were said to be extraordinary milkers, some of them giving from six to eight gallons of milk per day; and the red-polled cattle of both Suffolk and Norfolk of the present day are unquestionably good milkers, proving that the inferior milking properties of the Galloways are not by any means a fixed characteristic of the breed, but that they are just as capable of development as those of any other cattle. The Norfolk and Suffolk red-polled cattle are excellent fatteners, combining in themselves in a high degree the two leading uses of cow-existence—milk and beef.

To the courtesy of Mr. Loftt, of Bury St. Edmunds, we are indebted for the photographs of the animals whose portraits are given in the plate of Norfolk and Suffolk Polled Cattle.

WEST HIGHLAND CATTLE.

The West Highland cattle, or Kyloes, as they are sometimes called, are a singularly interesting breed of cattle. They are always picturesque in the field or park, and they are food for an epicure on the table. While the Ayrshires and the polled cattle owe their physical characteristics to the lowlands and less exposed districts of Scotland, the West Highlanders are essentially the cattle of the highlands and mountains. They possess all the features which a mountainous district will produce—compactness, agility, fearless courage, hardy constitution that no sort of weather can subdue, most sagacious instinct, diminutive stature,
and a warm, shaggy coat of hair. They are of various colours—black, dun, cream, red, brindled, &c.—but there is seldom more than one colour on the same animal. Reared in a bleak and boisterous district, they have acquired the ability of shifting for themselves, and of subsisting on food that would starve the lowland cattle. As with all the other breeds, nothing definite is known of their origin; it is probable that all alike have descended from one common ancestry, and soil and climate must be held accountable for the modifications. Be this as it may, however, the Kyloes are adapted to their native district, and they are found to do well when removed to others. They give, for the size of them, a fair quantity of milk, the quality of which is very good, but they are chiefly celebrated for the singular excellence of their beef, which always commands the highest price in any market.

**Irish Dairy Cattle—The Kerry Breed.**

We are indebted to Mr. R. O. Pringle, author of "The Live Stock of the Farm," and editor of the *Irish Farmer's Gazette*, for the following notes:

"The Agricultural Returns for 1878 state that in the month of June of that year there were 1,481,235 milk-cows in Ireland. The returns for previous years show that of late the number of cows has undergone a considerable decrease. Thus, in 1872 the number returned was 1,551,781, so that in six years there has been a decrease in the number of cows to the amount of 67,516 head; as compared with 1877, there was a decrease in 1878 of no less than 37,922 cows.

This serious decline in a leading department of Irish agriculture is chiefly owing to the difficulty experienced in nearly all parts of the country, of getting women servants qualified for dairy work. Many who were formerly engaged as dairy-women have emigrated, whilst those who remain are either imperfectly trained, or expect wages which the owners of dairies are unwilling or unable to pay. Hence, in many instances, dairy-farming has been abandoned, and the pastures stocked with young store beasts or with sheep.

"Irish cattle have from time immemorial been noted for their milking properties. The old-fashioned cow, now extinct through crossing, gave a large quantity of rich milk. Those cows were not Kerries; they were short-legged cattle, long in the body, and many of them were hornless, or, as they were called in Ireland, 'moyle' cattle. Others had wide-spread, elevated, and projecting horns. They were of all colours, but chiefly black, brindled, or red, and some were mottled along the ridge of the back. These characteristics, although indicating some distinction as to kind, did not affect the value of the cows for the dairy. No attention was paid to selection in breeding; but notwithstanding the neglect with which they were treated, their milking properties remained intact.

"The Kerry breed of cattle is undoubtedly an aboriginal breed, and is now the only native breed existing in Ireland; for although the common or native cattle of Connaught are larger than the ordinary Kerry, and differ to some extent in shape, still it is evident they are from the same original stock as the Kerry. There is much in the Kerry which indicates a relationship between it and the small Breton breed, and considering that Brittany and Kerry are the nearest points of France and Ireland, it is not improbable that at some remote period cattle may have been conveyed from one country to the other.

"The Kerry cow is a neat, light-made animal, with fine and rather long limbs, fine small head, lively eye, fine white horn, which in many cases, after projecting forward, is turned or 'cocked' backward. The rump is narrow, and the thigh light. The fashionable colour is pure black throughout, but some are black and white, and others red. The skin should have a mellow touch, and should be well eated with hair.

"The 'Dexter' variety is distinguished from the pure or true Kerry in having a round plump body, short and rather thick legs; the head is heavier, and wanting in that fineness which marks the true Kerry, and the horns are longer, straighter, and coarser. The real origin of the Dexter variety is not well understood, but it is supposed to be the result of special selection. Youatt described the Kerry cow as 'truly the poor man's cow, living everywhere, hardy, yielding for her size abundance of milk of a good quality, and fattening rapidly when required.' This is a correct description of the breed, both the true Kerry and the Dexter. In Ireland the Kerry is much esteemed as suitable for small villa farms; as the cows, although naturally active, are very gentle, and do well when tethered on confined bits of grass. They also thrive when kept constantly house-fed. We
have known a Kerry cow to be kept for five years in a dark stable in Dublin without injury to her health. About 12 quarts of milk daily is an average yield for a Kerry cow when she is fairly kept, and we have known some cows to give as much as 16 quarts daily for a considerable time after calving. The yield of butter is 1 lb. from 11 quarts of milk; but we have known a higher percentage of butter to be obtained.

"Youatt says the Kerry cattle fatten rapidly when required. This is true when they have been kept, as cows or otherwise, for a time on fair pasture; but poor Kerries, especially bullocks, when obtained direct from their native mountain grazings, take some time before they begin to show improvement. Once they do begin to improve their progress is rapid, and when slaughtered their flesh is of the best quality, fine in the grain and rich-flavoured. Their weight, when fat, is from 28 to 36 stones imperial. Extra-fed beasts will make 40 stones imperial.

"With a few exceptions, the breeders of Kerry cattle did not until recently devote much attention to the proper maintenance of the breed, and the fact that Kerry cattle have survived the neglect with which they have been treated without material deterioration, is strongly in their favour. The Knight of Kerry has a herd of Kerry cattle which has been bred with great care for a long period, and other gentlemen in that part of Ireland have also devoted attention to the subject; but the reputation of the breed has been considerably enhanced by the interest which has been taken in it by various gentlemen residing in other parts of Ireland, who have taken up the breeding of Kerry cattle not merely as a 'fancy,' but from the intrinsic merits of the breed as dairy-stock. The late Earl of Charlemont had a large herd of Kerries at his seat at Marino, near Dublin, which, under the management of Mr. James Brady, was long well known in Irish showyards. Of late years, Mr. James Robertson, La Mancha, Malahide, county of Dublin, has been a most successful exhibitor and breeder of Kerry cattle. His stud bull Basan took eight first prizes at shows of the Royal Agricultural Society of Ireland and of the Royal Dublin Society. He has also exhibited many animals in the female classes at these shows with great success, and at the recent International Exhibition at Paris he was equally fortunate, and a special medal was awarded to his herdsman. At the Dairy Show in London, and elsewhere in England, Mr. Robertson has taken honours, and at present he may be regarded as the champion exhibitor of Kerry cattle.

"Some attempts have been made to cross Kerries with other breeds. The West Highland, which may be regarded as a kindred breed, has been tried, with the result of giving more size to the Kerry, but in other respects the cross was not an improvement. We have seen cattle which were evidently derived from an intermixture of Ayrshire and Kerry blood, and also of Dutch and Kerry, but in neither case was the cross desirable. It is possible that these crosses were more the result of accident or of careless management than of intentional experiment. When a Kerry cow is put to a suitable Shorthorn bull, the produce possesses great aptitude to fatten, with superior quality of flesh and an increased weight of carcase. Crosses of this kind are frequently met with at shows of fat stock in Dublin, and seldom fail to obtain a good place in the prize list, and to secure a sale at top rates to the butcher.

"The following are the measurements of a prize fat Kerry cow exhibited at a show of the Royal Dublin Society:—38 inches in height at the shoulder, 70 inches in girth, and 42 inches in length from the top of the shoulder to the tail-head. We are inclined to believe that the cow of which these were the measurements was of the Dexter variety.

"The ordinary description of dairy-cows in nearly all parts of Ireland have much Shorthorn character—in fact, the more they have of it, the better they are liked. Nor is this confined to the cattle belonging to the owners of large dairies, for the cattle belonging to tenants holding small farms, say all under 50 acres, are as much improved as any, which is due to the large number of well-bred bulls which are to be found in most parts of the country. Many landed proprietors are in the habit of keeping well-bred Shorthorn bulls for the use of their tenants—a practice which has done much of late years to improve Irish cattle. In some parts of Ulster the farmers are partial to Ayrshire cows, and import these and also bulls from Scotland, so that the shows of the North-East Association, which are held at Belfast, usually present a fair display of that breed. Ayrshires, or what goes by that name, are also kept in some parts of the south,
but in such cases the breed has become degenerated from a want of fresh blood. The Dutch black and white breed, which formerly existed in the south, has been crossed with the Shorthorn, and is extinct.

"While the Kerry is essentially the cottier's cow in Ireland, the prevailing dairy-cattle are either Ayrshires or Shorthorn crosses on the old native stock. Shorthorns have, in truth, done great service in Ireland; and at the present time the great bulk of the cattle in many parts of the country are, to all intents and purposes, as truly Shorthorns in character as are the cattle of the midland counties of England. In the mountain districts of Ireland, where the land is poor and cold, and the herbage poverty-stricken, the Kerry is, and must remain, the poor man's cow; and beyond this she is cultivated in some of the better districts. The Kerries, for instance, whose portraits are given in the plate are from the herd of Mr. Robertson, and to the courtesy of this gentleman we are indebted for the photographs from which the plate was composed. Then Ayrshires, again, have taken fast hold of some of the dairying districts. But, generally speaking, the Shorthorns may be regarded as really the dairy-cattle of Ireland, and, indeed, excellent cattle they are; the soil and climate suit them to a nicety. Yet the Kerry is the only one of the old Irish breeds that still exists in its pristine purity; the rest are more or less derived from English stock. Formerly there was a breed of native Longhorns in Ireland. These, too, are merged in the English crosses."

**Welsh Cattle.**

There are, or were, three breeds of cattle in Wales from which the various types descended. Deviations from these breeds were found in different parts of the country, but they were no more than could be easily accounted for by the influence of locality and by more or less of crossing. Of those three breeds the Glamorgans are said to be now extinct, or nearly so, having faded away before the advance of the Shorthorns, Herefords, and Devons. This is much to be regretted, for they are said to have been excellent milkers, while their flesh was of superior quality.

In the colour of these cattle there was something remarkable, for while the cows were generally a rich brown or red colour, and many of them black, the bulls were invariably black with more or less of white on them.

The Pembroke or Castlemartian cattle still flourish in the Principality. In 1834 Youatt said of them, "Great Britain does not afford a more useful animal than the Pembroke cow or ox." They are fairly good milkers—as good, it is said, as most of the improved breeds. The meat produced by them is said to be of a superior kind, both in texture and quality. Their colour is black, as a rule, a few of them having a brown tinge of a peculiar hue, and now and again they have a little white on the faces or about the udders; but white about them anywhere, especially in the face, is regarded as an indication of strange blood. It has been feared that these cattle, like the Glamorgans, are likely to disappear as a distinct breed. We may, however, now hope that this misfortune will be averted, for a Welsh Black Cattle Herd-book, edited by Mr. R. H. Harvey, a well-known breeder of these very useful cattle, has recently been established, and it will doubtless have a great effect in preserving the breed select and in promoting its improvement. In the second volume of the herd-book the number of cows registered reaches 215, and of bulls 90; and from these it is to be hoped the breed will again become numerous in the district to which it is so well adapted. The best English breeds, however, the Shorthorns chiefly, have penetrated into every part of Wales, and they are rapidly effecting a transformation of the native breeds. But the admirers of the Castlemartins have taken the proper steps toward the preservation and the improvement of a breed which had well-nigh been lost through sheer supineness, and we may reasonably look forward to its re-establishment in many of the old haunts from which it had already vanished.

The Anglesea cattle, though claimed to be a distinct breed, very much resemble the Pembrokes. They are black in colour, but it is usually a deeper black than that of the South Wales cattle; this, however, may be attributed to the difference in climate. They are also a little larger, though not much, and are hardly so refined in head and neck. The milking properties of the Angleseas have been neglected for ages, and they are consequently inferior dairy-cattle. As with the Herefords and Scotch Polled, the raising of young stock, and not cheese or butter, has been the chief purpose to
which the Angleseas have been devoted; and it is not surprising that as milkers they are inferior. But as grazing stock they are, and long have been, justly celebrated. Their flesh is of excellent quality, and they are sent long distances to be fattened. It is perhaps less likely that the Angleseas may become extinct, than other Welsh cattle; their native habitat, and the primitive habits of the people, will tend to preserve them a long time in all their pristine purity. Still, the only, or at all events the chief, property that will preserve any of the British breeds of cattle intact in the present day is that of milk. Beef alone is not enough, nor is milk, perhaps; but the two combined are indispensable to a thoroughly profitable breed of dairy-cattle; and if any breed proves itself incapable of being trained and bred into giving a good paying quantity of milk, it must lose its hold on the suffrage of the people. In an economic age like this, antiquity of breed alone is not enough to preserve a race of cattle from extinction—utility is the one thing needful. It is, however, a pity that any of these time-honoured breeds should die out; they should rather be improved in those qualities in which they are deficient, so that they may hold their own against those breeds which will otherwise take possession of the entire country.

There is no need whatever for the old breeds of any district or country to die out, unless they are hopelessly beyond the reach of improvement in a sufficiently reasonable time; and this is certainly not the case with any of the British breeds of cattle. The laws which govern animal reproduction are now well understood, and the principles of breeding are equally well established. It is a well-ascertained fact that to intelligent cultivation and treatment all our breeds of cattle respond in a manner which leaves little or nothing to be desired, and this in a very short time; hence we infer that as a rule it is better that all our races of cattle should remain in their native districts, and not be wholly displaced by others from a distance. This end will be attained if the cattle that need it show the measure of improvement which is certainly within the reach of those who own them.

It is true that several of our more famous breeds have great aptitude for adapting themselves to new districts, climates, and soils, and that they are quickly at home in almost any portion of the British Islands, not to mention foreign countries. This fact, indeed, supplies a reason why they have penetrated so far, and why other races have faded away before them, and no doubt it does away to some extent with the economic reasons for maintaining the old breeds; at the same time we do not think the reason sufficient for the total disestablishment of the old breeds, and we should much prefer to see them so much improved by careful selection that they may be able to hold their own in any fair competition with those who otherwise threaten to supplant them. If the Welsh cattle do indeed die out, it will not be for the reason that they are not worth preserving, and we trust the time has come for them to re-assume their ancient popularity.

The portraits of Welsh cattle given in the plate are chiefly from photographs, for which we are indebted to the courtesy of Lord Cawdor and J. B. Bowen, Esq., M.P.

Some foreign breeds of cattle will be noticed in treating of Foreign Dairy Farming.
CHAPTER IV.

FEEDING AND TREATMENT OF DAIRY CATTLE.


That the feeding and treatment of cattle is a most important question few will be slow to admit, and yet in practice it is too generally neglected. If all dairy-farmers could be made to realise the simple fact—so simple that it is commonly lost sight of—that whatever milk or beef is produced must be produced wholly from the food that the animals eat, a great change in the treatment of cattle would spread over the face of the country. Not a morsel of beef and not a drop of milk are produced without food; not a movement of a limb can be made and not a breath be drawn that is not compensated for in food. If the cows travel two miles or one mile to pasture, or if they are hurried, or abused, or frightened—all is paid for by the food. If they are chased by dogs, or by flies, or by men, they are chased at the cost of food, and the milk is poorer in butter—the nervous excitement uses it up. There is not one degree of heat in the body of the cow that is not produced from the food she eats. If cows are exposed in winter to a temperature of fifteen degrees below zero, if they are "deformed by dripping rains or withered by a frost," food enough must be burnt in the stomach to make up for the loss of heat by the body. This is nature's law of equivalents: "Something must be paid for everything, for it is impossible to produce anything from nothing."

With regard to dairy-cows, it must be borne in mind that they have first of all to live before they can produce any milk at all from the food they eat; and about two-thirds of their food goes to keep them in fair condition before any milk can be made from it. This has been tested and proved over and over again. Some dairy-farmers seem to think that they can with impunity keep their cows on "short commons" during the winter, and that they will pick up in the spring and milk as well as ever; but this is a great mistake. A poverty-stricken cow must first of all supply the wants of her system and get back into decent condition before she can possibly give rich milk and plenty of it; and many cows for months in the summer do not fully recover from a winter's starving; some never get over it at all. All profit that comes from either a dairy-cow, or one that is being fattened, is derived from the food over and above that which is necessary to sustain the offices of life; and in a feeding animal that weighs no more at the end of the season than at its beginning, the food consumed has, except for the excreta, been wholly wasted—that is, the farmer derives no profit from it. So with a dairy-cow; if she gives no more than 300 gallons of milk in the season, she is kept at a loss.

A dairy-cow is simply a machine for the production of milk, just as a steam-boiler is a machine for the production of steam; and food is fuel to the cow exactly as coal is fuel to the boiler. If the cow is pinched of food she will not yield a profitable quantity of milk; this explains the proverb, "You had better be over-rented than
over-stocked." So with the boiler, if it receives only enough coal to make the water warm, there will be no steam. There is, of course, as already pointed out, a great difference in cows, as there is in boilers, as to the return they make for the fuel consumed; some cows and some boilers seem to burn a great deal of fuel to waste, and it is from the fuel, not from the cow or the boiler, that we derive our profit. It is, therefore, a mistake to bestow good and abundant food on cattle whose physical imperfections prevent their turning it to the best account. It is advisable to carefully test the milk-producing capacity of a suspected cow; this may easily be done by weighing the food she eats and the milk she yields during a given period, and comparing them with similar records of a cow that is a satisfactory milker. Such tests and comparisons as these are very instructive; and whoever makes them carefully and repeatedly is pretty sure to carry out the lessons they teach, which course will soon result in the production of a first-class herd of dairy-cows—a consummation that is within the reach of every dairy-farmer. It is scarcely necessary to say that calves from cows that are poor milkers should never be used to replenish the herd with; they should go to the shambles, not to the milk-pail.

EFFECTS OF FOOD AND EXERCISE.

The effect of food in animal nutrition, more particularly with regard to the production of cheese and butter, and taking into account the influence of breed in the animal consuming it, has been carefully investigated by Dr. E. L. Sturtevant, of Massachusetts, and he gives as follows a summary of his conclusions:—

1. That the production of butter is largely dependent on the breed.
2. That there is a structural limit to the production of butter in each cow.
3. That when the cow is fed to this limit, increased food cannot increase the product.
4. That the superior cow has this structural limit at a greater distance from ordinary feed, and is more ready to respond to stimuli than the inferior cow.
5. That, consequently, the superior cow is seldom fed to her limit, while the inferior cow may be easily fed beyond her limit; and as a practical conclusion, increased feed with a superior lot of cows will increase the butter product; but if fed to an inferior lot of cows, waste can only be the result.
6. That the character of the food has some influence on the character of the butter; but even here breed influences more than food.
7. That there is no constant relation between the butter product and the cheese product.
8. That the casein retains a constant percentage, and that this percentage does not appear to respond to increased food.
9. That the casein appears to remain constant, without regard to the season.
10. That increase in the quantity of milk is followed by an increase in the total amount of casein.
11. That insufficient feed acts directly to check the proportion of butter, and has a tendency to decrease the casein of the milk and substitute albumen.

12. That the best practice of feeding is to regulate the character of the food by the character of the animals fed—feeding superior cows nearer to the limit of their production than inferior cows; feeding, if for butter, more concentrated and nutritious foods than for cheese; feeding for cheese product succulent material which will increase the quantity of the milk yield.

It will thus be seen that to secure a full measure of success the dairy-farmer must devote at least as much care to the breeding of his cows for milk-production, as he does to their feeding and treatment, and to the improvement of his land for the same end. Not one or even two of these points, but all three of them demand special attention.

One of the reasons why poor land produces milk which, as compared with that produced on good land, is deficient in fatty matters, and so is better adapted for cheese-making than for butter-making, lies in the fact that the grasses on it contain a larger proportion of flesh-forming ingredients—as albumen, fibrin, casein, gluten, &c.—and a smaller one of fat-forming ones—as starch, gum, sugar, &c.—than are found in the grasses of rich land. But another reason is found in the additional respiration of oxygen which takes place in the animal economy when cows are pastured on poor land, and have to go through more exercise in the search for food. The oxygen of the air, which is inhaled to an increased
extent by animals who take an extra amount of exercise, has a direct tendency to consume the fat in the system of the animal—actual combustion of the fat takes place. Hence the increased heat of the animal's body, and hence also a diminished amount of fat among the tissues, and a diminished proportion of butter in the milk.

Again, the more exercise an animal takes, the greater will be the waste or breaking up of the tissue of the body; and, as this is the source from which the curd in milk is derived, milk produced on land whose herbage is scanty will contain a larger proportion of curd than milk produced on land whose herbage is abundant. And so the milk of unduly exercised cows, in whatever manner that exercise may be brought about—whether on poor land in search of food, or in travelling a distance to and from the pastures, or in being chased by dogs, or flies, or men—will likewise have a large proportion of casein in it and a small one of butter.

It is unnecessary to point out that the less exercise an animal takes, the sooner it will fatten, for this simple fact is known to every farmer; and it is equally well known that the more exercise an animal—a horse, for example—is made to take, the more food is required to maintain the condition and bulk of that animal. And the ratio of the consumption of fat is equivalent to the violence and extent of the exercise.

It will now be perceived why it is that the milk produced on poor land has a larger proportion of curd and a smaller one of butter than that produced on good land; it will be equally plain that the smaller the distance cows have to travel to and from their pastures, whether those pastures be rich or poor land, the richer in fats their milk will be; and it will be even still more evident that the faster they are made to traverse that distance, the poorer their milk will be. Distance and speed bring about a greater inhalation of oxygen, and the more the oxygen that enters the system, the greater will be the consumption of fat in it.

In the hot weather in summer, when cows are tormented by flies and by heat, the evening's milk will always be found poorer than the morning's in butter. This is explained on the same principle; and so is the fact that the milk of stall-fed cows is richer in fats than the milk of cows who roam at large on the pastures, presuming that the two sets of animals are fed on exactly the same kinds and quantities of food. Experiments have demonstrated the truth of this position. Upwards of thirty years ago, Dr. Lyon Playfair analysed the milk of a cow that was fed out in the meadow, and afterwards the milk of the same cow fed in the stall, and with the food the same in both cases; the milk produced in the meadow was found to contain more curd and less butter by several per cent, than that produced in the stall. The law holds good throughout the entire series—the more exercise a milk-cow takes and the more heat is given off by the body, the greater the amount of combustion of fat and the less butter will be found in the milk.

Professor G. C. Caldwell, of Cornell University, writes as follows on the relation between the composition of fodder and that of milk:—"That the composition of the milk may change with the changes in the composition of the food in the animal producing the milk, is another principle also fully established by the results of both experience and experiment; within certain limits the milk may be made poor or rich by supplying poor and watery fodder or rich fodder. Whether, however, this change simply affects the proportion of the solids as a whole to the water carrying these solids, or whether the composition of the dry substance of the milk of the same cow can be altered by changing her food, so that she can be made to give milk richer in fat without at the same time being richer to the same degree in each and every one of the other constituents, the albuminoids, sugar, and mineral matters, is a question that has been much discussed in the last few years; it is manifestly a question that can be settled only by the chemical analysis of that dry substance, while increased richness of the milk in general—a smaller proportion of water and a larger proportion of solids—can be detected by the lactometer, the cream-gauge, or even by the appearance of the milk to an experienced eye.

"The composition of the dry substance of the milk under varying conditions has been made the subject of many careful researches, some of which have appeared to lead to the result that it remains essentially the same for the same cow whatever may be the character of her ration—so long as it is a healthy ration. The statement, in accordance with these results, that the proportion of fat in the milk cannot be sensibly increased by any
system of feeding without at the same time increasing the richness in albuminoids and sugar, was undoubtedly misunderstood in many cases, and taken to mean that the richness of the milk in fat cannot be increased in any way by increasing the richness of the fodder in fat, or any other constituent. Such a misapprehension may have been the origin of some of the expressions that appeared in the agricultural papers of a want of faith in methods of scientific inquiry that led to such manifestly false conclusions.

"The most careful series of investigations on the influence of the composition of the ration on the composition of the milk has been carried on under the direction of Gustav Kuehn. From the results of these and other researches the following conclusions have been deduced, and may be regarded as sufficiently well established for all practical purposes: Firstly, an increase of the ration with respect to both nitrogenous and non-nitrogenous matter does, within limits, increase the yield of milk, and the richness of the milk in dry substance; and the better the natural yield of the cow, the larger will be this increase. Secondly, changes in the proportion of carbohydrates only in the fodder produce no effect on the yield of milk. Thirdly, the proportion of fat in the ration bears no special relation to the proportion of fat in the milk, but an increase of fat in the fodder rather increases the production of milk as a whole. Fourthly, the most constant interdependence between composition of the fodder and the yield of milk was found to exist with reference to the proportion of albuminoids in the fodder. Within certain limits the production of milk rose and fell with the proportion of albuminoids in the ration. But for every animal there was found to be a limit beyond which any addition of albuminoids to her food produced no effect in the yield of milk. Fifthly, in general the composition of the dry substance of the milk was not sensibly altered by changes in the composition of the ration; but to this there were some striking exceptions."

**General System of Dairy Management.**

The great bulk of dairy-farms, particularly of those which do not touch our towns' and cities' milk trade, are still conducted on the same general outlines that have been followed for many generations, though in most cases certain improvements in details have in one way or another been introduced in late years. On farms whose speciality is the production of cheese the practice still is, as it long has been, to have all the cows dropping their calves in the early months of the year; the bulk of them in March and April, and some of the heifers in May. In the first or second weeks of May, or whenever there is grass enough to go on with, the cows are turned finally out on the pastures, having for a week or two previously been pastured on "seeds" or other early grass during the day, to accustom them gradually to the change from dry to green food and from in-door to out-door feeding; and they commonly depend wholly on the pastures from this period until the time when the aftermath in the meadows is available. Later on they have early turnips or cabbages carted out to them on the pastures, until the time comes when out-door keep begins to fail, and the blasts of early winter give warning that it is no longer wise to keep them out of doors; they are then taken in o’night, still going out in the days for a short time longer, after which they are kept wholly in-doors until spring-time comes round again. This is, in brief, the old and still general system of managing dairy-cows on cheese-making dairy-farms.

The time for cows to calve which appears to be most in harmony with nature’s laws is the spring of the year; and in obedience to these laws, as well as to the expediency of having them in the flush of milk when “grass day” comes, dairy-farmers—but not those who have gone into the milk trade—always have their cows timed to calve between the middle of February and the middle of May. For purely cheese-making purposes there is nothing important gained by having them calving before the middle of February, for they would then have passed through the flush period of milk before the time when the grasses in the pastures are most plentiful, luxuriant, and nutritious; indeed, the only advantage of having them calving very early—say in January and the first half of February—lies in the better chance there is then of those calves that are intended for the herd eventually being well reared in good time; but this does not counterbalance the disadvantage of having the cows past the flush of milk when the period of succulent grasses comes on.

It is a serious mistake, and one too generally committed, to allow milch-cows to get into a
low condition of system during the last three or four months of the gestation period, or, indeed, at any other time for that matter; and this is too commonly done when they are "dry for calving." Many farmers milk their cows on too far into the winter, giving them too short a resting time before they calve again, and this is, where followed, an almost inevitable cause of winter lean-ness of milch-cows; for as the time of parturition approaches, the cow has enough to do to supply the increased nourishment which the calf in the womb demands, without giving milk in addition.

Some cows, indeed, are such willing milkers that it is difficult to let them dry at all before calving, and it is even necessary in some cases to put a cow on "short commons" for a week or so to check the flow of milk. Generally speaking, however, cows show signs of drying up in milk some six or eight weeks prior to the time at which they are due to calve, and it is as a rule advisable that they should give no milk during the last month or two of gestation; the length of this period may be governed by the quality of the food which the cows receive; the better the food, the shorter the period of dryness, and vice versa. Some farmers think cows are less liable to lose quarters if they are not let dry at all; but all danger of this disaster is avoided by drawing the teats now and then, after the cows are let dry, to rid them of any milk that may accumulate. And, indeed, they should always be let dry in a gradual manner, by milking once a day for a time, then once in two days, and so on till the milk is gone; this done, the quarters are safe enough.

If cows are lean and weak at calving-time, they are occupied during the best part of the ensuing summer in "getting their backs up again," during which has slipped away that which ought to be the flush period of milk; and it should ever be borne in mind that well-bred cows are particularly honest and grateful animals, always returning excellent interest on any little additional capital which is invested in them in the shape of nourishing food, especially at those times when they need it most—that is, when their systems are, or ought to be, laying in vigour for the following summer's work. Farmers too seldom think of this, and seldom do they put it in practice. The most profitable milking season—the one, that is, when there is the highest return on the lowest expenditure, and with the least labour—is when the grass in the pastures is most nutritious and tender, in the months of May, June, and July, and the lacteal stage of the cows themselves should correspond with this, by their having but recently passed through parturition. If cows are turned out to grass in good condition, and have not been calved too long, they will always give a good account of themselves, providing they are of a good sort for milk.

Many dairy-farmers make the costly mistake of thinking that when cows are dry for calving is the time to economise food by keeping them on straw or weathered hay—or on anything, in fact, which they would never think of giving them if they were in milk. And yet this is the very time when a generous diet will lay the best foundation for after usefulness. It is true that the inferior kinds of forage may be most conveniently consumed at this period, but they should be improved by the addition of a few pounds of cake per day to each cow; and if straw is being used at this time, it should be chaffed and improved by adding to it some kind or other of meal, and its bulk may well be increased by brewers' grains; but in any case the quality of the ration must be made at least equal to that of good meadow hay: less than this is insufficient to enable in-calf cows to acquire before parturition that amount of bodily condition which is necessary to enable them to give a good flow of milk during the coming season. A handy system of improving inferior hay, without chaffing it, is to scatter a handful or two of maize-meal over it in the mangers before the cows; this done, not only will the hay be consumed with a relish, but the mangers will be kept clean without any trouble on the herdsman's part; the quantity of meal so used will be regulated by the quality of the hay and the condition of the cows. It will pay well to treat even good hay in this manner, particularly when fed to cows in milk and when it is rather scarce, so as to spin it out to the best advantage; this is the best way to save hay in winter, when there is no other bulky food to be had.

It is necessary in artificial feeding of cattle to remember that the flesh-forming and the heat-producing elements should be made to bear a given relationship to each other, according to the season of the year. If a cow is not in milk she may not need any more albuminoids in cold than
in warm weather; but she will need more heat-producing food. In summer she will require 3 lbs. of heat-producing food for every 1 lb. of flesh-forming food she uses, and in winter 5 or 6 lbs.; and she will live well on food in such proportions if she is doing nothing more than merely living. 25 lbs. of good hay per day would supply her with 2 lbs. of flesh-forming and 10 or 11 lbs. of heat-producing elements, and on this she would do well enough, along with water ad lib. But when she is in milk she requires a much larger proportion of albuminoids, say 2 to 5 lbs.; so to keep up the flow of milk she must receive those kinds of food in which albuminoids bear a larger proportion, as compared with heat-producing materials. These kinds of food would be meal of various kinds and corn generally, bran, oil-cake, cotton-cake, and hay cut a little under-ripe. The following table shows the proportions of these different elements in various kinds of food, and a careful study of it will enable a farmer to give his cows such a ration as will admit of the least waste of food and loss of money:

<table>
<thead>
<tr>
<th>Various Foods</th>
<th>Percentage of Albuminoids</th>
<th>Starch, Sugar, Gum, etc.</th>
<th>Fat</th>
<th>Manurial worth, in ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linsed-cake</td>
<td>28-3</td>
<td>41-3</td>
<td>10-0</td>
<td>76</td>
</tr>
<tr>
<td>Decorticated cotton-cake</td>
<td>41-0</td>
<td>57-0</td>
<td>10-0</td>
<td>105</td>
</tr>
<tr>
<td>Undecorticated</td>
<td>24-0</td>
<td>66-0</td>
<td>8-0</td>
<td>58</td>
</tr>
<tr>
<td>Bean meal</td>
<td>25-4</td>
<td>45-5</td>
<td>2-3</td>
<td>62</td>
</tr>
<tr>
<td>Pea</td>
<td>22-4</td>
<td>53-2</td>
<td>2-3</td>
<td>62</td>
</tr>
<tr>
<td>Rye</td>
<td>11-0</td>
<td>60-2</td>
<td>2-0</td>
<td>30</td>
</tr>
<tr>
<td>Indian corn</td>
<td>10-0</td>
<td>68-0</td>
<td>7-0</td>
<td>25</td>
</tr>
<tr>
<td>Rice meal (best)</td>
<td>6-9</td>
<td>77-0</td>
<td>4-0</td>
<td>25</td>
</tr>
<tr>
<td>Palmonat meal</td>
<td>14-0</td>
<td>76-0</td>
<td>4-0</td>
<td>25</td>
</tr>
<tr>
<td>Wheat bran</td>
<td>14-9</td>
<td>50-0</td>
<td>3-8</td>
<td>55</td>
</tr>
<tr>
<td>Oats</td>
<td>12-0</td>
<td>60-9</td>
<td>6-0</td>
<td>23</td>
</tr>
<tr>
<td>Barley</td>
<td>9-5</td>
<td>66-6</td>
<td>2-5</td>
<td>25</td>
</tr>
<tr>
<td>Malt</td>
<td>0-0</td>
<td>76-0</td>
<td>5-0</td>
<td>26</td>
</tr>
<tr>
<td>Malt culms</td>
<td>26-0</td>
<td>60-0</td>
<td>4-0</td>
<td>71</td>
</tr>
<tr>
<td>Alsike clover in blossom</td>
<td>15-3</td>
<td>20-2</td>
<td>3-3</td>
<td>2</td>
</tr>
<tr>
<td>White</td>
<td>14-9</td>
<td>34-3</td>
<td>3-5</td>
<td>2</td>
</tr>
<tr>
<td>Red</td>
<td>13-1</td>
<td>29-9</td>
<td>3-2</td>
<td>2</td>
</tr>
<tr>
<td>Lacerne</td>
<td>14-4</td>
<td>22-5</td>
<td>2-5</td>
<td>2</td>
</tr>
<tr>
<td>Maize, cut green</td>
<td>2-0</td>
<td>39-9</td>
<td>1-3</td>
<td>2</td>
</tr>
<tr>
<td>Common meadow hay</td>
<td>8-2</td>
<td>41-3</td>
<td>2-0</td>
<td>15</td>
</tr>
<tr>
<td>Pea straw</td>
<td>6-5</td>
<td>35-2</td>
<td>2-0</td>
<td>8</td>
</tr>
<tr>
<td>Oat</td>
<td>2-3</td>
<td>33-2</td>
<td>2-0</td>
<td>8</td>
</tr>
<tr>
<td>Barley</td>
<td>3-9</td>
<td>32-7</td>
<td>1-4</td>
<td>8</td>
</tr>
<tr>
<td>Wheat</td>
<td>2-9</td>
<td>30-2</td>
<td>1-5</td>
<td>8</td>
</tr>
<tr>
<td>Potatoes</td>
<td>2-0</td>
<td>21-0</td>
<td>0-3</td>
<td>7</td>
</tr>
<tr>
<td>Carrots</td>
<td>1-5</td>
<td>7-0</td>
<td>0-2</td>
<td>4</td>
</tr>
<tr>
<td>Turnips</td>
<td>1-1</td>
<td>5-1</td>
<td>0-1</td>
<td>4</td>
</tr>
<tr>
<td>Mangels</td>
<td>2-0</td>
<td>8-0</td>
<td>0-2</td>
<td>5</td>
</tr>
</tbody>
</table>

In using the foregoing substances, or any of them, the farmer will naturally be guided to some extent by the market prices of all those of them that he has to buy. At present prices (£7 per ton), decocted cotton-cake is decidedly the cheapest and best article that a farmer can buy for milk-cows, especially in winter. (In the summer, when the cows are receiving a large quantity of green food of one kind or another, which is always more or less relaxing in its action on the bowels, it will generally be found advisable to use undeccotitted cotton-cake, which is an astringent, and counteracts any undue relaxation of the bowels caused by green food.) Palm-nut meal is offered on the market at a reasonable price (£6 10s. per ton), and from its composition it can hardly fail to be a valuable and cheap article of food. Malt culms are excellent milk-producers; but as they are singularly forcing in their action, and have the property of swelling out into a large bulk when soaked in water, it is advisable to use them with discretion.

For the production of milk, grass of good quality is the most nearly perfect food that cows can eat. If it is required to increase the quantity and the value of the milk for cheese-making purposes, artificial food rich in nitrogenous matters—albumen, casein, legumex, &c. may be fed to the cattle; if to increase them for buttermaking, non-nitrogenous food may be given, in which there is a large proportion of starch, gum, sugar, oil, &c. And in winter it is well to prepare the food so that it may be easy of digestion and assimilation, taking grass as a standard of perfection in this respect. This can only be done either by steaming the food, or by moistening it with water or pulped turnips, and allowing it to lie together in a heap until the fibre is softened by incipient fermentation. In cold weather, tepid water given to cows will increase the flow of milk.

Arable Dairy-Farming.

We naturally, or rather from force of habit, associate dairy-farming chiefly with grass land. The districts specially known as devoted to dairying in the British Islands are the grass-land districts, in those sections of the country where the humidity of the air is well suited to the growth of permanent pastures; and our arable districts, on the other hand, are chiefly those in which, owing to the dryness of the climate, the area of grass land is very limited, and where dairy-farming is carried
out on a very small scale. In only isolated cases has dairy-farming been extensively followed on an arable basis, with only a small amount of permanent grass; and we have consequently grown to regard dairy-farming as being inseparable from a large proportion of grass land.

This idea, however, though based on the practice of many generations, is not necessarily the only one that may be entertained with respect to dairy-farming. Permanent grass land, as the leading feature of the farm, is not by any means essential to successful milk-production in the great bulk of cases, and in dry climates it is certainly unfavourable to profitable dairying. While it is true that some kinds of land in given districts are more profitable in grass than under the plough, it is none the less so that other kinds will not pay either the landowner or the farmer if they are kept in permanent pasture. It follows, therefore, that in some districts, and almost everywhere on light and naturally dry land, dairy-farming will yield better returns in conjunction with arable cultivation than it will in any other way.

On farms that have hitherto been given up mainly to the growth of cereals and to sheep, the changes necessary to dairy-farming are not difficult to bring about. Nearly all that is required is an increase of green and a decrease of white crops; instead of taking two cereal crops in a rotation, only one must be taken, and its place filled in with a variety of green crops. On a 300-acre farm, 200 of which are under the plough, the rotation suitable to dairy-farming might be as follows:

First year, Oats, or other straw crops ...... 40 acres.
Second " Turnips, mangels, carrots, &c. ...... 40 "
Third " Winter oats in part, rye, or vetches 40 "
Fourth " Clover, trifolium, lucerne, &c. 40 "
Fifth " Second year's clover, or lucerne 40 "

It would always, providing the farmer was not bound under a given order of cropping, be a simple matter so to vary the items in the rotation as to suit the requirements of the period. A rotation of this kind, in which the land does not often lie still more than one clear year, is so pliable that it may be made to suit almost any purpose. More straw, roots, clover, vetches, or any other crop may be grown at will; any one crop may be dropped wholly or in part to make room for an increase of another one. The clover, or lucerne, or rye-grass may lie a second or even a third year if it is found necessary, and if they are doing well; green crops may displace white ones, or the latter may supplant root crops, and a regular succession of those crops that are intended for soiling may easily be arranged, and a maximum area of forage crops may with equal facility be secured.

On this system, where the farmer has freedom to crop as he likes, dairy-farming may be carried on with a very small area of permanent pasture, or, for the matter of that, with none at all; but if pasture were wholly dispensed with it would of course be necessary to keep the cows and young stock wholly in sheds or yards, and feed them there, cutting and carrying to them all the green food in spring, summer, and autumn, as well as the dry food in winter. And it is true that on this method a larger number of cattle can be maintained than on any other, because the land, being constantly under cultivation for the several crops, produces a maximum supply of food, and also because the waste of food is reduced to a minimum. It must be borne in mind, however, that the labour bill, the outlay in manures and feeding-stuffs, and the wear and tear of horses and implements will all be much greater on this plan than on any other; and as all farming is or ought to be carried on to the profit of the farmer, it will be necessary to ascertain which system will admit of the most satisfactory results.

The Soiling System.

The practice of "soiling" dairy-cows, throughout the spring, summer, and autumn, with one kind or another of green food, is coming greatly into favour, especially with those who send off their milk to some town or city. Some have even carried the system to the length of keeping the cows in the sheds all the year round, cutting and carting to them all the green food they eat; and there can be no doubt that this system is a money-making system, provided it is intelligently and thoroughly carried out. But where it is followed, two-thirds or more of the land is necessarily under arable cultivation. On this system it is possible to carry on dairy-farming in a profitable manner on land which, being of a light and dry character, and situated in a dry climate, is commonly considered most suitable to sheep, roots, and cereals. Such land will commonly grow good rotation crops of clover, rye-grass, *Trifolium incarnatum*, vetches, &c., all of which are well
adapted to soil ing; while it will produce, in the shape of straw and other forage, plenty of food for winter consumption.

There can be no doubt that on light land in a dry climate dairying can only be profitably carried on in conjunction with arable cultivation and the growth of green crops for soil ing. Left in permanent grass, such land is of very little value. It can only be made to pay by keeping it constantly under the plough, taking many green crops, and now and then a white one, and manuring each of them lightly, instead of one of them heavily and the next not at all; for light land does not retain manure from one year to another as heavy land does. It is, however, doubtful whether such a system of dairy-farming would be suitable to cheese-making on English methods. It is well known to English dairy-farmers that when cows are eating in the early spring young clovers and grasses on newly-seeded land, it is very difficult to make sound cheese from the milk; and on some kinds of land, particularly marls, this difficulty is very marked. In the dairying districts of France the soil ing system is much more extensively practised than it is in England, and both cheese and butter of excellent quality are made; but the French make principally soft cheese, much of which is for early consumption; and the English hard cheese differs so widely from the French soft, that a system of farming suitable to the one would in all probability not be suitable to the other. But a great deal depends in all cases on the care and system on which the cheese and butter are made, and on this point we shall have more to say later on.

Where the soil ing system is carried out in its entirety it is necessary to have a regular succession of green crops, commencing with the early spring and continued until winter sets in. It is important to remember that dairy-cows when in full milk should have an abundant supply of succulent food; and on land which is well adapted to the growth of various kinds of green crops a special effort should be made, and a regular system laid down, to provide these crops for consumption from April to November inclusive, along with a small proportion of dry food. It is a good system to give the cows throughout the summer one feed a day of green and dry food chaffed up together. The dry food may consist of straw or hay, whichever happens to be the more plentiful, and the mixture may with great advantage be improved by an addition of a moderate quantity of bean, pea, palm-nut, rice, or maize meal, bran of wheat, malt culms, linseed or cotton cake; for these kinds of food will supply the albuminoids of which, as a perfect ration for cows in milk, the addition of straw or hay may have made the mixture more or less deficient. Lucerne and various other clovers are excellent soil ing crops, and when cut whilst they are in blossom contain a proper proportion of the different food-elements required by cows in milk; but most other soil ing crops, such as rye-grass, green rye, vetches, green maize, and the like, are more or less deficient in albuminoids, and these elements should be supplied by one or other of the concentrated kinds of food mentioned above.

Crops Suitable for Arable Dairy Husbandry.

For earliest green food in spring, rye is found to answer very well. Sown in September, on corn or potato land, it is usually ready to cut for soil ing early in April. As soon as the corn or potatoes are harvested, the land should be well cultivated, cleaned and manured, and the seed drilled in at the rate of 2 bushels per acre; or, if the land is clean, they may be broadcasted. One of the best manurings for rye is sot, at the rate of 100 to 200 bushels per acre; but if sot cannot be readily obtained, 10 or 12 tons per acre of good farm-yard manure, ploughed under when the land has been cultivated and cleaned, will be found to produce a good and early crop. It must be borne in mind that the rye will be ready for cutting a fortnight earlier if the land is well prepared and manured than it will if these matters have been imperfectly performed or neglected altogether; and the secret of early cutting rests in having the land in high condition. The period during which rye is available for soil ing is short, as it becomes too tough before May has far advanced; but it may commonly be used until the succeeding crop is ready to take its place, and as soon as it is cleared off, the land may be ploughed up at once, and planted with turnips, cabbages, or some other green crop, for autumn consumption.

To come into use immediately after the rye is finished, winter vetches, sown at several times in September and October, either with or without
a little wheat or winter oats to keep them standing, will provide a large amount of food in May, June, and July. Spring vetches should be sown at intervals from the beginning of March to the middle of May; and if there are two sowings in the autumn and four or six in the spring, the successive crops will bridge over the summer, from May to October, especially if they are assisted in May and June with clover or rye-grass—they will last, in fact, until turnips and cabbage are available. As vetches are in the best state for use when the seeds are beginning to form in the pods, the first spring sowing may be so regulated that the crop will be ready for use when the winter vetches are cleared off. There need, however, be no great amount of anxiety on this point, for clovers and rye-grasses are available in May and early June. To secure a good thick-set crop of vetches, 4 bushels of seed per acre should be sown if they are sown broadcast, but if drilled, 3 or 3½ will be enough; and drilling is the best system, on account of the facilities it affords of hoeing the land so as to keep down the weeds until the crop is fairly established. A good crop of vetches will completely smother all the small annual weeds, and most of the others too; but with a poor crop the land is certain to become so foul that it is better to plough it up at once and put in some other kind of a crop. Along with spring vetches it is a good plan to sow a little rape-seed, say 1 lb. per acre, in order to keep the vetches standing better than they would alone. Though rape is an excellent green food for sheep, it is not much used for dairy-stock.

Rye-grass and red clover, either together or separately, are commonly sown on a crop of corn in spring, and they come into use the following spring. They are exceedingly useful for a time for soiling purposes, say from the beginning of May until the middle of June, after which it is necessary to cut the remainder for winter forage, because if overgrown they are far less valuable than they are up to the blossoming period of the clover. Some farmers advocate sowing rye-grass early in July on land from which a crop of *Trifolium incarnatum* has recently been consumed; it is only necessary to surface cultivate the land, providing it is clean, when it is fit for the rye-grass seed. When sown alone, 1½ bushels per acre is recommended; when with clover, 1 bushel; of clover seed, 14 lbs. per acre along with the rye-grass will be enough; if alone, 20 lbs. To grow either rye-grass or clover successfully the land must be in good condition, or failing that the crop must be well manured just before sowing, or at some convenient period afterwards. A good dressing of well-made farmyard manure, well incorporated with the soil, will ensure a good crop; failing that, the crop may be dressed in early spring with 2 ewt. of guano per acre, or a mixture of nitrate of soda, superphosphate of lime, and gypsum—say 1 ewt. of the first, 1½ ewt. of the second, and 2 ewt. of the third. These artificial manures are best sown in damp weather.

Maize is an excellent green crop for soiling; it has for years been extensively grown for that purpose in America, and it is, in fact, the favourite green crop in most of the great dairying districts of that country. It is also grown widely in France and other continental countries for soiling dairy-cows. It is a plant whose growth is rapid, and it answers well when sown for successive crops; it is, however, deficient in albuminoids, and though a most valuable crop in itself, it is greatly improved by cotton-cake, pea or bean meal being fed along with it. Simple of cultivation, a large cropper, of rapid growth, and rich in sugar and other heat-producing elements, maize ought to become quickly popular in Britain for soiling purposes or for winter forage. It is suited to a variety of soils, and when the land is in good condition and the weather hot enough, will grow an astonishingly large bulk of food per acre. It is especially adapted to the production of milk, increasing the quantity and improving the quality; while, being tender, sweet, and succulent, it is much relished by cattle, so long as it is not overgrown. When the land has been well prepared by cultivation, maize may be planted after the manner of potatoes, the land well manured, and the seed scattered pretty thickly in drills 2 feet apart; this admits of the horse-hoe being used freely for a time. There need be no hesitation about sowing a good quantity of it, say an acre for each six or eight cows, to come into use in successive half-acre lots, for if there is more than enough for soiling purposes, it is a simple matter to cut and stock the overplus, after the manner of oats, and it will be found to make excellent winter forage.

Turnips are more costly and troublesome to
THE SOILING SYSTEM.

51 grow than the preceding crops, and are not so well adapted to the production of milk, not alone because they will not produce so much of it, but also because they give it an unpleasant flavour; yet are they useful because they come in when most of the other green crops are over. Owing to the attacks of numerous enemies, of which the "fly" is the most destructive, turnips are a crop on which no certain dependence can be placed, and this very uncertainty detracts greatly from their value. It is estimated that one-sixth of the turnips sown in these islands are annually destroyed in this manner. One chance of checking such wholesale destruction lies in having the soil well pulverised and mellowed by winter frosts, and in manuring it well in the spring, so that the crop may make rapid progress out of the reach of its enemies; and yet this forcing of the crop in its early stages diminishes its subsequent keeping properties, and it is liable to early decay. The turnip-fly is said to be driven off if the land has been manured with dung that has been produced in stables where disinfecting powders are constantly used; or by a sprinkling, repeated now and again while the danger lasts, of paraffin oil diluted with water over the young plants.

In some districts it is the custom, when the land is clean, to plough under 10 or 12 tons per acre of farmyard manure in the autumn, and to give it a further dressing of 3 cwt. of superphosphate in the following spring at sowing-time; but as farmyard manure may generally be applied with greater advantage to meadow land and to the growth of soil crops, it is on the whole better to keep it for those purposes, and to grow the turnips with 3 cwt. each of superphosphate and dissolved bones. The thinning-out and repeated hoeings which turnips require make them an expensive crop to grow, and when to this is added the uncertainty of the crop, it is no matter for surprise that they are much less widely cultivated than they were a few years ago.

Turnips and swedes alike are grown to the greatest advantage in a cool, moist climate, and on rather light, friable loams. Swedes are very useful for pulpings purposes in the early winter months, because they keep sound longer than either of the other roots, and also because they improve in quality by keeping until February or March. The cultivation, manuring, and general treatment are much the same with all of them.

In some localities kohlrabi has of late years attained a certain amount of popularity. It has been found a good substitute for swedes where the latter have failed. The chief advantages of this root over others are that it is comparatively free from the attacks of insects and game, and does not suffer like them from drought and mildew. The cultivation of kohlrabi is similar to that of swedes, though, being of slower growth, it requires a month's earlier sowing.

Of all crops cultivated for late autumn consumption, cabbage is without doubt the most valuable in all respects. Under generous treatment it will produce heavier crops than any other kind of green food, while its adaptability to the production of milk is of a very high order. It does not impart, as turnips do, unpleasant flavour to milk, its feeding properties are much superior to theirs, and withal it is a healthy and most valuable article of food for dairy-stock. The seed is usually sown in the autumn on well-prepared beds, the plants are moved later on into other beds, and in the spring are finally transplanted out in the fields. The soils best suited to them are deep, rich, friable loams; but if the land is well manured and properly prepared, they will grow successfully in almost any soil. It is best, generally speaking, to ridge the land, as if for potatoes, and after putting in 12 or 15 tons of well-rotted farmyard dung per acre, along with 2 cwt. of nitrate of soda, or 3 cwt. of Peruvian guano, the ridges should be re-split, and the cabbage plants "pricked in" about two feet apart. The horse-hoe should afterwards be used once or twice between the rows, and the soil "earthed up" again with the ridge-plough.

The lupin is well known in England as a large and handsome flowering plant for the garden or shrubbery, but though it is extensively cultivated, both for its seed and as a forage plant, in Northern Germany, it has not at present gained much popularity amongst the farmers of Britain. The plant itself, if cut young enough, makes excellent hay, while the seeds are found to be very superior food for fattening sheep, as well as for ewes and lambs. It is said to grow fairly well on
DAIRY FARMING.

land that is too poor to grow even middling crops of anything else; striking its roots deeply down into the subsoil, it procures more or less of hard-earned nourishment that is out of the reach of other crops, and it is consequently, being perennial, well suited to occupy poor, sandy, or chalky soils, which do not pay to cultivate under any regular system. It needs first of all a soil which has depth enough, and though it may be more productive than anything else in a comparatively barren soil, it will of course do still better in a fairly good soil. Any way, it would seem to possess merit enough to recommend it to a fair trial on certain kinds of soil. As to the seeds, the following analysis will show that they possess a high order of merit as food for stock:—

<table>
<thead>
<tr>
<th>Component</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>14.15</td>
</tr>
<tr>
<td>Flesh-formers</td>
<td>33.36</td>
</tr>
<tr>
<td>Fat-formers</td>
<td>32.67</td>
</tr>
<tr>
<td>Woody fibre</td>
<td>11.12</td>
</tr>
<tr>
<td>Mineral matter</td>
<td>3.94</td>
</tr>
</tbody>
</table>

The lupin will be found represented in the coloured plate containing clovers and other leguminous plants.

Prickly comfrey (Symphytum aspernum) has in recent years attracted considerable notice as a forage plant; but though many farmers have tried it on a limited scale, it does not at present appear to be gaining ground as one of the acknowledged crops of the farm. Providing only that animals would eat it freely, it might and would, after a time, come into extensive cultivation, but we not uncommonly hear the objection urged against it that they will not; this objection, if sustained, is of course fatal to its popularity. The plant, however, is said to possess such uncommon merits that it deserves to be much more widely tried before it is discarded. It is said to be "especially adapted for the feeding and fattening of stock, and for increasing the milk of cows; it grows more rapidly and luxuriantly than any other green soiling plant, producing in a given space a far greater quantity of forage. Being a deeply-rooted plant, it is independent of weather or climate, and in the hottest seasons it will afford several heavy cuttings, when all other vegetation is either burned up or at a standstill. It comes in earlier than other crops, and lasts longer, continuing to afford forage until it is cut down by severe frosts. Comfrey culture is simple and not costly. The ground is either forked or ploughed 6 or 8 inches deep, and well manured. The crowns, or root cuttings, are then planted like potato sets, 3 feet apart. The plant, when dried into hay, makes a good food for horses, cattle, sheep, and pigs. When once the plant is established, no further expense is needed. It may be cut several times during the growing season, and will yield 80 to 120 tons of green food to the acre." This is certainly magnificent testimony, but, so far as our own observation goes, it is not borne out. We have it in two or three plots in the botanical gardens of the Royal Agricultural College at Cirencester, and it has been used as food for horses; yet not only are the horses averse to it, but it is not by any means an extraordinarily heavy cropper; still the land there is light, dry, and generally inferior, and under more favourable conditions the plant would, no doubt, do very much better; but we feel bound to express our unqualified disbelief in the statement that it will produce "80 to 120 tons" per annum of green food to the acre. It is said to be a native of the Caucasus, and, according to Loudon, was first introduced into England in 1799; but its reputation as a forage plant is quite recent. Dr. Voelcker says of it:— "In its fresh state, comfrey contains still more water than white mustard; but, notwithstanding this large proportion of water, the amount of flesh-forming substances is considerable. The juice of this plant contains much gum and mucilage, and but little sugar." A representation of it will be found in the chapter on forage plants.

Lucerne (Medicago sativa) is already, and most worthy, popular in some parts of Britain, and we venture to predict that its popularity will increase. In the Western States of America, particularly in California, it is held in very high estimation, and under the name of alfalfa it is very extensively cultivated both for soiling purposes and for winter forage. A practical Californian dairy-farmer writes of it in the following terms:—"We speak our own experience, which has been considerable, and the experience of every dairyman in the northern half of the State, when we say that alfalfa is the best butter and cheese making plant we have ever fed cows upon, either in the summer or winter, either as grazing or hay. Indeed, it is the general testimony of dairymen who pasture cows on the native grasses and on alfalfa, that when pasturing on alfalfa the milk and butter are at least 20 per cent. greater,
and much richer and finer, than when pasturing on native grasses." Lucerne, being one of the many kinds of clover, requires the same sort of general treatment as the others do; like them, it does best in a deep soil into which its roots penetrate deeply, and though it prefers a soil that is not very dry, it likes a warm climate. Under favourable conditions it is said to produce 30 to 40 tons of green food, or 5 to 6 tons of hay, per acre per annum, in three or four cuttings. This plant will be found in the same plate which contains the lupin.

The Right Use of Straw.

The remaining crops grown on a dairy-farm where soiling is practised will be wheat, oats, or barley, as the case may be; a portion of the land will be in permanent pasture for the use of young stock, and the remainder in meadow. While meadow hay is next to indispensable in winter-time, all the straw of the cereal crops will be turned to good account by being chaffed and mixed with pulped roots or brewers' grains, and brought up to a high standard of quality by the addition of various kinds of purchased feeding-stuffs, the selection of which will be partly governed by the state of the markets. In many cases, however, especially where the farmer has no conveniences for chaffing his straw, and where the straw is very good in quality, well harvested, and not overgrown, it is expedient to feed the straw to the cattle without chaffing it; and where it is given this way, it is found to be enhanced in value by setting the "battens" or sheaves on end out in the stack-yard a few days before it is eaten, and either pouring water over it or allowing the rain, if any, to soak it; the soaking softens the fibre of the straw, prepares it for the stomach, makes it easier of digestion as well as of mastication, and the cattle relish it better, eat it up cleaner, and there is less waste. This may appear too simple an expedient to be valuable; but try it—we can recommend it. If there is any good in "steaming" such food, it is just the same good, done in a different way, which the straw derives from the soaking with water out in the rick-yard.

The same principle is involved, done in yet again a different way, and along with certain other improvements, in the system of preparing straw-chaff described as follows by Mr. Samuel Jonas, in the Journal of the Royal Agricultural Society, vol. vi., 1870:

"I use a 12-horse-power engine by Hornsby, which enables me (when used on home premises) to thrash, dress, and sack the corn ready for market, and cut the straw into chaff. I use one of Maynard's powerful chaff-cutters, which sifts and puts the chaff into bags, ready for being carried into the chaff-house. The straw, when delivered from the thrashing-machine, is carried by rollers to the height of 9 feet; it then comes down an inclined plane. Three men get in the straw, and hand it to the chaff-cutter; it is then cut, and carried into the chaff-lorn and well trodden down, mixing about a bushel of salt to every ton, and also a certain quantity of green-stuff. Tares or rye, cut green into chaff, are sown by the hand as the chaff is brought in. This causes it to heat, and adding the amount of green-stuff required to give it a proper heat is the secret of the successful operation of storing chaff.

"Respecting the quantity of green-chaff to be mixed with the straw-chaff to cause a proper fermentation: I use about 1 cwt. to the ton of straw-chaff, and 1 bushel of salt (56 lbs.) to the ton of chaff. But some judgment is required as to the state of the green-stuff. If it is green rye on the ear, a full cwt. is required; if very green tares, a rather less quantity will do, as the degree of fermentation depends upon the quantity of sap contained in it. This is done in spring and summer—the chaff is not used till October and the winter months. I can thus thrash and dress the corn crops, and cut the straw into chaff, in one process, the expense of cutting and storing the same being about 1s. per acre; the principal additional expense is for about 4 cwt. of coal per day, and we thrash and cut from 8 to 10 acres per day."

This extremely simple, inexpensive, and in all respects excellent plan of dealing with straw for feeding purposes recommends itself to farmers throughout the length and breadth of the land as one of sterling practical value, and it is to be hoped the system will obtain a wide-spread popularity. The straw annually wasted in these islands, in one way or another, would keep thousands of dairy-cattle through the winter; and there is a still larger quantity which, though not absolutely wasted, is "next door to it." Vast quantities of straw which, prepared on Mr. Jonas's simple plan, would make valuable food, are now trodden
down into manure as expeditiously as possible, as if that was the first object for which straw is cultivated and the best use to which it can be put. This, however, cannot be helped at present, because most farmers are forbidden to sell their straw, and on many arable farms there is not half enough stock kept to consume it, unless treading it down into manure can be called consuming it. It is easy to understand why, half a century ago, they should be forbidden to sell it, for at that period they had no chance of restoring its value to the farm in the form of purchased manures. But a different state of things rules in the present day, and the restriction has now become both useless and injurious. Numbers of dairy-farmers would be rescued from serious and frequent embarrassment in the management of their stock if they could buy good straw at a moderate price; for it is a simple thing to improve it so that it will answer admirably for the winter-feed of cattle. It may be hoped that these useless and absurd restrictions will shortly disappear, as they are already doing under the more enlightened landlords.

The following analyses by Dr. Voelcker show the composition of ordinary meadow hay, Mr. Jonas's fermented straw-chaff, and of ordinary wheat-straw chaff respectively. Tabulated side by side, the reader can see at a glance the great improvement produced by the fermenting process, and also the difference which yet remains between the fermented chaff and meadow hay:

<table>
<thead>
<tr>
<th>Compositions of</th>
<th>Ordinary Meadow Hay</th>
<th>Fermented and prepared Straw chaff</th>
<th>Wheat-straw chaff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture ...</td>
<td>14.61</td>
<td>7.76</td>
<td>13.33</td>
</tr>
<tr>
<td>Oil and fatty matters</td>
<td>2.56</td>
<td>1.60</td>
<td>1.74</td>
</tr>
<tr>
<td>*Aluminous compounds</td>
<td>8.44</td>
<td>4.19</td>
<td>2.33</td>
</tr>
<tr>
<td>(flesh-forming matters)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sugar, gum, and other soluble organic compounds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digestible fibre ...</td>
<td>41.07</td>
<td>10.16</td>
<td>4.26</td>
</tr>
<tr>
<td>Indigestible woody fibre (cellulose)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mineral matter (ash)</td>
<td>6.16</td>
<td>6.01</td>
<td>4.21</td>
</tr>
<tr>
<td></td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
<tr>
<td>* Containing nitrogen</td>
<td>1.35</td>
<td>0.67</td>
<td>0.47</td>
</tr>
</tbody>
</table>

In respect of these analyses, Dr. Voelcker remarks:—(1) The prepared wheat-chaff is one-fourth richer than the unprepared in materials which produce the substance of the lean fibre of meat, or of muscle; (2) the percentage of sugar, gum, &c. amounts to nearly two and a half the quantity which occurs in good unprepared wheat-chaff; (3) the treatment rendered soluble 50.85 per cent. of the vegetable fibre of the fermented chaff, whilst the soluble portion of vegetable fibre does not amount to more than 26.38 per cent.; (4) the fermentation has the effect of rendering the hard and dry substance, which constitutes the bulk of straw, more soluble and digestible than it is in its natural condition; (5) the prepared straw-chaff has all the agreeable smell which characterises good green meadow hay, and a hot infusion with water produces a liquid which can hardly be distinguished from hay-ten; and (6) about 2 cwt. of decorated cotton-cake ground into meal and added to 1 ton of fermented straw-chaff constitutes a mixture which agrees closely in composition with good meadow hay.

No definite rules can be laid down as to the quantity of food which dairy-cows should receive—this will depend entirely on the capacity of each cow individually; but it must be borne in mind that it is an unwise policy to over-feed them. They should receive just what they will eat up cleanly; more or less than this will be detrimental not only to the condition of the animals, but also to the quantity and quality of milk they give. The feeding of stock both requires and rewards careful and intelligent attention. Over-feeding is not only a waste of food, but is injurious to the cattle. Indiscriminate and lavish feeding will keep the cattle poor. During the time a cow is in calf and in milk, and especially toward the end of the period of gestation, she will require an increased proportion of albuminoids or nitrogenous food, and a smaller one of carbonaceous, than if she is neither in milk nor in calf—if she is merely growing or fattening.

The question of feeding cattle on sound principles is one that needs to be studied more than it has been by practical farmers, and we are glad to see that this is coming to be the case in many parts of the country.
CHAPTER V.

MILKING, CALVING, AND CALF-REARING.

Modern exigencies have very much upset many old-fashioned methods; and milking has shared in the change which seems to have passed over all things: the hour—five in the morning and five in the evening—which used to be pretty uniform throughout the country, is now varied in different places to meet the needs of the milk trade. A given train has to be met, and the station is two or three miles away; the milker therefore often sits down to his cow in the morning while the cold stars are still seen in the sky. Punching his hat well into her flank—a hat well covered with hairs, much battered and shiny with grease from the skin of the cow, and which is kept for this one use, and lasts through many years—he tugs away lustily with hands and arms and shoulders, first on the fore teats and then on the hind, the hands working alternately because it is easier so.

Out of doors the milker is exposed to all sorts of weather. Storms of wind and rain contrive to be at their worst when the milking is half done. Very soon the soil is soaked with rain, in a day or two it is mud, and it sucks at one's boots. The three-legged stool, whose rude surface is roughly polished by use, sinks deeper and deeper into the mire. The gates, and the trees, and the old rails in the fence are dripping with wet, and the air is a vapour. The rain runs in streams from the back of the cow and pours on the arms and thighs of the milker, while the wind blows big drops into the nape of his neck. But in fine weather, when the cows are contented, out-door milking is not the least pleasant of the farmer's duties.

After considerable experience with both ways, we are strongly in favour of having the cows brought into the sheds and tied for milking, rather than of milking them out of doors in a corner of the field, and especially so if the corner is not railed off from the rest. On some inconvenient farms, however, the pastures are so far away from the buildings that it would be a mistake to bring the cows to the sheds to be milked, for the more exercise of this kind dairy-cows are compelled to take, the less milk they will give. In cases of this sort it is a necessary evil to milk out of doors. It is necessary because it is an unsound policy to bring the cows home from a distance, and it is an evil because the milkers themselves lose a great deal of time in going to and from the milking field. The cows are, especially in hot weather, much more restless out of doors than in, and it is consequently not only more troublesome, but more annoying to milk them so. Wherever the pastures are within easy reach of the buildings, it will be found more satisfactory in all respects to milk the cows in their stalls.

In winter more particularly, but at any other period if the cows are kept indoors and fed there, it is well before the milking commences for some person to go round with a brush or a coarse cloth in his hand and rub off from the cows' udders all the loose dirt and dust, in order to keep the milk clean, and in some cases it may be found necessary to wash the udders and teats; and it is no less expedient that those who are to do the milking
should first wash their hands, and should never have long finger-nails, or the cows will have sore teats. Really good and careful milkers are scarce and valuable, and cows will soon fall off in flow of milk under the hands of poor milkers. More frequently than people imagine, especially in the hot weather, milk has been injured by milkers' unclean hands and by cows' unclean udders at milking-time; and we have seen milkers, with the false idea of milking easier, dip their dirty fingers into the milk in the pail, and then go on milking, the drops of dirty milk oozing out between the fingers and returning to the pail from which they were taken. Where this is done, the cheese and butter will suffer in quality more than those who do it are in the habit of thinking. Milk is a peculiar product, and exceedingly susceptible of injury from dirt of any kind and from impure odours; and if it is not taken proper care of it soon goes sour in hot weather, its natural tendency to decay being always promoted by the presence of impurities.

Twice a day, generally speaking, is often enough to milk a cow, but for a few days after she has calved—and afterwards if she is a deep milker—it is a good thing to milk her thrice a day. Some people say that each cow should, if possible, be always milked by the same person, as all cows will not let down their milk to strangers. Now this, in our opinion, is the very way to train cows not to let down their milk to strangers, and when the person who has been in the habit of milking them happens to be away, the result is that some of them are milked with great difficulty by strangers. A better plan is to accustom every cow from the first to be milked by any one to whose turn she happens to fall.

Milking should always be done quietly, regularly, and thoroughly, though at the same time quickly. It should be done quietly, without any scolding or beating of the cow—some cows, though, are very provoking—and with as little talking and noise as possible, for some cows will hold their milk if they are scolded. It should be done regularly, for cows give their milk more freely, and they soon learn regularity themselves, if they are treated with regularity and system. It should be done thoroughly, getting out every drop when "aftering," because a cow will soon fail in her flow of milk if she is not milked clean each time; and it should be done quickly, for cows appreciate despatch, providing you do not hurt them, and because a good milker is almost invariably a quick milker. Undue nervous excitement not only lessens the quantity but lowers the quality of the milk. Cows are essentially creatures of habit; they soon learn to come toward the sheds at milking-time, grazing homewards, and sooner still they learn their own places in the sheds; they soon also acquire the habit of letting down their milk at regular times, and it is therefore decidedly necessary to always milk them in the same order in the sheds, beginning so that each successive cow can be sat down to without disturbing the previous one—that is, begin first with the cow whose left or near side is next to the wall at the end of the shed, and they will all very quickly learn to expect being milked in order as they stand. This milking in order is one of the advantages of shed milking, for if the cows are milked out of doors, standing loosely about, it commonly follows that all the easy ones are milked first, but not in order, each milker aiming to get hold of the easiest cow he can find; but in sheds the cows must be taken in order as they stand, and so each milker gets his share of the "hard" ones.

Some farmers tie together the hind-legs of each cow, in order to prevent her kicking the pail over while she is being milked. With many cows this is absolutely necessary, and we are inclined to think it is a good system to adopt, now and then a most respectable sort of a cow, when anything hurts her, and sometimes when it does not—a cow whose general conduct is above reproach—will lift up her foot suddenly and overturn the pail in the twinkling of an eye, not that she intends at the time to be vicious, but it is a way cows have. It is a most unpleasant and startling thing for one to have his pail of milk knocked over when he is milking, and this is oftenest done by cows whose character is good, and with whom he is not so much on his guard as he is with one whose morals are shaky; hence we think it a good system to tie all cows' legs at milking-time, as the milkmaids do in Ireland.

Whether cows ought or ought not to be milked oftener than twice a day is essentially a matter in which circumstances alter cases; but the following propositions may be accepted as being fairly established:—1. As a general rule, milking three times a day influences the secretion of milk,
So far as its quantity is concerned, more favourably than twice milking. 2. Under certain circumstances, in the case of cows that are large milk-givers and are highly fed, and are yet in the early period of lactation, milking three times a day may be absolutely necessary for their health, especially with a view to the prevention of diseases of the udder. 3. The shorter the time that has elapsed since the last milking, the richer and fatter is the milk; so that in milking thrice a day a milk richer in dry substances is obtained than is given on the twice-a-day system. On the other hand, the following points require to be taken into consideration:—1. Milking three times a day necessitates a greater demand on the strength of the cows. Only where this is compensated by a corresponding amount of nourishment can milking three times a day be of lasting advantage. The better the cows are fed, the more likely is thrice-a-day milking to be more profitable than twice-a-day milking. 2. The better milk-giver a cow is, and the less she is advanced in lactation, the greater is the advantage of the thrice-a-day over the twice-a-day system. 3. On the three-a-day system the greater amount of labour required in it must be taken into consideration, a factor in the calculation which becomes of no little importance when the pasture grounds of the cows are at any considerable distance from the dairy.

**Milking-Pails.**

Every one who has been accustomed to milking is well aware what a difference there is between a properly and an improperly constructed milking-pail, so far as the milker's comfort is concerned. Deep, narrow cans are not only difficult to hold between the knees, but they are generally awkward and uncomfortable. Milking-pails should always be narrower in the bottom than at the top, as in Fig. 10. Some people still prefer wooden pails to milk in, but they are objectionable chiefly on account of the greater difficulty of keeping them sweet and clean. In Fig. 11 we give an illustration of one of these pails, to which is attached a pair of ears which, resting on the milker's knees, are very useful in sustaining the pail between the knees. In Fig. 12 we give an illustration of a newly-invented milking-pail, for which several advantages are claimed—viz., the seat and pail are combined in one; the cow cannot kick over or put her foot into the pail; the milk is kept free from hairs and dirt by the strainer inside the funnel; and the impure atmosphere of the cow-shed comes as little as possible in contact with the milk. We cannot speak practically about this pail, never having tried it, but we think the former two advantages are practical ones, whatever the latter two may be.

At some periods of the year, oftenest in the autumn, cows' teats are apt to crack and become sore. A little fresh lard, applied at milking-time and well worked into the skin of the teat during the operation of milking, will generally cure the sores with three or four dressings, and it certainly makes the milking much less painful to the cow, whether it cures the sores or not; but where the lard fails to cure, a little well-
prepared salve should be used. A cow will now and again have a teat badly cut, or scratched, or torn by accident, and sometimes a sore will come which re-opens every time she is milked, and which for a time defies all attempts made to heal it. These injuries cause great pain to a cow when she is being milked by hand; and to avoid giving this pain, as well as to give the sore a good chance of healing, it is a good thing for a dairy-farmer to keep always in his possession, locked up in a place where it can at any time be found, a silver "syphon," or "milking-tube." The sore teat should be milked with this whilst the sore remains, and the tube should be carefully smeared with fresh lard before using, in order that it may be easily inserted into the teat, and it should be carefully cleaned each time after using, in order to prevent clogging up with coagulated milk.

**Milking-Machines.**

It is estimated that 200,000 persons are required to milk the cows in England alone, so it is easy to understand that an inceaseable amount of time and labour is expended in milking cows by hand, and it is hardly too much to say that milking is the great bugbear of dairy-farms. It is far from being easy work; it comes round twice a day with monotonous regularity, and it must be done, whatever else is left undone. Dairy-farmers feel the strain, and servants dislike the task of milking. A great number of attempts have been made to produce a thoroughly satisfactory milking-machine. There are many different machines in this country, and more in America, for which patents have been taken out, and it is to be hoped that one will before long be produced which shall embody the necessary qualifications of simplicity, effectiveness, rapidity in working, and harmlessness to the cows' teats; such a machine would be a great boon to dairy-farmers. The Royal Agricultural Society of England, alive to the importance of this matter, offered a special prize of £30 for an efficient and satisfactory milking-machine at the Bristol Show in July, 1878; but as no machines were entered for competition, it is plain that no inventor had then produced one which he deemed likely to be successful. This is, however, essentially an age of mechanical inventions, and we feel confident of the ultimate production of such a machine. Attempts have been made in the direction of imitating the manner of a calf sucking, by means of india-rubber sockets which enclose the teat, and, by forming a vacuum inside the sockets, a partial success has been achieved. We think this is the right direction, and that perseverance in it will be eventually successful; but a great difficulty lies in the diversity in the size and position of cow's teats, and in the application of the motive power. But the bulk of the "cow-milkers" hitherto invented are on the syphon principle—that is, tubes of one pattern or another are inserted into the cows' teats, and as these tubes have holes near the upper end, the milk simply runs out by the force of its own gravity. These various machines resemble each other so much, and are so closely identical in principle, that we need only mention one of them, described as a "new self-acting cow-milkier" by way of illustration. It consists of four metal tubes, a, a, a, a (see Fig. 14), two inches long, attached to india-rubber tubes, b, b, b, b, seven inches long, which are fastened together at the lower end, and which conduct the milk into the pail. The contrivance is effective enough so far as milking the cow goes, but the objection to passing tubes into a cow's teats every time she is milked is a serious one. The internal mechanism, if we may so term it, of a cow's teat is of a most delicate description, and is easily deranged by the introduction of foreign substances. At the lower end of the teat is an aperture closed by an elastic band, which prevents the emission of milk, except under pressure; farther up is a cavity enlarged in the middle, and at the top of it a diaphragm, which separates the cavity in the teat from a larger
cavity above it, and a hole in the diaphragm about the size of a pea; the upper cavity serves as a reservoir for holding milk, and the diaphragm at the base of it prevents an undue pressure of milk in the teat when the udder is full. Tubes inserted into cows' teats are, unless inserted with great care, apt to produce inflammation. We have known at all events one cow, a valuable heifer, killed in this way; and if the tubes do no other harm, a complaint is lodged against them to the effect that they permanently distend or otherwise derange the opening into the teat, so that the milk runs out of its own accord and is lost. Fig. 15 is a representation of the milker in operation. We have heard both favourable and unfavourable opinions given as to its utility; and though we should not venture to recommend its indiscriminate use, we consider every farmer should possess one, if only to milk very "hard" cows a few times with it. The teats of such cows would be all the better for being distended a little.

It is recommended to milk a few drops from each teat before using the cow-milker, then insert the tubes (not exceeding an inch), when the milk will flow freely. No difficulty will be experienced whatever if the operator, in the first instance, take the precaution of seeing the hole in the teat before inserting the tube. The apparatus should not be allowed to remain in the teats after the milk has ceased to flow, or air will find its way into the udder.

Some cows are extremely "hard" to milk, and are consequently seldom milked "clean"; this is sure to cause the flow of milk to diminish, for if any milk is left in, the udder becomes more or less inflamed, and the milk falls off in quantity. The hardness in milking is caused by the hole in the end of the teat being too small; it may be distended by the insertion of a small plug or cone of ivory, bone, or hard wood, well oiled, when the milking is over, and leaving it in the teat until the next milking-time, after which it must be reinserted each time until the cow becomes easy to milk. The cone should be made as seen in Fig. 16, with a head at the lower end, then a neck, after which it is sloped to a point. If made the right size, no harm will come of its use, and in a short time the orifice in the teat will become permanently enlarged, and the cow will no longer be difficult to milk.

The Rearing of Calves.

It may be laid down as a first proposition that a dairy-farmer should raise at least as many heifer-calves as are required to fill up the vacancies which occur year by year in his herd of dairy-cows, and it is all the better if he has a few more than he wants for that purpose. Some people contend that three-year-old in-calf heifers can be bought for less money than they can be raised for, counting in the risk; this, however, depends entirely on the facilities a man has for keeping young cattle so as not to interfere with his milk pastures. On all mixed farms it is commonly a simple matter enough to summer and winter young cattle so cheaply that it is better to raise them than to buy others for the dairy-herd, and many farmers find it to their advantage to raise them for sale when "on note," or to fatten for the butcher. Judiciously carried out, rearing pays very well, and heifers raised on the farm are commonly found more suitable to it in after-life as milkers than others that are raised elsewhere and purchased; besides which, it is more than probable that rearing will always pay well in the British Islands, providing only that the stock is of good quality, for the demand for milk in our towns and cities is sure to go on increasing, and there will always be a brisk demand for store stock of good quality for grazing purposes. A careful breeder can but seldom buy dairy-stock that will suit him as well as those of his own rearing; those he buys may, perhaps, be as well bred as his own are in every respect, but if they are only as well and no better bred, they will scarcely ever do as well in the milk-pail as those that have been reared on the farm.

There should always be one or two loose boxes available into which cows may be taken if anything is wrong at calving-time; but, generally speaking, they need not be taken away from their stalls at this period. There is a good deal of philanthropy wasted on this point by some people, for a cow will be more composed and tranquil in her own stall than in a loose box to which she is strange. It is a mistake to hurry cows over their calving. Give them time,
supplement the efforts of nature, not supersede them altogether, and immediately they have calved give each cow about two quarts of cold water; it takes away the sickly feeling better than chilled water does, and it does the cow no harm whatever. Afterwards it is a good thing to give them linseed and flour gruel for a few days; it strengthens the cow and promotes the flow of milk. We have tried this system for years, always with the most satisfactory results.

It does not follow that a cow need be in very good condition herself in order to produce a strong and healthy calf; rather the contrary. A cow will often be rather lean at calving-time, if she has been indifferently fed, and yet produce a surprisingly good calf; the calf is the explanation, in part, of her leanness, and if she had been better fed she would not only have produced a still better calf, but would have been in a more profitable and satisfactory condition herself. On the other hand, it is not uncommon for a cow in very high condition to either produce a small and delicate calf, or to go barren altogether.

Many farmers like to have a given number of their best cows calving rather early, so that they may have their number of rearing calves in forward condition before cheese-making gets into full swing. There is, indeed, no real but only a fanciful reason why calves that are dropped in April should not be as well reared as those that are dropped in February. But the reason commonly assigned is this—as soon as cheese-making has fairly begun, the calves are begrudged the milk which is freely enough given to them before it commences. And yet milk applied to cheese-making is not by any means so essentially the most profitable use to which it can be devoted that the later calves should be unduly deprived of it on that account. This is a point on which a little reflection will dispel much of the prejudice that exists; and it must be borne in mind that calves will thrive faster in May than in March on a given allowance of milk, simply because the weather conditions are then more favourable. It is, however, an advantage to have the calves so far advanced that when grass-day arrives they are fit to be turned out on the pastures in good form, and this they hardly can be unless they are dropped pretty early.

Perhaps the most potent argument in favour of giving calves as good a start as possible in life lies in the fact that at no subsequent period do they grow so rapidly on a given quantity and quality of food. Moreover, if they are well started they never, as a rule, except from accidental causes, suffer a check in their progress to maturity. In any case, no matter when they are born, it is "a penny wise and pound foolish" policy not to rear them very well—always avoiding pampering them, mind. Except when rearing pedigree stock, or in case of late calving, it is seldom a good plan to allow the calves to suck at all from their mothers, because it makes the cows and calves alike unsettled; and, once acquired, a calf seldom forgets the habit of sucking, but in after-life will commonly begin to suck the other cows of the herd, or even to suck herself, which is most objectionable. And yet there are complaints sometimes of young calves dying from an excess of coagulated milk forming in a mass in the stomach when they are fed from the pail—a misfortune which is said never to occur when they obtain their sustenance in the manner which nature so beautifully teaches. The complaint is certainly not without foundation in fact, for calves are apt to drink too greedily from a pail, in which case a due proportion of the saliva of the mouth is not mixed with the milk. One of the digestive agents is thus deficient in quantity in the stomach; hence the formation of masses of casein, which are simply evidences of imperfect digestion. This, to a great extent, if not wholly, may be obviated by allowing the calves, during the first week or two, to have only a small quantity of food at a time—a regimen which nature dictates to the instinct of the cow—and they should have that little often.

At the same time we think it is well in some cases, especially when the udder is "hogged," to allow a stirk or a heifer to suckle her first calf for a week or two, even at the risk of making her unsettled when the calf is taken away, for she comes to milk freely in a shorter time, and there is less risk of spoiling her temper. Yet we should not advise this to be followed as a regular practice with stirks and heifers. It must, however, be always remembered that a calf will as a rule do better when sucking from its mother than when it is brought up by hand, and it will in the former case seldom take any harm at all even in bad weather, while in the latter it needs to be most carefully sheltered.
The feeding-pail, of which we give an illustration (Fig. 17), was invented several years ago, and it is claimed for it that, by causing the calf to suck the milk through the India-rubber tube shown in the engraving, nature's process is closely copied, and the calf cannot gulp down its food, as it too commonly does when drinking from a pail; the saliva of the mouth mixes freely with the milk, and an improved digestion is the result; it obviates the necessity of teaching the calf to drink by putting one's finger into its mouth; and as the pail stands on a broad base and cannot easily be knocked over, one person can tend a number of calves whilst they are being fed, and none of the food is wasted. We have used these feeding-pails, and although they require more cleaning than ordinary pails, we consider they are a useful invention.

Young calves that are intended for dairy-cows eventually should always be allowed to receive a sufficient quantity of new milk for the first three or four weeks; after this period skim-milk may be fed to them, but it must be improved by ground linseed, with ground wheat or oatmeal added. And these additions to the skim-milk should always be boiled or steamed, and not given raw to the calves—not so much that they may possibly do harm in the raw state as that they are made more effective and are more easily digested by having been cooked; and the food, when it is given to the calf, should be at a temperature of 95° to 98°, which is the temperature of the milk in a cow's udder. If the prepared food is higher or lower than this, it is so far a deviation from nature's rule in this respect, and so far it will be improper.

While the quantity of food a calf requires will naturally increase a little day by day, overfeeding should always be carefully avoided, for a calf will always thrive better when its appetite is stimulated by under rather than satiated by over feeding, and in the first two or three days it should be decidedly under rather than over fed. It is difficult to lay down any rule as to the quantity to be given, for a strong and vigorous calf will naturally require more than a weak and delicate one—this is a point on which judgment must be exercised at all times. For the first two or three days 2 to 3 quarts of mothers' milk per day will be enough, and this may be increased to 4 or 5 quarts by the end of the first week, to 6 or 8 in the second week, and to 9 or 10 by the end of the first month. These quantities refer to new milk or to its equivalent, and to a full-sized and healthy calf. The food should always be good in quality and reasonable in quantity. When skim-milk is used, linseed-meal should be employed to make amends for the cream which has been removed, and a little oat, pea, or flour meal to restore the lost casein.

By the time they are two or three weeks old young calves will begin to nibble a little sweet green hay, if it is given to them in racks or nets, and it is a good plan to teach them to eat it early. This is best done by suspending a netful of hay so that it dangles in front of them; rubbing their noses, they soon begin to nibble.

Many people are in the habit of giving "hay-tea," as it is called, to young cows along with the milk, with the view of getting them used to a hay diet before they are able to eat the hay for themselves. The tea is made by putting some hay in a kettle that is half filled with water, and letting it simmer over a slow fire for an hour or two; the water is then poured off and set aside for use. There is, no doubt, a good deal of merit in this system, for the calves get all the nutriment the hay contains without any of the indigestible fibre. It is well, however, as soon as the weather is warm enough, to get the young calves out of doors for a few hours each day, so that they may nibble the fresh and tender grass.

**Condimental Foods.**

For some years we have used condimental food in the rearing of calves—just a "pinch" in the "beastings," and increasing it as the time goes on to a good tea-spoonful—and we have found it an excellent thing in keeping the calves healthy, and an effectual preventive of "scour," a malady from which young calves, when reared away from their mothers, are constantly liable to suffer. The condiment gives a tone to the stomach, and when used in moderation is a very useful kind of food. There are various kinds of condimental food in the market, some...
of which have obtained considerable reputation, but the chief objection against them all is that they are sold at a far higher price than a fair profit would seem to justify. Much credit has been claimed—and we believe justly so—for the stimulating effect which a properly prepared "cattle-food" has on the digestive organs, and it is no doubt true that a sparing use of it will prevent many illnesses in young stock; but the price at which it is usually sold is far higher than any farmer is justified in paying, especially when he can compound for himself, at a reasonable cost, a food which will be found equal to any that are sold, and superior to most,—vastly superior to some of them.

Mr. Pringle, in his "Live Stock of the Farm," gives the following formula, which represents a safe mixture:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Cwt.</th>
<th>qr.</th>
<th>lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locust beans, finely ground, at £6 per ton</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Indian corn</td>
<td>0.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Linseed-cake</td>
<td>0.05</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Powdered turmeric</td>
<td>8d.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sulphur</td>
<td>2d.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sulphate</td>
<td>5d.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Liqueur</td>
<td>1s.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ginger (ground)</td>
<td>6d.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Aniseed</td>
<td>9d.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Coriander</td>
<td>9d.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Gentian</td>
<td>8d.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cream of tartar</td>
<td>1s.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Carbonate of soda</td>
<td>4d.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leavened antimony</td>
<td>6d.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Common salt</td>
<td>1d.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Peruvian bark</td>
<td>4s.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fenugreek</td>
<td>8d.</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Total: 20 0 20

With calves that are being fattened for the butcher the case is different; the object with them is to feed them as quickly as possible consistently with safety, and they may receive as much milk as they will take, along with an increased quantity of condimental food. With fattening calves we have not to consider the effect of the feeding on their constitutions in after-life, for they have no after-life, and all we want is to quickly and successfully fatten them.

It is a common practice to bleed fat calves some hours before they are killed, and to keep them without food for a day or so; these "dodges" are supposed to improve the veal somehow or other—a great mistake. It is better to kill the calf without previously interfering with any of its natural functions. The veal will be better and healthier in all respects if the calf has not been put through any change of treatment, and there is a gain on the side of humanity.

The calf-houses should not only be kept as clean as possible whilst the calves are in them, but when the calves are turned out to grass they should be thoroughly cleaned out, the floors scrubbed and swilled, and the walls lime-washed. Whilst the calves are in them they should be well ventilated, but not cold, and a daily supply of litter—the old litter being removed once or twice a week—should be placed on sparrowed floors, which will admit of the urine passing freely away. On a sparrowed floor the litter keeps clean and dry for a much longer period than on an ordinary floor, and the cost of it is soon saved in litter alone. Such a floor is cheaply and quickly made of young larch-trees, split down the middle, and nailed across on sawn spars, on unsplit larch-trees, or on any odd pieces of planking that will rest on the paved floor beneath. The intervals between the lower spars may be about 2 feet, and between the upper ones about 1 inch. Put down in squares not too large—say 4-feet squares. These sparrowed floors are easily taken out to be cleaned, and as easily replaced. If well cleaned, dried, and stored away when the calves have done with them, they will last several seasons; and they not only keep the calves clean, dry, and warm, but also economise litter, and on dairy-farms straw can be put to a better purpose than that of mere litter. These precautions properly attended to, young calves will seldom suffer much from any kind of ill-
health, and they will certainly grow the faster on a given quantity of food.

The surest way to prevent scouring in calves is to feed them regularly, and to keep them clean, dry, and warm, but not too warm. Neglect of these matters is a fruitful cause of "scour," and of the other ailments to which young calves are liable, while attention to them will prevent much trouble, loss, and disappointment. Since adopting these measures, now some years ago, and by giving the calves from the first a little condiment or spiced food in their milk, we have had no losses and scarcely any illness of any kind among young calves. The usual complaints met with in rearing calves will be treated in the next chapter.

The Growing Calves.

There is much difference of opinion as to the after-treatment of calves—say from the time they are turned out to grass until they are twelve or fifteen months old. In their first winter, especially in certain localities, calves are extremely liable to the fatal disease of "hay-fever," "speed," "quarter-evil," or "black-leg," as it is variously termed. This scourge is said to be the effect of an excess of fibrin in the blood or of some kind of blood-poisoning. Be that as it may, however, the causes to which it is more obviously due are changes of food and of temperature, and it generally seizes on the best and the worst calves in the lot, passing over the medium ones. It is a very precarious malady, being much more active in some years than others, and in autumn and spring rather than in mid-winter, but it is not infections. We have tried many highly-recommended nostrums, both scientific and eclectic, with a view of preventing it—curing it is out of the question. Some of these would seem to succeed one year and would utterly fail the next, and we have frequently, in spite of the nostrum, lost half the number of calves in the course of a single winter. For some years past, however, we have lost only one calf from this cause, and the immunity is owing to an improved system of treatment:—The calves are taught, when they are six or eight weeks old, to eat linseed-cake, broken into small pieces and put into their "suckling," and when the latter is cut off, which is commonly done soon after they are turned out to grass, the cake is continued to them throughout the summer and winter and until the following "grass-day," along with a pinch of common salt to each calf once or twice a week, and they run loose all the winter on a sheltered portion of the land, having a building or shed into which they can go when they choose to eat the hay which is placed at their disposal inside. Instead of hay, they sometimes have had chaffed oat-straw and hay, improved by some kind or other of meal—rice, maize, oat, pea, or bean meal—and they have had the linseed-cake in addition; this last is a sine qua non. The one calf we lost from "black-leg" since commencing the system just described owed its death to decorticated cotton-cake, which we thought we might safely substitute for the linseed-cake.

When a calf is seized with "black-leg" it will go away from its companions, and will stand in a dejected manner under a fence or in some out-of-the-way place, quite alone, and it prefers not to move away. It does not seem to be in much pain, but it will go lame if made to stir about, and sometimes will carry the infected leg clear of the ground. The location of the disease is easily ascertained by passing the hand over the infected quarter; a rustling, crackling noise is heard under the skin, as if there were an accumulation of air or gas in the subcuticle, which in reality there is. After a time the poor animal sinks into a kind of stupor, from which there is no release but death.

Linseed-cake, given daily throughout the summer, autumn, and winter, starting before the calves are weaned from liquid food, we have proved to be efficacious in preventing "black-leg." When the calves are turned out to grass they may receive as much cake as they care to eat (but that will not be much, say ½ lb. each per day), along with a little common salt, say a table-spoonful among half a dozen, once or twice a week. As the autumn comes on they will require and will eat a little more cake, say 1 lb. per day, and this may be gradually increased during the winter until they are getting 2 lbs. per day per calf; but on no account must cotton-cake be given instead. If the calves are on sheltered land, with an open shed as a protection against storms, and are receiving good hay in addition to the linseed-cake, they will commonly be big enough to put to the bull during the ensuing summer; and it is thought they become better milkers—they are thrown more into milk—
by having their first calf when they are two instead of three years old. But it is necessary to rear them well if this system is carried out; half-rearing will not do. The chief advantages of this system lie in getting them into work a year earlier, and in saving part of a year's keep.

The system of wintering may be varied. Chaffed food, of the kind the rest of the stock are receiving, may, for instance, be given in the place of hay; but we consider the linseed-cake should in all cases be given, whatever may be the other kinds of food they have, and not alone on account of securing the calves' safety against "black-leg," but also because it pays well in all other respects. In their second summer the "yearlings" should run on a good pasture, so that the rate of progress may be maintained; and in their second winter they should have a generous diet, and be kept in-doors, for the same reason. If at fifteen months old any of them are found to be unfit to go to the bull, these ought to run on another year, and come into the herd as heifers instead of stirks—that is, at three years old instead of two. Formerly all young stock ran on to three years old before the first calf, and it would have been thought strange to "bring them in" as stirks; but now it is the exception rather than the rule for them to run on to heifers before calving. The new order of things is in keeping with the spirit of the time.

Anti-Sucking Devices.

One of the chief objections against rearing young calves by allowing them to suck from their mothers lies in the fact that they frequently pick up the habit again in after-life, and suck their companions or themselves—generally their companions. Some years ago we had a cow who had acquired by some means or other, by accident or by instinct, the habit of sucking herself; she was very cunning over it, and for a time defeated all our efforts to cure her of the habit. We tried what is called a "cradle" round her neck, and smeared her teats and udder with various nauseous things; but all to no purpose. At length a neighbour lent us a nose-piece that would cure her, he said, simple though it seemed to be. The nose-piece was made out of a piece of oak board, 8 in. long, 5 in. wide, and about ¼ in. thick, and was shaped like Fig. 18. We sprung or bent her nostril until the piece fitted, as seen in Fig. 19, and watched the result with interest. The cow tried again and again to get one of her teats into her mouth, but all to no purpose, for the nose-piece, hanging down, always came between the mouth and the teat. At length she gave it up in disgust, and went on with her grazing. The nose-piece formed no obstacle to her in eating, for it floated easily over the grass, and was really no detriment whatever. In making such a nose-piece care must be taken not to make the two points of it too far asunder, as it will easily slip off the nose. The points should be about ½ in. apart, and nicely smoothed and rounded off so that they will not hurt the cow.

Another device is shown in Fig. 20. This is useful in preventing calves from sucking cows, or cows from sucking each other, but we have not found it effectual in preventing a cow from sucking herself. The nose-piece, on the other hand, it must be remembered, is not so effectual as the spiked halter in preventing one cow from sucking another. All dairy-farmers should have both these devices in readiness. There are various other kinds, but none of them that we have ever seen or tried are so certain in action as the two we have described and illustrated. The spikes in the halter are simply wrought-iron nails, with flattened heads, stuck through a stout piece of leather, and the heads protected underneath by another piece of leather. The wooden sufficiently describes the form, size, and method of attaching the halter. These devices may also be used to prevent calves from sucking cows when both are out together on the pasture.
CHAPTER VI.

PARTURITION, AND DISEASES OR DANGERS INCIDENTAL TO CALVES AND DAIRY STOCK.

Dairy-stock are subject to various accidents and diseases, many of which are, however, either entirely prevented or greatly mitigated by intelligent care. Well reared when calves, neither stinted nor over-fed, allowed the exercise which young growing animals require, and put to the bull when about two years old, there is seldom difficulty with their breeding. Where any delay or difficulty occurs, change the feeding and management of the heifer, and try another bull. If estrum is irregular, or more frequent than eighteen days, service should not be allowed. One service is sufficient, and the cow should thereafter be kept quietly by herself for at least one day. The average period of gestation is 284 days; small cows, heifers with their first calf, and old animals usually go a day or two less; bulls are carried a day or two longer than cow-calves.

Abortion, or slipping—the most serious mishap affecting cows during gestation—results from long fattiguing travel, the shaking of a railway journey, the galloping and excitement caused by the sudden appearance of foxhounds, laborious toiling through a yard full of wet manure or a muddy lane, slipping or getting crushed in an awkward stall. The overloaded stomach sometimes presses injuriously upon the gravid uterus; the fetus is injured by the eating of ergotted grasses or grain, or of frozen roots, or by the copious drinking of ice-cold or of foul water. Mouth-and-foot complaint and contagious pleuro-pneumonia also often produce abortion. These and other such causes directly injure or kill the fetus, or more gradually interfere with the health of the dam, so that the offspring is insufficiently nourished and prematurely brought forth. But many cases result from a species of contagion or nervous sympathy. Other in-calvers in the same house, yard, or pasture with an accidental case, within a week or ten days often abort, and thus the mischief steadily spreads sometimes throughout the whole breeding cows of the farm. The evil is also liable to recur; the cows that slip one year are apt to do so about the same period of their subsequent gestation. The mishap comes on suddenly, usually without warning. The fetus being of small size is generally got rid of easily and without assistance; if over seven months it is occasionally born alive; unless near the full period the subsequent yield of milk is not so large as if matters had gone on naturally. The cleansing often clings firmly to its uterine connections, and does not entirely come away for weeks; it is not desirable to use much force to remove it, but annoyance and smell are much abated by washing the parts twice daily with carbolic soap, or with one part of carbolic acid to 100 of tepid water, and if need be by injecting such a solution into the uterus. The chief preventive measures consist in keeping the in-calf stock quiet, protecting them from undue excitement and from being run by dogs. When the gadfly is about, have them in the yards; see that no blood or decomposing, badly-smelling refuse is about the yards or pastures; avoid ergotted or mildewed fodder; keep them out of woods and plantations where
yew and other resinous leaves and twigs are apt to be eaten; provide pure water; take care that the stalls are comfortable and not too much on an incline; immediately remove to outlying premises any cow that has aborted, and keep her apart for some weeks and until all discharge is gone. Before returning her amongst the herd, wash her well with carbolic soap; bury the fetus promptly; cleanse and disinfect the place where it was dropped, and do not for some weeks use it for in-calvers. Endeavour to prevent any impending attack of abortion by perfect quiet, laxative rather than concentrated food, and, if there is straining, by frequent doses of opium, belladonna, and chloral, or other antispasmodics.

As parturition approaches, the cow instinctively separates herself from her fellows and seeks quiet. This natural feeling should, if possible, be satisfied. If housed at night, she should have a box or quiet stall. In large herds the hamehching and running of heavy in-calf cows should be avoided by placing them by themselves. Some big poor cows, owing to the relaxation of the ligaments of the pelvis, for some days, or even for a week or two before calving, are unable to stand; but so long as no symptom of illness is observed, alarm need not be felt. The cow may be fed as usual, mainly on sloppy, moderately good food. If she does not care to exert herself and rise, she should be propped comfortably with boltings or bags of straw, turned night and morning, care taken that her udder does not get pressed upon; any milk that can be got should be drawn away twice daily. Released of her burden by calving, she will usually speedily recover the use of her limbs.

The signs of approaching parturition are distension of the udder, swelling and firmness of the teats, secretion of milk, loosening of the ligaments of the pelvis, giving the cow a rocking, unsteady gait, relaxation of the external organs of generation, and discharge of a glutinous mucus from the vagina. These appearances may continue for several days. Within an hour or two of calving the animal usually, in addition, is restless, seeks to be alone, gets up and lies down frequently, and whisks its tail. Labour pains, continuing for one or two minutes, now occur; the annual, or water-bag, is forced against the os uteri, gradually dilating it and the vaginal passages; shortly the bag bursts, softening and lubricating the parts; and cessation of labour pains, continuing sometimes for half an hour or longer, occurs. The cow, if hitherto loose, should now be tied up. If an examination as to the position of the fetus and condition of the passages through which it has come has not already been made, as it generally is after straining has begun, it should be done now. The hand and arm are oiled, the fingers and thumb drawn together and carefully introduced, advantage being taken of a period when straining has ceased. Special notice is taken of the amount of dilation of the os uteri, the presence of any tumors or other obstructions likely to interfere with delivery, the position and size of the calf, whether it is alive, whether there is more than one. Most cows calve standing; the labour pains are more powerful and effective; the diaphragm and abdominal muscles are more readily brought into play, whilst in the standing position help can be more conveniently and effectually rendered. Roomy cows, having had several calves, sometimes get through parturition in fifteen minutes; it more usually occupies an hour; but when there are false presentations or other difficulties it is sometimes prolonged for a day, or even longer.

The calf most commonly comes with its fore-limbs outstretched and its head (a little to one side) resting upon its knees, and into this position it must be got when it comes with the anterior extremities first. There occur, however, abnormal or, as they are termed, false presentations. One or both fore-limbs may be bent at the knees, when the calf must be put back and the limb or limbs straightened. One limb is sometimes over the head, or the head is depressed underneath the breast or laid to one side, or the head protrudes, whilst the limbs, closely compressed, lie underneath the body. Occasionally the calf comes backward, with the hind-feet in the passages, when it should be got away with all reasonable speed, as the cord in a tardy delivery is rather apt to get pressed upon, and suffocation may ensue. Occasionally the hind-limbs are flexed at the hocks, which are the first parts grasped, and require to be pushed back and the hind-feet got into the passages. A still more troublesome presentation is when nothing but the tail and buttocks can be felt, and the hind-limbs are down underneath the body. Occasionally all the four feet are presented together; sometimes only the back of the calf can be felt. Twins, being usually smaller than when there is only one, seldom cause much
trouble, unless each happen to lie with a leg in the passages. The successful management of these and other abnormal presentations often demands much tact, patience, manual dexterity, and strength. It is usually necessary to raise the cow's hind-quarters; cords are placed round the head and any limbs of the calf that are accessible; the hand of an assistant is often usefully introduced to replace the calf as far as possible into the womb, whilst the operator endeavours to rectify the faulty position, raise and straighten flexed limbs, and get into the passages either the fore-limbs and head, or the hind-limbs, as may be most convenient. When this is effected there is seldom much difficulty in getting away the calf. The cow, if exhausted or long in labour, should meanwhile be supported with gruel, ale, whisky and water, or other nutrient stimulants. If the pains are feeble, or have ceased, infusion of ergot of rye may be given. Simultaneously with the occurrence of the pains, gentle steady traction is applied to the limbs, round which a little hay is twisted to secure a firmer hold, or broad straps, as described, are fastened. Pulling should be made not horizontally or straight back, but downwards towards the cow's hocks, which increases the amount of room. Whilst the head or buttocks are coming, the hand of the operator should be occasionally passed round the contracted holding part of the os. Sometimes, when the head, withers, or other part appears wedged and almost immovable, progress is attained by putting the calf back a little, allowing a short respite, and turning the intractable portion somewhat more obliquely. Precipitate, rash, violent interference is unjustifiable and often injurious. More time may be allowed in cattle than in other animals. Calves have been got away two or even three days after labour pains have occurred, and after a portion of the amnial fluid has escaped.

Protracted labour usually depends upon the false presentation, death, or deformity of the foetus; on disease of the fetal membranes; on weakness or deformity of the cow; rigidity, spasm, or torsion of the cervix uteri, or tumors in some of the passages. Careful skilful examination can usually discover the cause of difficult labour, and can frequently remove it. When the calf is discovered to be dead, if the water-bag has presented and burst, assistance should be rendered, as the natural pains are seldom so regular and powerful as when the calf is alive. When the maternal pelvis is of insufficient capacity, from tumors in the passages, from adhesions between the fetus and uterus, or from unusual size or deformity of the calf, natural delivery is sometimes impossible, and the fetus must be reduced in size, usually by the removal of one or more limbs. The calf is sometimes retained in the uterus much beyond the natural period. Sometimes it softens, putrefies, and causes enueto-metritis; sometimes it is broken up and discharged piecemeal; sometimes it becomes shrivelled up and mumified. Whilst the uterus is thus occupied the cow cannot breed, but occasionally continues to come to the bull. A manual examination readily discovers the state of matters.

The fetal membranes, cleansing, or after-birth, often comes away shortly after the calf, especially if it has reached its full period. Sometimes, however, it is wholly or in part retained for many days—a source of annoyance to the cow herself, and from the offensive smell very undesirable in premises occupied by in-calf cows, in whom it is apt to excite abortion. When firmly attached, dangerous bleeding may result from rashly tearing it away, and the safer course is to twist the protruding portion into a cord, attach a weight to it, giving a few extra twists daily, and waiting for natural separation. Irritation and smell are abated by washing the external parts with carbolic solution, about one part to a hundred; and if there is much offensive discharge, injecting daily tepid water and a similar carbolic solution into the uterus. In such cases the cow is often low and weakly, and requires liberal feeding.

The slight bleeding occurring after severe labour seldom lasts long, but occasionally blood is shortly poured forth with alarming rapidity. Rags soaked with cold water must be laid over the loins, and kept wet by pouring water freely on them. A cloth wetted with cold water is introduced into the uterus; ice, if procurable, is placed in the uterus and vagina, large doses of opium and lead-acetate given, and ergotine injected subcutaneously.

Straining, or after-pains, ensue sometimes from the retention of clots of blood or portions of fetal membrane, which are removed by the hand or by injection of tepid water. But sometimes they result from inversion of the uterus or vagina, and still more seriously from tearing or injury of some of
the passages, effected in severe or protracted labour, whilst occasionally they depend only on weakness and nervous irritability. Perfect quiet, soothing injections, full doses of opium, chloral, and belladonna, and laxative, digestible, good food are the appropriate remedies.

Inversion of the uterus results from violent continued straining, from undue force in bringing away the calf, from a relaxed state of the weakened, over-taxed organ. It usually occurs within two days after calving. So small a portion of the horn in which the calf has lain may be inverted that it does not protrude externally, and is only discovered when the straining suggests examination. But unless soon rectified the unnatural position excites more straining, and gradually a large bulk of the inverted uterus is protruded, constituting a pear-shaped tumor, weighing sometimes as much as 100 lbs., reaching down to the cow’s hocks. Sometimes the fetal membranes are still attached; sometimes it becomes much congested, dark-coloured, and gangrenous; sometimes it gets torn and bruised. When first thrown out it is seldom difficult to return. The cow, if down, should be got on her legs and firmly secured, her hind parts raised, her rectum and bladder emptied. The uterus, supported on a level with the vulva on a tray or sheet held by two assistants, is carefully washed and thoroughly cleansed with tepid water; the placenta, if adherent, removed. Subsequent sponging with or immersion in ice-cold water for five or ten minutes contracts the organ and facilitates its return. When congested or abraded, it is moistened with diluted spirits, astringents, or laudanum. The cow, if straining, is much quieted by tweezers in the nose, a chain round the chest tightened when straining comes on, and a full dose of opium, belladonna, and chloral. The displaced organ, held well up and kept moist with cold water, is usually returned by pressing steadily with the closed fist against the horn, the farthest part protruded, and forcing it backwards and inwards, taking advantage of the intervals between the pains. Care must be taken that replacement is properly made, without twisting, folding, or irregularity of the membrane. To retain the uterus the hand should be held within it for some time; injection of cold water, or a cloth steeped in cold water placed in the vagina, causes contraction if the organ is soft and flaccid; straining is combated by full doses of antispasmodics. Pessaries, pads, and bandages are sometimes required to retain the irritable organ. In extreme cases, when the uterus cannot be returned or has been hopelessly injured, it is sometimes successfully amputated.

Protrusion or inversion of the vagina occurs within a few days after calving or abortion, depending upon the parts being injured by the forcible withdrawal of the calf, or from the cow having undue over-exertion shortly after. It also frequently appears in lymphatic, wide-hipped cows as pregnancy advances, and the gravid uterus is pressed back upon the vagina, when the digestive organs are over-filled with bulky food, or the animals lie in sheds with a sharp slope. The soft, yielding tumor varies in size from an orange to a child’s head, is perfectly smooth, and marked in its lower surface by a depression leading to the urethra. Unlike the cornu of the uterus, for which it might be mistaken, it has no cotyledons or placental follicles; unlike the elevated urinary bladder, it is not corrugated, has no openings or urinous smell. Although easily returned, it is apt to reappear; is usually more insubstantial than dangerous; is much abated by keeping the cow with the hind parts raised. When in an irritable or congested state it should be wetted twice daily with an astringent lotion, made with an ounce of sulphate of zinc to a quart of water; in bad cases a pad or bandage is applied.

Milk fever, or parturient apoplexy, is a formidable disease, attacking good milk-cows in the prime of life, at their third or fourth calving, when their time has been an easy one, when they are in high condition, or are poor and suddenly transferred to liberal dietary. It usually comes on within three days after calving. Its nature is not clearly understood. The large supplies of blood which have been nourishing the rapidly growing calf are suddenly thrown, as it were, on the system; brain congestion ensues, specially apt, according to Professor Walley, to occur in ruminants, owing to the special arrangement of the vessels of the brain. Such congestion is favoured by any conditions which withdraw blood from the skin, digestive organs, or udder. The cow is dull, with drooping head, is careless of its food and its calf; the milk flow is diminished; the gait is staggering; the red and blood-shot eyes and hot head point to brain congestion. This is shortly relieved by effusion of blood, more often of serum,
and anaemia consequently ensues, producing the paralysis, unconsciousness, and convulsions so characteristic of the later stages. The earlier the cases occur after calving, the more rapid and fatal they are. Returning consciousness, ability to swallow, warmth of the surface, the passage of urine and feces indicate a favourable issue. Three-fourths of the cases early and properly treated should recover.

The cow, if still on her legs, or if, although down, she has a tolerably full and firm pulse, and slow, deep breathing, may be bled to the extent of 3 or 4 quarts, drawn from a large opening in the jugular vein. In the later stages, when the pulse is weak and fluttering and the surface cold, bleeding only hastens death. If the animal can still swallow, a full dose of purgative medicine is given, consisting of 1/2 lb. each of common and Epsom salts, 20 drops of croton oil, 2 ozs. of oil of turpentine, and 1 lb. of treacle, dissolved together in 1 or 2 quarts of water. Endeavour should also be made to rouse the torpid bowels by laxative stimulant clysters, repeated several times daily. It is most essential that the cow be placed in a comfortable position, propped on her broad breast-bone, supported by boltings of straw or sacks containing chaff, her drooping head raised by bags of straw or chaff, and steadied by a halter attached to the manger or other elevated fixture. Thrice daily the patient should be turned, the udder rubbed and emptied, the bladder also emptied. Ammonia liniment or mustard paste should be rubbed down each side of the spine, or counter-irritation produced by a hot smoothing-iron used night and morning, a piece of rug or several folds of paper being interposed between the skin and the hot iron. Stimulants are useful almost from the outset; a glass of whisky or other such cordial, and a draught of carbonate of ammonia given in half a pint of water, may be repeated every two hours. Beware, however, of attempting to give stimulants or anything else if the cow cannot swallow; congested and inflamed lungs, and sometimes immediate suffocation, are thus apt to be induced. As appetite returns, care should be taken that the animal is provided for a few days with only a moderate supply of sloppy food; solid, bulky fare is apt to cause indigestion and relapse. Recovery once begun is generally rapid. To prevent milk fever, good milk-cows with great appetites and in the prime of life, as they approach within a month of parturition, should be kept somewhat sparingly on laxative fare; they should not be allowed to graze all day on abundant first-class pasture; they should, however, have plenty of exercise. A week before calving, or earlier if the udder is distended, it should be drawn, and as much milk as possible removed. Many observant dairymen regard the establishment of the milk secretion so important in preventing milk fever that they never allow the best Guernsey, Alderney, or dairy Shorthorns to become dry between their calvings. Bleeding before parturition is not desirable, but a dose of physic should be given to all predisposed subjects a week before, and another as soon as calving is over. For three or four days subsequently the diet, as stated, should be laxative and rather sparing.

Metritis, or inflammation of the womb, attacks cows that have aborted or had a hard time of calving, that have had inversion of the uterus, retention of the fetal membranes, that have been over-driven, knocked about shortly before or soon after calving, or have been exposed to morbid poison, which the vascular uterus at this time is apt to absorb from the hands of persons assisting at parturition, or even from an impure atmosphere. In from two to eight days after calving fever comes on; there is restlessness, shivering, and straining, which continues even after the fetal membranes are removed and the uterus injected with tepid water. In marked contrast to puerperal apoplexy, or milk fever, in which the temperature is normal, or even below normal, the thermometser, especially in the rectum, speedily rises above 100°. There is grinding of the teeth and colicky pains; the external organs of generation are swollen, and the swelling extends to the udder and down the thighs; from the vagina there issues an offensive, often blood-stained discharge. But even to the last the animal rises and lies down, and retains consciousness. The disease runs its course usually in three or four days; about half the cases are fatal. Examination discovers that the uterus contains foul, decomposing serum, blood, and portions of the fetal membranes. Its walls are not contracted, but are soft and thickened, and its mucous lining dark-coloured and filtrated. Sometimes the inflammation has extended to the serous covering of the bowels, constituting metro-peritonitis. To allay inflammation and bring away irritating secretions, the uterus should be carefully syringed with tepid
water, containing about one part to sixty or eighty of carbolic acid, or other effectual disinfectant; and this cleansing ought to be repeated twice daily. Sulphites or carbolates which counteract septic poisoning may be administered; laxatives are prescribed if necessary; frequent small doses of alcohol and other stimulants, with good gruel, help to sustain strength. Regarding preventive measures, avoid rough treatment during calving, or too early over-exertion or exposure subsequently. If any injury has been inflicted in bringing away the calf, especially if it has been dead and putrid, inject tepid water and carbolic acid night and morning; remove carefully retained foetal membranes; administer twice daily 1 oz. of sulphite of soda; supply the best of digestible food; avoid having calving cows in yards or fields where any animal has had metritis or meto-peritonitis; and never allow herdsman or shepherd to help in calving who has recently been about such cases, who has been removing offensive placenta, or otherwise handling putrefying animal matter.

Garget, mammitis, or inflammation of the udder, is induced by careless dripping, by sore teats, or by the cruel practice of over-stockling, or leaving. It also results from blows and injuries, from attacks of foot-and-mouth complaint, and from exposure to cold and wet, which seize on the mucous and fibrous textures of the udder—the most sensitive, vascular, and vulnerable part of a good milk-cow. Many recently-dried feeding-cows suffer from garget. Wet weather, succulent or feeding, stimulate the recently-active udder; milk is secreted; the irritable engorged state of the bag often, however, escapes notice; the fluid is not drawn away; it becomes stale, and the source of irritation. Hot weather especially favours this decomposition. On strong wet land the cows are further liable to suffer from garget conjoined with rheumatic inflammation of the joints.

Sometimes the skin and mucous coat of the bag are first and most prominently affected; the case is a sort of catarrh of the udder; the skin of the affected portion becomes hard, shining, and somewhat reddened. But in the worse cases the glandular and connective tissues are also inflamed; one quarter or one half is attacked; more rarely the whole organ is involved; often the seizure is ushered in by shivering and fever. From exudation pressing upon and blocking the secreting parts, the yield of milk is diminished; it is drawn away with difficulty, and is serous, curdled, and offensive. The bag in a few days is very tender and painful, much swollen, hard, and nodulous, and the swelling extends to the chest and back to the hind-quarters. The cow usually stands, or lies with the inflamed side upwards. When inflammatory symptoms are not combated within a week, induration and loss of a quarter or of half of the gland usually result. Sometimes during the several months the cow is dry, the induration gradually disappears, and the damaged quarter again becomes serviceable. When inflammation has been intense, and continues for six or eight days, suppuration may be expected, and abscesses form, opening into the teat, bursting externally, or requiring to be opened. When the whole gland becomes inflamed, and is not promptly relieved, still more unfavourable results may ensue, the part may be mortified, or the acute inflammation and fever kill the patient.

As to treatment, the first matter is to empty the udder of every particle of milk that can be withdrawn. If the teats are too tender or are blocked with knots of curd, a syphon must be used, and milking repeated at intervals of two or three hours. Warm fomentations, followed by poultices of spent hops, tea-leaves, or bran, afford much relief, should be frequently repeated and applied suspended in a web passed round the loins with a T-shaped piece running backwards and upwards between the hind-limbs, and secured to the web passing over the loins. Such poultices and bandages, softening and mechanically supporting the inflamed organ, remove congestion and pain, and greatly hasten recovery. Extract or ointment of belladonna, rubbed daily over the tender udder, not only abates tension and pain, but also lessens the troublesome secretion of milk. Clots of curd accumulating in the teats must be gently broken down, and got away either by the hand or by the teat-syphon. In chronic cases the hard swelling should be rubbed twice daily with a stimulating dressing, which may consist of equal parts of compound solution of iodine, tincture of opium, and soap liniment. Abscesses must be opened and dressed with antiseptics. Constriction and febrile symptoms should be combated by oil and treacle; and a daily dose of 4 0zs. of Epsom salt and 1 oz. of nitre will relieve fever and lessen milk secretion. In acute casesaconite is prescribed. Unless the cow is reduced, the diet for some days should be sparing and not succulent.
The teats are sometimes closed congenitally, or from exudation filling the tubes. The careful passage of a teat-syphon usually suffices, but where the obstruction is considerable a bistoury or perforating sound must be introduced, and the opening kept clear either by retaining the syphon in the teat for several days, or by passing a bougie twice daily.

Cracks and sores on the teats, interfering with milking or sucking, are sometimes irritable, extensive, and bleeding, requiring that the milk be withdrawn by a syphon, that the parts be kept scrupulously clean, and dressed at each milking with glycerate of tannin or other mild astringent. Sore teats, when neglected or mismanaged, are apt to cause mammitis.

Horei tympanites, or distension of the rumen or first stomach with gas, is not peculiar to dairy-stock, but milk-cows, being often greedy feeders, furnish a large proportion of such cases. Prominent amongst the causes are frosted grass or clover, wet roots, raw grain, especially wheat, a meal of unacquainted food, or a foreign body in the gullet. A few morsels of unsuitable food sometimes suffice to interfere with digestion; the mass of soft food ferments, with evolution of gas. The animal becomes much distended, especially on the left side; its nose is poked out; it blows, moans, and, unless relieved, sometimes dies from the pressure of the enormously distended stomach on the lungs and heart. Moving the animal about often favours expulsion of the gas; but if not promptly effectual, administer a full dose of oil of turpentine, whisky, medicinal ammonia, or carbonate of ammonia in a pint of oil, milk, or cold gruel. If no relief occurs in an hour, another stimulant should be given. When stimulants, a dose of physic, exercise, and external friction have been vainly tried, and the symptoms increase in severity, an opening must be made into the rumen with a large knife, or, better still, with a trochar and canula (Fig. 21), at a point equi-distant from the spine of the lumbar vertebrae, the anterior tuberosity of the ilium, and the last rib. In all cases, and especially if an operation has been necessary, it is important for several days that the animal be restricted to moderate amounts of soft food which can be digested without the need of rumination.

Impaction of the first and third stomachs with food.—The first and third stomachs of cattle are liable to be over-gorged with dry innutritive food, such as chaff or straw insufficiently moistened by roots or cake, too liberal supplies of undercorticated cotton-cake, or hard stems of clover or vetches. The nervous power of the organ appears to be impaired; the muscular contractions which should move the food onwards are hence feeble or wanting; appetite and rumination are suspended; the belly becomes distended; any dung passed is dry, caked, and covered with mucus. When the first stomach is over-gorged, the symptoms of abdominal fulness and distress are early and urgent. A full dose of physic, with stimulants, is prescribed, solid food withheld, every encouragement given to drink treacle-water, salt and water, and other diluents; in extreme cases the overloaded paralysed rumen is cut into and relieved of its contents. When the food has got impacted between the leaves of the third stomach, constituting fardel-bound, symptoms of indigestion and constipation are more slowly shown; usually there is a moan or groan resembling the grunt of pleuro-pneumonia; sometimes there is vertigo, convulsions, and other symptoms of nervous derangement. In many of those cases the mucous membrane of the third and fourth stomach is inflamed. Hence the large and repeated doses of drastic physic formerly given are not advisable. All solids should be interdicted, and the animal allowed only thin gruel and treacle-water. A pint of oil, with 1 oz. each of laudanum and tincture of belladonna, helps to open the bowels and relieve gastric irritation; soap and water oysters aid in unloading the bowels. A few doses of aconite and salines abate any febrile symptoms; 2 ozs. of Epson salt and 1 oz. of powdered gentian, repeated once or twice daily, impart tone. It is mischievous to attempt by powerful physic to force the bowels to resume their functions; and in cattle there is no fear of immediate death from constipation or torpidity; ten days in such cases sometimes elapse without any movement, when the bowels gradually resume their action.

Foot-and-mouth disease, or contagious eczema, is apt to attack dairy-cows, and punishes them more severely than it does store stock. It is a contagious, eruptive fever, characterised by the appearance of blisters or vesicles on the skin and mucous surfaces, and attacking sheep, pigs, and
poultry, as well as cattle. It was introduced into Great Britain from the continent of Europe in 1839, and, although it has frequently been reduced within narrow limits, it has not since been extirpated. Cohabitation with infected subjects, and the eating of food on which they have slavered, in experiments at the Brown Institution were found to communicate the disease; but the litter on which patients had stood did not convey it, nor was it produced by rubbing the gums with infected saliva, or scraping with it the gums or feet. But although attempts artificially to produce the disease are attended by negative results, it must not be concluded that manure from foot-and-mouth infected premises can with impunity be brought amongst sound animals. The movement of stock, placing them in markets or fairs, trucking them by rail, conveying them by vessel, and the carelessness of dealers in herding together sickening or convalescent animals have been the means by which the virus has been preserved and disseminated. A period of incubation, varying from one to four days, elapses between the inception of the infective material, and the elevation of temperature, appearance of the slavering, congestion of the mucous membrane, and eruption of the characteristic vesicles about the mouth, on the udder, or between the digits. Vesicles also often occur throughout the alimentary canal, causing gastric derangement and diarroea. The udders of cows in full milk, being very sensitive, usually suffer; the thin skin and the mucous lining of the teats and milk ducts are inflamed, milking causes pain; milk is hence apt to remain in the imperfectly dripped udder, causing garget. Abortion and uncertainty in breeding are also very common results amongst dairy-stock. Milk secretion is early diminished, but what is yielded contains yellow granular masses, pus corpuscles, bacteria, and other abnormal matters, and doubtless the special infective virus, for when given to calves or pigs it usually produces diarrhoea, and sometimes kills these young animals within a few hours. The mortality from foot-and-mouth complaint does not exceed two per cent.; but this does not adequately represent the vexatious loss it produces both in herd and flock—heavy fat beasts lamed and thrown back during several months; cows in full profit suddenly dried, slipping calf, becoming uncertain breeders, or permanently deteriorated by damaged bags; feeding sheep lamed and stripped of flesh; ewes slipping lamb; lambs wasting and dying. Throughout a mixed herd the loss from an outbreak of this complaint averages £3 to £4 on the numbers attacked, whilst 20s. per head is the depreciation usually suffered throughout the affected flock. To prevent these ever-recurring wide-spread losses—for, unlike other eruptive fevers, foot-and-mouth attacks the same animal in consecutive years—the Contagious Diseases (Animals) Act, 1878, has been framed to check the re-introduction of fresh virus from the continent of Europe, and to stamp out the disease both in Great Britain and Ireland by stringent uniform measures of inspection, isolation of infected subjects, and disinfection of sick and convalescent animals and of infected premises. Whenever the temperature of a beast reaches 102° Fahr., it should be carefully watched, for some fever or other mischief is apt to be brewing. As it runs a definite course, medical interference is less needful than good nursing, soft, easily-masticated digestible food, and clean comfortable quarters, and in cows careful attention to the udder. The mouth and feet, if sore, may be washed several times daily with dilute Condy’s fluid or other mild astringent antiseptic lotion. After perfect recovery, it is a wise precaution to wash or dip the subjects of such a contagious disorder with a solution of carbolic soap before placing them with healthy stock.

*Pleuro-pneumonia,* or contagious lung complaint, causes serious losses, especially in town and suburban dairies recruited by frequent purchases in open market. The disease is propagated by some infective material, perhaps by special virus, which is, however, long and uncertain in producing its prominent constitutional effects. The increased temperature, dry cough, grunt, and other symptoms may show themselves in three weeks after exposure to contagion, or may not be developed for three months. Professor G. F. Yeo, in his report on the pathological anatomy of pleuro-pneumonia (Journal of the Royal Agricultural Society, vol. xvi., 1878), demonstrates that inflammation and exudation may extend for several weeks in the substance of the lung, causing consolidation, without seriously disturbing the health of the cow, or attracting the attention either of attendant or owner; but that so soon as the pleura becomes involved, febrile and other prominent distinctive symptoms are apparent. Professor Yeo defines pleuro as “a chronic, specific, local disease, starting in the bronchi, and insidiously implicating the parenchyma of the lung, by occlus-
sion of the bronchi and inflammation extending along the lymphatics; the other organs and the blood possess a singular immunity from the specific contamination. It is not accompanied by constitutional symptoms, and only gives obscure physical signs. At any time during the progress of the disease its existence may be manifested clinically by the occurrence of complications—acute pleurisy or hemorrhagic infarction with pleural inflammation—which excite high fever with various functional derangements. Cohabitation appears necessary to the transmission of the disease; but many experiments, notably those of Professor Burdon Sanderson and Mr. Duguid at the Brown Institution, indicate that the exudation from the lungs of diseased subjects does not reproduce the lung complaint. Inoculation with such exudation, usually on the tail of healthy animals, has been proposed as a preventive to pleuro, and has found favour especially in Australia, and with some German veterinarians; but the supposed protection at best is uncertain; inoculated cattle frequently take pleuro; and the operation has besides the disadvantage of occasionally depriving the cow of her tail. French experiments indicate that about one-fifth of the animals subjected to contagion prove insusceptible. Of those attacked 30 to 40 per cent. die in periods varying from ten to fifty days. Even in favourable cases, carefully nursed and doctored, recovery is generally tedious, and often leaves the animal wasted and with diseased lungs. These considerations, and the hope of stamping out the complaint, wisely dictated those clauses of the Contagious Diseases (Animals) Act, 1878, which order the slaughter of all pleuro-pneumonia cases, allowing their owners two-thirds of their value, the compensation being limited, however, to £30 for each animal. Killed before febrile symptoms show themselves, the meat of pleuro subjects has been eaten without harm.

Black-leg, quarter-evil, or congestive fever, is a serious plague on many breeding farms, suddenly attacking and almost invariably killing calves, yearlings, and occasionally two-year-olds. It is a septic or charbonous disease, depending upon the blood getting charged with effete or deleterious matters, and hence becoming dark-coloured, fluid, and liable to pass from its vessels. This septic condition is induced in young cattle by sudden changes from poor to liberal dietary, by undue supplies of rich albuminoids, such as decorticated cotton-cake, given especially to animals unused to them or in poor condition, by drinking foul or sewage-contaminated water, by exposure to cold or wet, which retard skin secretion and excretion of excrementitious matters. The disease is not contagious, but is produced by inoculation; the flesh of animals dying from quarter-evil often causes gastric and constitutional derangement in animals eating it. Dulness, stiffness, indisposition to move, febrile symptoms, and elevated temperature are sometimes noticed a few hours before the extravasations of serum and blood appear about the quarters, loins, or chest. The animal dies exhausted sometimes in six, usually in twelve hours after it is first observed to be amiss. Rapidly-thriving young calves occasionally suffer from an allied septic condition, in consequence of which blood is outpoured within the membranes and in the structure of the brain. Sometimes the hemorrhage occurs from the mucus membrane of the bowels. In adults, especially in good thriving milk-cows living on rich food, the spleen becomes engorged with dark fluid blood, and sudden death occurs from splenic apoplexy. None of these septic disorders are amenable to treatment: no known remedies can sufficiently rapidly remove the faulty state of system on which they depend. In black-leg, bleeding, salines, stimulants, scarifying of the tumors seldom save or even considerably prolong life. Prevention is, however, secured by careful management and feeding, by keeping the young stock steadily thriving, by avoiding too large amounts of decorticated cotton-cake or other albuminoids, by inserting a seton in the dewlap, and when the disease has shown itself giving the other young cattle 1 oz. of sulphite of soda twice a week in their milk or mash.

Parasites of several sorts attack dairy-stock. Ringworm, a cryptogamic parasite called the Tricophyton, occurring in characteristic circular patches, appears on the skin, chiefly of calves and young cattle, is engendered by the use of damp mouldy straw, especially of soft barley straw; and is removed by washing the roughened skin daily with soft soap, potashes, and warm water, and then dressing with a lotion made by shaking together one part each of iodine and common salt, which secures solution of the iodine, and twelve to fifteen parts of water. Solutions of corrosive sublimate, chlorides of zinc and of iron, and nitrate of silver also destroy the cryptogamic growth.
Lice, or pediculi, are common amongst poor, badly-nourished stock, kept dirty, or in the vicinity of neglected fowl-houses. Tobacco-juice, mercurial ointment, and corrosive sublimate solutions are frequently used to kill them, but, unless applied with caution, sometimes injure the health of the cattle, and even cause death. A safe and effectual dressing is made with 1 oz. of powdered staves-aere seeds boiled for fifteen minutes in a pint of water.

Intestinal worms are not so common amongst cattle as in horses and dogs.

Diseases and Accidents of Calves.

The calf is sometimes born weak and feeble, and it is needful that its head be raised and laid between its outstretched limbs, its buttocks slapped to favour inspiration, its mouth and nostrils cleared of mucus and amnial fluid by the hand, and, if need be, by suction. If these measures do not establish breathing, artificial respiration should be adopted, and a little ammonia held to the nostrils. No milk or other fluid should be attempted to be given until the calf shakes its head, breathes regularly, and can swallow.

Bleeding occasionally occurs at birth, or within a few hours after, from the rude tearing of the umbilicus cord, or from its being licked or bitten by the cow. The cord, if sufficiently protruding, should be enclosed in a ligature, care being taken that no portion of the intestine is included. Or the bleeding end may be wetted with some strong styptic solution, such as of sulphate of iron or of copper.

Urine sometimes trickles from the cord, but after a few days generally takes its natural course. If it persists, and the bladder and urethra are found to be in a natural state, the end of the cord may be ligatured, or, if too short to hold a ligature, the fetal channel may be closed by suture.

Bruising and laceration, with consequent swelling about the umbilicus, occasionally result from cows violently licking the protruding portion of the cord, or from other calves sucking at it. Male calves suffer more than female. Cleanliness and soap and water are the first essentials; if the parts are hot and tender, fomentations are applied; if fulness is the only symptom, wash with some astringent solution, such as one part of alum or of sulphate of zinc to twenty of water.

Navel-ill, technically termed omphalitis, begins with inflammation of the cord, torn off close to the abdomen or otherwise injured at birth or shortly after. The severed raw surfaces are liable to absorb any exudation from adjacent injured parts, or any putrefying germs that may be on the ground, or even in the air of the cow-house. In his admirable work on "Veterinary Obstetrics," Mr. Fleming records cases of navel-ill produced by exposure of the newly-dropped calf to filth and over-crowding, to wet and cold, as well as to such special infective materials as arise from putrefying of the placenta and other organic matters. The tediousness and danger of navel-ill depend, however, not only on the external enlargement, the infiltration of serum or even of blood into the connective tissues, or the firm hard swelling of the protruded portion of the cord, but on the fact that the inflammation early seizes on the interior of the open umbilical blood-vessels, and travels along them, reaching sometimes the liver and other internal organs. The protruding end of the cord, instead of gradually drying and withering, is hard, swollen, moist, and hot, the little patient is feverish and arches his back. From the peritoneum becoming inflamed there is sometimes eolie. From inflammation of the vein abscesses result, sometimes within the abdominal ring and difficult to get at, causing hectic fever, pyaemia, and death, or in more chronic cases being complicated with inflammation of the joints. Often the liver becomes implicated, as indicated by yellowness of the membranes during life, and after death by enlargement, but sometimes by wasting and bloodlessness. A fatal result sometimes occurs in three days; more frequently the patient survives for a week.

The irritable swollen parts should be carefully fomented and cleansed with tepid water, and washed with a one to twenty solution of carbolic acid; and this fomentation and disinfection should be repeated two or three times daily. Any abscesses within the abdominal ring should be opened, and a diluted carbolic solution injected. German veterinarians further recommend that a diluted astringent solution be cautiously introduced into the inflamed umbilical vein. When the intense painful external inflammation does not yield to fomentations and antiseptics, it is well to searify, and subsequently wash with carbolic solution. To counteract pyaemia, sulphite of soda, with other antiseptics, and tincture of the chloride of iron, are prescribed. Cleanliness and disinfectants are
enjoined about the premises, in order to prevent further absorption of septic materials and avoid their transference to other animals. Strength must be maintained by frequent supplies of milk and linseed gruel; constipation is combated by castor oil.

Chronic swellings of the umbilicus are not uncommon in young bulls; when hard they are difficult of dispersion, and sometimes interfere with the animal's usefulness. Whilst hot and tender they should be treated by hot fomentations or continued cold applications; when hard or non-inflammatory they are painted with iodine or blistering liniment; and all risks of having the parts rubbed or pulled are prevented by keeping the bull by himself.

Indigestion is common amongst young calves, owing to their being so generally brought up on the bucket, subjected to long fasts and subsequent rapid gorging, or compelled to drink sour, stale milk, sometimes given at too high a temperature. Occasionally the mischief results from the milk containing noxious matters, owing to the cow being over-driven, excited, or having access to foul, sewage-contaminated water. The calf is dull and uneasy, its appetite capricious, and it often lies outstretched on its side; the belly is over-distended, gas is passed by the mouth and anus; the faeces are curdy, yellow, acid, fetid, usually fluid, and passed with straining. Amongst carelessly-managed calves inflammation of the stomach and bowels sometimes supervenes, proving fatal in three or four days. The diarrhoea to which such indigestion often leads is noticed below. A dose of castor oil, with twenty drops of laudanum added to counteract straining and pain, will gently remove the sour curd lodged in the stomach and bowels, keeping up the irritation. If the calf has remained with its dam, her milk must be examined; it may, especially in old cows, contain too much curd, or it may have been secreted so abundantly that a weakly calf, unable to take it all, had it stale. At intervals of three or four hours the little patient should have 4 or 5 ozs. of good milk, freshly drawn from a recently-calved cow, and diluted with half its bulk of lime-water. A daily dose of three or four drops of hydrochloric acid and a tea-spoonful of whisky or gin in a wine-glass of water often benefits such cases. The old-fashioned popular remedy of a little rennet is also useful. Perfect cleanliness, fresh air, and comfortable quarters hasten recovery from these gastric attacks, and also go a long way to prevent them.

Diarrhoea, or white scour, carries off a large number of newly-born and carelessly-managed young calves. It spreads rapidly in crowded, insanitary places; it is contagious, and once occurring in the pens, it continues to haunt them until they are thoroughly cleansed and disinfected. But although distinctly contagious, several experimentalis have failed to produce it by giving healthy calves the intestinal excretions of those affected. It is most common where cows and offspring are housed, and amongst calves brought up artificially. Its chief causes are those above noted as producing indigestion. The first symptoms are: a dirty tail, dulness, carelessness as to food, and abdominal fulness. The faeces are fluid and charged with mucus, are sour and bad-smelling, yellow or white from the imperfect digestion of the milk rapidly hurried through the digestive tube, and are discharged with violence and pain. Weakness is early apparent, the calf lies much, its eyes are sunk, from the reducing discharges and consequent anaemia it is sometimes blind and unconscious, dying without a struggle. In foul, dark cow-houses, young calves are frequently attacked and die within twenty-four hours. The stomach and intestines are usually empty, their lining membrane covered with mucus of a dirty grey colour and studded with patches of congestion and oedema. Cases that have survived a few days exhibit spots of ulceration, especially of the lower bowels, with deposits of purulent matter, amidst which float crowds of minute organisms, by different authorities regarded as microscopic entozoa or cryptogramic parasites; whilst adjacent lymphatic glands are reddened, swollen, and infiltrated. The liver is small, pale, and bloodless. The muscles and organs generally are pale and bloodless.

With the view of clearing the digestive canal of irritating food and acid discharges, a dose of castor oil is given, excessive action being prevented by the addition of thirty or forty drops of laudanum. The patient must be removed to a clean, airy, but warm box. If in spite of the oil and laudanum pain and flatulence continue, give three or four times daily forty to sixty drops each of laudanum and sulphuric ether in a little water. At intervals of three or four hours supply from a bottle 4 or 5 ozs. of new milk diluted with an equal bulk of lime-water. If the milk, however, continue to disagree, withhold it for several days, and sustain the calf.
with well-boiled starch gruel, of which 6 or 8 ozs. are given every three or four hours. White of egg or beef tea stirred amongst it renders it more nutritive. Condensed milk and Liebig’s farinaeons food are also useful in such cases when the ordinary milk keeps up the wasteful diarrhoea. An occasional oyster of 3 or 4 ozs. of tepid well-boiled starch gruel, containing twenty drops of laudanum, often relieves straining.

Professor James Law, of Utica, N.Y., writes as follows on “Scouring in Calves”:

“Perhaps the most common cause of indigestion and scouring during the first week of life is the want of tone and activity in the bowels. These are clogged at birth with tough, yellowish-brown biliary products that have been accumulating for months, and that virtually glue the walls of the intestines together, and prevent their natural movements or the passage of anything through them. To remove this, nature has provided a first milk—colostrum—rich in albumen and salts, and actively laxative; and if from any cause this is withheld, danger can only be obviated by the substitution of some other purgative, such as 2 ozs. of castor oil or magnesia. To make these more effectual, and more like nature’s laxative, they should be given in one-half these doses for several days in succession until the natural activity of the bowels has been established.

“Apart from costiveness, other evils may result from improper milk. If the dam is worked or otherwise excited till fevered, the milk is altered in quality, and often proves poisonous to the offspring; and the same may result from diseases of various kinds in the mother, or from supplying her with unsuitable food, the hurtful elements of which pass into the milk or lead to an altered secretion. Another common cause is giving the meals at too long intervals, so that the calf comes with stomach empty, faint, and languid, and loads it with an excess in the shortest possible time; and the simple distension for a time partially paralyses it, not only in movement, but in secretion as well.

If to this is added that the milk has been altered by too long retention in the udder, or soured or otherwise decomposed by standing in vessels of questionable purity, we have a combination of evils that too often prove effectual for harm. There is therefore always greater danger in bringing up by hand on cold or on soured milk, though the mere souring, apart from putrid decomposition, may soon beget an accommodating action on the part of the stomach, which will in many cases render it proof against its evil effects. Even this, however, it is well to avoid, and hence the allowance of a couple of table-spoonfuls of lime-water with each meal is a valuable precaution when young animals are fed with milk from a pail. This substitution of farinaeons gruels for the natural milk is still more reprehensible, and its effects should be watched with the greatest care.

Another common cause of direct disorder of the stomach is the pressure of hair-balls that the calves have swallowed while licking themselves or sucking their fellows, and which, rolled into firm masses in the fourth stomach, entangle a quantity of putrefying milk, and speedily set up noxious fermentation in whatever is introduced into the stomach. As already suggested, foul air, damp beds, and cold exposure are prolific causes of digestive disorder in the young. Finally, the constitution has much to do with the result. Certain breeds of families, of strong constitution and rounded forms, will in the main resist these injurious influences and survive under the worst treatment; while others with narrow, shallow chests, their necks hollow, lengthy flanks, and light-coloured skins, will bear little, but sink under slight exciting causes. Hence, to avoid losses by scouring, we must begin at the beginning,
and lay the foundation of a sound constitution, derived from a strong, vigorous race, kept and bred in the most healthy conditions.

“A very simple treatment will often be successful, if adopted at the outset and accompanied by a removal of all the removable causes of illness, as noticed above. If the sick calf has been put on the milk of a farrow, he must be put on that of one more recently calved; if that disagrees, still another nurse must be sought; and if from any cause the health of the cow fails, or if her bag cakes, let the calf have its supply from a more wholesome source. When the calf is given to rapid drinking, this may be partially remedied by fixing an artificial teat in the pail for him to suck while drinking.

“As a rule, the stomach should be cleared of its morbid accumulations by a dose of 1 or 2 ozs. of castor oil and a tea-spoonful of laudanum. If the skin or membranes of the mouth, nose, or eyes are of a yellowish tint, two grains of calomel and twenty grains of chalk may be added, and repeated daily for some time. In the absence of the yellow tinge, give with each meal a tablespoonful from a bottle of sherry wine in which one-eighth of the fourth stomach of a calf has been steeped for twenty-four hours. A tablespoonful of tincture of cinnamon, with twenty grains each of chalk and gum-arabic, will be an excellent adjunct. Finally, if the abdomen is tense or tender to the touch, it should be rubbed over with a thin pulp made of the best ground mustard and tepid water, and covered with a bandage to prevent drying until it has taken effect on the skin.”

Diarrhoea, or scouring, amongst older animals is produced by much the same causes which induce it in calves, notably by coarse, indigestible, innutritive food, by bad water, by long fasts and subsequent greedy feeding. It is often a symptom of anemia, reducing and carrying off many badly-nourished cattle rising one or two years. Treatment consists in judicious feeding, nutritive fare, restricted water supply, laudanum and ether or chlorodyne to abate spasm and pain; iron, acids, and bitters to promote the healthy tone of the weakened membrane, and comfortable protection from wind and weather.

*Brachial filaria* (*Strongylus mecriurn*), the cause of huck, or house, in young cattle, are picked up in their larval state from the muddy water of pools, from rough herbage, or are swallowed in the bodies of small slugs or minute insects. They appear to be carried in the circulation to the lungs, and there undergo full development into thread-like worms, 1 to 2½ in. long. Hundreds are sometimes found rolled into masses, blocking the lesser bronchi, exciting a tickling cough, which is so frequent that it interferes with feeding and thriving, and the animal soon becomes thriftless, tuckered up, and anaemic, and the breathing increasingly difficult. The parasites sometimes multiply in the digestive canal, setting up diarrhoea. Lambs are liable to the invasion of an allied strongylus. In the autumn months, in woodland districts, on flooded or rough old pastures, where facilities occur for the propagation of the strongylus, it is wisdom to have the young cattle housed at night after the middle of September; or, if this is impracticable, give them daily a good meal of dry food, and as a further preventive provide them with salt to lick. The most effectual method of killing the intruders is to bring the husking cattle into a house, and cause them to inhale sulphur anhydride, produced by burning sulphur on a shovel of live cinders. Two or three inhalations effect a cure. Chlorine gas is also used, but is more irritating. A few doses of oil of turpentine, given in milk or lime-water, are also effectual, and promptly destroy any of the worms lodged in the bowels. Concentrated, nutritive dry food and iron salts are valuable in restoring the impaired appetite and strength.


CHAPTER VII.

DAIRY HOMESTEADS AND BUILDINGS.


Among the more important requisites to successful dairy-farming are a good and convenient farm-house and a well-planned set of farm-buildings. To farm either profitably or pleasantly with an ill-adapted house and with ill-arranged, ill-ventilated, scattered, and otherwise defective buildings, is not to be expected—that is, both pleasure and profit are diminished under these conditions. Though a great deal has been done in recent years to improve the building and house accommodation on dairy as well as on arable farms in the British islands, no one who is well acquainted with our dairying districts can have failed to be struck with the great amount of improvement which still requires to be made in many places. Noteworthy examples of improvement in farm-homesteads on their estates have been set by several large landowners, and the spirit of progress is gradually spreading over the whole country. It is a herculean task to re-construct the myriad farmsteads of such a country as this, or even to sufficiently improve the existing ones; and as the work of improvement has not yet been active for a very long period, we may not only regard with satisfaction the progress so far attained, but also look forward to its being continued, and in course of time completed.

A modern farm-house on a dairy-farm consists, first, of a good substantial portion for the accommodation of the farmer's family, including servants; and in the rear of this are usually situated the various buildings, rooms, and offices which are devoted to the speciality of the farm—cheese-making. These last consist, first of all, of a good and spacious room, in which the milk is placed during the longer or shorter time which passes before it is made into cheese, and in which the various operations belonging to cheese-making are performed; adjoining this is the press and salting room; and in the rear of or alongside these are the scullery, where the butter is manipulated, and the open shed, where the milk-pails, cheese-vats, and various other utensils and implements are scalded, cleaned, and laid aside until they are again wanted.

Various modifications and arrangements of these rooms are adopted, and in many cases the cheese-making is done in a part of the general kitchen of the house, which is made large enough for the double purpose, but this plan is not to be approved, and it is better in all cases that a room be specially set apart for the actual cheese-making. In other instances the cheese-making room and the press-room are combined in one; this, again, is objectionable. In yet other instances these various rooms are all combined in one, and all the work appertaining to both cheese and butter is done in it, even to the washing and cleaning of the utensils; there may be economy of space in this arrangement, but on every other consideration it is to be disapproved of. It is not objectionable that the milk should be kept overnight in the room in which the cheese is made, and it is commonly kept in the milk-vats, or tubs, or kettles in which it is afterwards coagulated, and in which all the processes up to "pressing" are usually performed; but the room should always be kept perfectly sweet and clean, or the milk will take injury through
absorbing smells and odours. The "cheese-room," or "drying-room," or "curing-room," as it is variously named, is commonly on the first floor, over the general kitchen, where it is placed on account of the warmth which it derives from the kitchen beneath. This room is the most important one in the house, for here the cheese is "made or marred" in the ripening. It is not enough to make the cheese well, but it must ripen properly too, for much cheese is ruined in the ripening; hence the importance of the "cheese-room." On a few large dairy-farms the house is built apart from the rooms which are devoted to cheese and butter; but this is a matter of no importance—it is one of taste only, and needs no more than to be mentioned. To the construction and heating of cheese-rooms we shall refer at greater length later on.

Where cheese-making is done at home it is especially necessary to have the house, or other building in which the milk is made up into cheese, so situated that the buildings in which the cows are kept in winter and milked in summer shall be within easy access of it. Some farmers would object to having their dwelling-house, even though the cheese-making be done in it, at all near to the cow-sheds; there is at least one well-founded objection to such an arrangement, but we consider that one to be more than counterbalanced by certain advantages. It may with truth be said that if the farm-house is situated near to the cow-sheds, unpleasant odours may at times obtrude themselves, and that these would be objectionable not alone on the score of a hygienic or sanitary nuisance, but also because the milk, when once taken from the cow, is better removed quite away from any odours which it would absorb to its hurt. But it may be said, in reply, that although the house and buildings are within easy distance of each other, the latter may be so constructed, and ought always to be kept in such condition, that no odours worth speaking of should reach the house from them. Then, again, whoever has had a dairy-farm on hand will without hesitation allow it to be a matter of very considerable importance that the distance to be traversed at milking-time should be as short as can be conveniently arranged, for where the milkers have far to carry their milk from the shippens to the dairy, a great deal of valuable time is continually wasted.

It is, of course, in all cases that admit of it, an excellent thing to have both house and buildings situated as nearly as may be in the centre of the farm, and contiguous to a main road, in order to economise labour as much as possible. Time is money, and where much of it is occupied in journeys to and from a distant part of the farm, it is so much to the wrong side of the farmer's balance-sheet; it is, in fact, so much money lost, though it may not at first sight be quite so obvious as the loss of actual money. And it is not only a loss in respect to the servants' and masters' and horses' time in the general work of the farm, but if the dairy-cows themselves have to perform a double journey twice a day in going to their pastures and in returning from them to be milked, the journey will tell on the milk-pail; this, again, may not be very obvious to every one, but it is there nevertheless. Dairy-cows as a rule are not good pedestrians, especially when in the flush of milk; and if they have to do much walking, either to or from their pastures, or in the pastures themselves in search of food when grass is scarce, there is a loss of tissue and of rest, and a consumption of fat, which are detrimental to the production of milk. These are cogent reasons why farmsteads should, in respect to the land, be conveniently situated.

There are, however, other considerations not to be lost sight of which cannot fail to influence the location of the buildings. Generally speaking, it is an advantage to have them, where the formation of the land admits of it, on the more elevated portion of the farm, with the bulk of the land sloping downwards away from them all round; and this is important on sanitary grounds, and in respect of an economical distribution over the land of the farm-yard manure—the liquid portion particularly, which in that case may be sent over the meadows by means of sluices, without any carting whatever. But as the natural supply of water, especially in the case of streams, is commonly found on the lower portion of the farm, it is a matter which well merits consideration whether the farmstead should or should not be placed contiguous to it. It must be borne in mind that if a high situation gives facilities for the removal of manure, it is more or less awkward for the harvesting of crops; but, again, as manure is commonly carted out when the land is wet and soft, and crops are carted in when it is dry and hard, the balance of convenience rests on the
manure side of the question; and to this position weight is added by the fact that in low situations there is always a greater or lesser waste of manure. The rain falling in the yards and on the manure-heaps goes to largely increase what may be properly called the liquid portion of the manure, and this, being unable to be turned to good account by being run directly over the land, escapes—at all events, a good part of it—into the stream below. We admit that in theory there is no necessity for this waste, yet in practice it very commonly happens; and as the manure produced on a farm is of great importance to the farmer, it follows that any waste of it is a loss, and the question of location of farm-buildings ought not to be decided without reference to it.

It is, however, an advantage to have the shelter which a low situation affords, providing this cannot be attained by the planting of trees on a higher situation; and if the low situation makes that cheapest of all power—water-power—available for the driving of farm machinery, this again is a point which commands attention. All things else considered, cleanliness and health particularly, we are inclined, in most cases, to favour a high rather than a low situation, within reasonable limits. But as the great bulk of English farm-homesteads are already located somewhere or other on the farms to which they belong, and as but in few cases are they likely to be wholly removed to some other place, we pass on to consider the most convenient arrangement to be aimed at in the erection of new buildings, either on the site of the old ones, somewhere near to them, or, it may be, on some other part of the farm.

It may be laid down as a first proposition that buildings scattered here and there about a farm, as was too commonly the custom in the olden times, is anything rather than an economical arrangement. To have them centrally situated and compactly arranged, with a view to economy of time and labour in tending the cattle, is a matter of prime necessity in these days of high wages and sharp competition. Every dairy-farmer is alive to the importance of this now-a-days. It is thought by some that scattered buildings form a sort of desultory protection against the spread of infectious diseases, on the ground of partial isolation; but we think there is no real safeguard in this, for epizooties not uncommonly break out first in outlying buildings in a most maccabooous manner, and the germs of infection are commonly carried to all the buildings before the disease is known to be on the farm at all.

Farm-buildings should always be constructed with a view to convenience and to saving of labour, and not only for the comfortable accommodation of the cattle which they are intended to contain. The latter is, of course, a permanent consideration, but not the only one. In these days of dear and scarce labour it is highly important that no time be wasted by the men who tend the wants of the animals in going about from one part to another by indirect or awkward paths. Where food is prepared for the animals by steam or other machinery, it is necessary that the mixing or preparation rooms be so centrally and conveniently situated that easy and direct access may be obtained from them to the various food racks and troughs in front of the animals, and to the sheds which contain them. The loss of time—time, which is money—in carrying food to animals, and to sheds which have been built in a haphazard manner, remote from the central preparation-sheds, is greater and more serious than many imagine; and in only too many farmsteads we find the buildings arranged with a total disregard of the principles of convenience. Compactness and symmetry are features as valuable in farm-buildings as in pedigree shorthorns, and considerably more permanent. Three sides of a square, or of more squares than one, commend themselves to our notions as combining those features with the important principle of handy convenience, while they offer greater advantages for the economical erection of covered yards—one of the most valuable characteristics of modern farm-yard architecture. With such the convenient location of the rick-yard is also not only possible, but easy, and this is a matter of almost as great importance as the other.

In many cases it is expedient to have ladders in barns instead of steps or stairs, so as to have them occupy as little room as possible. A flight of steps or stairs takes up considerable space which cannot always be conveniently spared for that purpose, but a fixed perpendicular ladder may be placed so as not to take up any appreciable room, and yet answer the purpose sufficiently well. In Fig. 22 are given three such ladders, any one of which will be found both simple and useful. A represents a post-ladder, consisting of an upright post, through which pins either of iron or tough
wood are inserted at proper intervals; B, a plank-ladder, consisting of an ordinary 9-inch plank, through which a number of holes are cut, alternating first on one side and then on the other; and C, a ladder in frame: it may be an ordinary ladder in a fixed position, or with one side only added; the staves or rungs may be inserted on the other side into an upright piece of timber which forms part of the building, the lower end of the added side being fixed to the floor, and the upper to a cross-beam, as shown in the figure.

The question of covered yards for young stock is one that has been much debated. Those who are in favour of them have at least two cogent arguments to support their views—the additional shelter afforded to the cattle, saving thereby a given quantity of food; and the economy of litter, much of which is always trodden to waste, or next to waste, in open yards. On the other hand, some writers contend that open yards are conducive to the health and hardiness of the animals; fresh air, and even exposure to the elements, being necessary to give them the desired vigour of constitution. It is true enough that young animals may easily be injured by being kept under cover too much, but we fail to see any advantage in exposing them to the storms and blasts of winter. Fresh air is necessary to them, and so is exercise, but it is a simple matter enough to arrange that they shall have plenty of both in connection with covered yards. The mistake made by those who on these grounds condemn covered yards lies in assuming that when once put in the yards the cattle are not allowed out of them during the winter. In this matter we may admit the teachings of instinct in the animals. If young stock have a building, a shed, or a covered yard into which they can retire when they choose, we find they always do retire into it in bad weather, and that they require little or no teaching to do so. So with covered yards it is a simple matter, which suggests itself to any one, to allow the animals to go out in fine weather and to come in in foul; they will do both these things of their own accord, if they are allowed.

Covered yards, equally with open ones, are not adapted for breeding cattle. Not on account of the shelter question—for on this they are certainly better than open yards—but because breeding cattle should never, at all events when in calf, be allowed to run loose in a confined space, and this for the reason that they will frequently be goring each other under such conditions, and thus bring on abortions. They must either have plenty of room to get out of each other's way, or be tied up by the neck, and this last is the better plan in most cases. For fatting beasts covered yards are well adapted in districts where there is no scarcity of litter; and for young stock they are best of all adapted, even where litter is not plentiful.

At least three prime factors enter into the consideration of erecting covered yards, and these are shelter, litter, and manure.

1. Shelter.—In some localities there is no need to provide any sort of shelter for young stock. Down in the warm valleys which are out of the reach of cold blasts, and in other places where there are plenty of plantations or good hedgerows, and in most districts that are within 300 feet of the sea-level, and where the land is sound and dry, young stock will as a rule be found to do quite as well without as with the shelter that buildings supply in winter-time. Dairy-cows, too, in such districts require to be housed only for a comparatively short period—say from the beginning of January until the middle of April, according to the season. While they are clearly doing well out of doors in the late autumn it is unnecessary to tie them up, but as soon as they show the least symptoms of taking harm, or when the weather is such that we have reason to expect they are taking harm,
Dairy Farming.

whether they show symptoms or not, then they must be tied up at once. If the land is sopping wet they should be tied up, no matter if the weather be cold or not, for they do great harm to the land at these times by trampling on it when it is soft; and fattening beasts should always be under cover as soon as the chilly nights warn us that winter is upon us. Altitude will generally decide these points, for the nearer we are to the sea-level, the longer will winter be deferred. The turning out to grass in the spring will in all cases be governed by the grass itself—when there are good pastures it is time to turn out. In high, cold, or exposed districts anywhere it is generally expedient to provide shelter for all stock, young and old alike; and though all in-calf stock should be tied up, it is advisable on fairly dry land to allow the young stock to run in or out as they choose, but they should always be fed under cover, in order not only to economise food, but to train them to make use of the shelter provided for them.

2. Litter.—In districts where litter is scarce, open yards are next to impossible, and it is best for all kinds of stock to stand in stalls during the winter, if the weather is such that it is unfit for any of them to be out of doors. Tied in properly constructed stalls, there is no need whatever to give the cattle any litter at all; they will do perfectly well without it. But where there is a moderate quantity of litter to spare, covered yards will be found the best for young stock, and either stalls or boxes for fattening stock, while dairy-cattle should in all cases stand in stalls. Where litter is so abundant that it cannot all, or nearly all, be consumed as food, there open yards may be tolerated, because in them the greatest quantity of litter can be trodden down into manure, the liquid portion of which needs to be soaked up by the straw. But all kinds of straw are in these days too valuable to be merely trodden down into manure; and for this reason, if for no other, covered yards are preferable to open ones, simply because they economise litter. Stalls are preferable to covered yards for the same reason.

3. Manure.—We contend that it is next to impossible so to construct open yards that rain-water shall not carry away a large and valuable portion of the soluble constituents of manure, and it is in nearly all cases, in a wet climate such as ours, a prodigal waste of straw to use it in open yards to soak up rain-water that falls in them. It is not so very difficult to make the manure of a uniform quality, because the wetter the weather, the more litter will be used, and vice versa; but if we soak up all rain-water, in addition to the liquid portion of the manure, we throw, all to no purpose, an extra burden of labour on our men and horses, and we have a large bulk of inferior manure. The cost of making an open yard so that there will be no waste of the soluble portions of the manure will probably exceed that of a covered yard; so that we are fain to believe the order of the day in the future will be either covered yards or no yards at all.

In many cases it has been the practice to have the open yards made so that each of the four sides slopes into the centre; that is, the yard is dished. Either a liquid-manure tank has been previously constructed under the yard, or there is one at a distance. In the former case the liquid manure drops directly into the tank, and in the latter it is carried from the centre by a drain. But the great objection against trying to preserve liquid manure that is produced in open yards lies in the fact that it always gets too much diluted with rain-water, and so is hardly worth carting out to the fields. Nor is it possible to prevent one of two results: either that the liquid manure is too much diluted, or that the solid consists too much of litter which has been used to absorb the rain. It may be, however, that the farm-buildings are placed on an elevated spot, so that the contents of the tank can be distributed over the land below by means of hose or sluices, and without any carting at all, in which case it is a matter of but little moment whether or not the tank be half filled with rain-water each time; may, it is almost better it should be, because the liquid manure can then be distributed more evenly over a large area of land. This, indeed, where the slope of the land admits of it, is by far the best and cheapest and most effective way of distributing liquid manure. Even were the rain-water kept wholly out, it is still an expensive and troublesome thing to distribute the liquid manure by carting; and as it is better—much better—that it should be put on the land in damp weather, the hose or sluice method of distribution does away with the injury which the land would receive from the wheels of the carts and the hoofs of the horses.

It will therefore appear that the question of
the location of a liquid-manure tank is an important one in connection with open yards; and, indeed, it is a question well worth thinking out—whether or not there shall be a tank at all. Assuming that the buildings are situated on sloping land, the liquid manure can be economically distributed over the meadows as it is produced, without a tank; or with a tank it can be distributed any time when the weather is suitable, and this, indeed, is the chief, perhaps the only, advantage which tanks afford. If, however, the buildings are in a hollow, or on flat land, the liquid manure cannot be utilised without the aid of a tank, unless litter is used to absorb it, and in either case it requires to be carted out or pumped. But whether there be a tank or not, or whether the yards be open or covered ones, it is better that the latter should slope a little toward the centre, and that they should be well and firmly paved, so that loaded carts will not break up the surface. This done, the manure question, always an important one, is very much simplified.

The farmstead of Tattenhall Hall, of which, by permission of the author, we give an isometrical view and a ground-plan, copied from Mr. Bailey Denton’s “Farm Homesteads of England,” is considered to be a favourable specimen of its class. It is situated on the estate of Robert Barbour, Esq., and is occupied by Mr. George Jackson. Mr. Bailey Denton gives the following description of the homestead:

“The buildings were erected in the year 1860. Exclusive of house and piggeries, the haulage of materials, the formation of roads, and the making of the necessary approaches, they cost £1,600. This sum does not include a small portion of old materials used in them. The arrangements were designed by the tenant; Mr. J. Harrison, of Chester, acting as architect.

“The dairy-cows, eighty in number, occupy the principal building (the cow-house), in close proximity with which are the food-chambers, machinery, and barn. The cows are placed on each side a central feeding passage, along which the cut food is carried by a truck to the troughs; while a constant stream of water passes along the two lines of stalls, and furnishes each with an ever-fresh supply. The central portion of this large building is higher than the two ends, and contains a hay-loft, into which hay is brought direct from the field and there stored. Ventilation is gained by an air-shaft, in the shape of a centre cupola, and by side openings. There is accommodation for fourteen calves and twelve store stock, in addition to the dairy-stock. Stabling is provided for nine working horses, besides which there is a mag stable with three stalls, a loose box, and a hospital for cows. The piggeries, which are supplied with whey by means of a pipe-drain direct from the dairy, are fitted up for about fifty breeding, store, and fattening pigs, and are very complete.

“The machinery consists of a portable steam-engine, with a thrashing apparatus, and also a 6-in. cylinder fixed steam-engine, which drives a chaff-cutter placed in the straw depot and a root-cutter and cleaver in the room below. The latter is supplied by the engine-boy from the adjacent store, and the roots, when cut, are taken by ‘elevators and mixed with the chaff; the whole being sprinkled with hot water or oil-cake gruel as it descends to a chamber, the floor of which is perforated, in order to allow the waste steam from the engine to ascend and sweeten the whole. The cows are kept on this steamed food throughout the winter; as spring approaches an addition of oil-cake, bean-meal, and a little chopped seeds and clover is made to it.

“The milk when brought from the cow-house is collected into two cheese-tubs, or vats, placed on the kitchen floor, and capable of containing 240 gallons. Each tub is provided with a \( \frac{3}{4} \) in. plug, and a strainer guards the opening through which the whey, when separated from the curd, passes into one of four slate cisterns. When all the cream has been removed from the whey, a valve is raised, which allows of the escape of the refuse whey into any or all of the pig-troughs, a little meal from the corn-flour bin being added to it. The curd, when separated, is passed through the curd-mill. It is then salted, vatted, pressed into the proper cheese shapes, and elevated into the cheese-drying room, and after four months’ detention the cheeses are lowered by the same contrivance, and sent to the London market.

“The buildings are drained into two large liquid-manure tanks, the contents of which serve to irrigate about 14 acres of meadow land. The rain-water and the wash of the house is conducted to suitable reservoirs, and is made to flow over a small meadow at pleasure. The buildings are supplied with water from a pond, which receives the drainage water from about 15 acres of land.
The corn crops are well housed in skeleton barns having clay floors, the crops being preserved from contact with the clay by means of an intervening layer of brushwood.

"In addition to this homestead, which has the disadvantage of not being at the centre of the holding, twenty-four cow-stalls, a food-house, and labourer's cottage have been erected at a distant part of the farm. At this steading the barren cows are fatted and the calves are kept, the latter being supplied with roots and fodder. By this means much cartage is saved, and manure is made where it is wanted. The farm consists of about 320 acres, of which about 100 are arable, the rest being pasture and meadow. The land consists mostly
of clay, resting on a substratum of New Red Sandstone."

On his Cheshire estates, at Peckforton, Lord Tollemache, of Helmingham, has erected or rebuilt many substantial, handsome, and well-appointed farmsteads. With a personal industry and a care for the comfort of his tenantry which are as rare as they are estimable among landlords, Lord Tollemache has provided farm-houses, dairy-offices, and farm-buildings which are wonders of substantial neatness and of complete and convenient arrangement. We are enabled, through his lordship's kindness, to give in Fig. 25 a view of one of the farmsteads, and in Fig. 26 the ground-plan.

The outlay incurred in the erection of these complete farm-offices amounts, on the average, to about £2,500 per set. In an agricultural journal of May 13, 1878, was given a summary of this outlay, and we reproduce it:

**Entire Cost of the Erection of a Farmhouse and Buildings.**

<table>
<thead>
<tr>
<th>Farm-house</th>
<th>£ s. d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bricklayers' and masons' work, including bricks, tiles, lime, &amp;c.</td>
<td>520 0 0</td>
</tr>
<tr>
<td>Carpenters' work, including timber, iron work, door frames, latches, &amp;c.</td>
<td>380 0 0</td>
</tr>
<tr>
<td>Plumber, including spouting, glazing, painting, and papering</td>
<td>112 0 0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,012 0 0</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Piggeries.</th>
<th>£ s. d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bricklayers' and masons' work, including all materials</td>
<td>170 0 0</td>
</tr>
<tr>
<td>Carpenters' work, &amp;c.</td>
<td>56 0 0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>226 0 0</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outbuildings.</th>
<th>£ s. d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bricklayers' and masons' work, including bricks, lime, and all materials</td>
<td>740 0 0</td>
</tr>
<tr>
<td>Carpenters' work, including timber and iron work, and all materials</td>
<td>435 0 0</td>
</tr>
<tr>
<td>Plumber, including glazing, painting, &amp;c.</td>
<td>43 0 0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,218 0 0</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Summary.</th>
<th>£ s. d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm-house</td>
<td>1,012 0 0</td>
</tr>
<tr>
<td>Piggeries and pump</td>
<td>226 0 0</td>
</tr>
<tr>
<td>Outbuildings</td>
<td>1,218 0 0</td>
</tr>
<tr>
<td>Paving yards, roads, gates and posts</td>
<td>60 0 0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,512 0 0</strong></td>
</tr>
</tbody>
</table>

In this set it will be seen that ample covered-shed accommodation for young stock is provided, in addition to the stalls for dairy-cows, and boxes for fattening beasts. The original drawings, of which the plates are fac-similes, were courteously made, at our request, by W. St. A. Rouse-Boughton, Esq., of Downton Hall, near Ludlow. The ground-plan is so fully detailed as to explain itself without further description.

**An American Barn.**

For reasons that will appear on perusal, we take the following description and drawings of an American octagon barn from the *National Live Stock Journal*, in which they were published. They present several novel and interesting features:

"This form is most admirably adapted for cheaply enclosing the greatest space within the shortest line of outside wall. The circle is still more economical of outside wall, but would be more expensive to build, while the octagon is as easily and cheaply built as the rectangle. The barn given in Fig. 28 was designed to replace four barns which were destroyed by fire; the four barns had a basement area of about 7,000 square feet, while the octagon covers only 5,350 square feet; yet the internal capacity of the latter is greater than that of the former, because it has outside posts 28 feet high, while the others had outside posts 16 to 20 feet high. The octagon has an outside wall of 265 feet, while the four barns had an aggregate of 716 feet of outside wall, showing the great economy of this form in expense of wall and siding. If we compare it with a single barn 108 by 50, the latter will enclose the same number of square feet and have the same capacity at the same height, but requires 51 feet more of outside wall. The rectangular barn will also require many more interior cross-beams and posts, which besides adding to the expense are always in the way. The long rectangle requires, for convenience, two cross-floors, which take up more room, and, being separated, are less convenient than the single floor through the centre of the octagon. The long barn requires posts and purlins to support the roof, which are obstructions in filling with hay and grain, while the octagonal roof of one-third pitch is self-supporting, resting only on the outside plates, and may be safely stretched over a diameter large enough to accom-
moderate a farm of 1,000 acres, or say 150 feet in diameter. The plates perform the office of the bottom chord, and the hip rafters of the top chord, in a truss. The strain on the plates is an endwise pull, and if they are strong enough to stand the strain of the push at the foot of the rafters, the bottom of the roof cannot spread, and the rafters, being properly bridged from the middle to the top, cannot crush, and the whole roof must remain rigidly in place. Its external form being that of an octagonal cone, each side bears equally upon every other side, and it has great strength without any cross ties or beams, requiring no more material or labour than the ordinary roof.

"It will be seen by Fig. 28 that there is a drive-way 15 feet wide through the centre of the principal storey from north to south, There is a line of 'big beams' on either side of this drive-way, 13 feet high, across which a scaffold may be thrown to enable us to occupy the high space over this floor. The posts being 28 feet high and roof rising 22 1/2 feet, the cupola floor is 50 feet above the drive-way floor below. The space above these 'big beams' is quite clear of any obstruction, and a horse pitching-fork may be run at pleasure to any part. The bay for hay on the left side of this floor is 80 feet long and has an area of 2,030 square feet, and is capable of holding, when filled to the roof, 160 tons of hay. This bay, extending along the floor 50 feet, may be divided into as many parts as required for different qualities of hay, and each part may be quite convenient for filling and taking out.

"On the right-hand side of the floor is a scaffold, 8 feet high, having the same area below (2,030 square feet) for carriages, farm-tools, and machines; above this scaffold is—a height of 18 1/2 feet to the plates—a large space for grain, affording ample room for the separate storage of each kind to the aggregate storage of 2,000 bushels or more. It will be seen that the large space in this barn is all reached and filled from one floor, saving much labour in changing from one floor to another. In our other buildings we had six places for hay, holding less than this one bay, requiring the moving of the horse fork and tackle to six different bays, while in this bay the haying will begin and end, with room to spare. Fig. 27 shows the basement as we intend to use it, yet there are many different ways in which it may be divided for stock and other purposes.

"The drive-way through the basement is from west to east, being the feeding-floor between two rows of cattle, whose heads are toward the floor. The floor is 14 1/2 feet wide, out of which come two rows of mangers 2 1/2 feet wide, leaving a space of 10 feet wide for driving a wagon through, or running a car carrying food for the animals. There are places for twenty cows or other cattle on each side, leaving a space of 18 feet at the west end to drive a cart around behind the cattle on either side to carry away the manure and pass out at a side stable-door, 8 feet wide. The horse-stalls are arranged on the south side, but may be placed on either of several other sides, or on all. By placing tails to wall and heads on an inner circle, drawn 12 feet from the wall, with feed-box room 3 feet wide for each horse, with ample
room at the rear, sixteen horse-stalls may be arranged on south-west, south, and south-east sides. But for 200-acre farms, generally, no more than forty head of cattle and six horses would be kept, and for such our ground-plan would be most convenient, because it furnishes easy access with a cart, both for supplying fodder and carrying away the manure. On our plan we have much space on the north, north-west and north-east sides, which may be used for various purposes, such as root-cellar, sheepfold for fifty sheep, or for stowing away tools, working waggons, and implements.

"The basement is not sunk in the earth, but on the north and south sides it is graded up to the floor of the second storey, so as to make an easy drive-way into the barn. The base line, as represented on the drawing, is 4 feet below the general level of the land on the north side, but there is an open channel of water, into which every part is drained, on the south side. The earth on the east and west sides is scraped upon the north and south sides to grade up the drive-ways into second storey. This basement is lighted by six windows of twenty lights, 8 by 12 glass, and six of ten lights each.

"A little examination of this form of barn will not only show its adaptation to large farms, but to all sizes—from the smallest to the largest. A farmer has but to calculate how much room he wants for cattle, how much for horses, how much for sheep, how much for hay and grain, how much for carriages, waggons, tools, or any other purpose, and he can enclose just the number of square feet needed, and with the shortest outside wall. He may be liberal in his allowance of room, for it costs less, in proportion, as the size is increased. Suppose he requires for a 50-acre farm 2,090 square feet of room; this would require a 50-foot octagon or a 40 by 52 rectangle. Now he would require timber 40 feet long for the latter, while he could build the octagon with timber for the sills and plates only 22 feet long, and this would be the longest timber, unless he wished his posts higher. Each side would be only 20 ½ feet, and the wall for the basement 105 feet long, whilst the other would be 184 feet long, saving 19 feet of wall and siding by the octagon, requiring but eight corner posts, and no intermediates, as the girts would be less than 20 feet long. He would require no interior posts or beams, except those for scaffolds. All the ordinary purlin posts and beams would be saved, and the labour on them. It is easy, also, to see that a few feet added to each side would furnish room for another 50 acres, and so on to any size desired. This form of building, properly understood, would lead farmers to abandon the building of a separate barn for each specific purpose, and to providing for all their necessities under one roof. If several barns are placed so as to be convenient, the danger, in case of a fire, is about the same as in one barn, for all would burn in either case. The economy of roofage is exhibited strongly by a comparison of my four barns with the octagon that takes their place. One hundred thousand shingles were required to roof the former, while sixty thousand covers the octagon.

"We have made these general points in explanation of the outline drawing, but there are many other considerations which will occur to our readers that they may study for themselves.

"At the suggestion of a gentleman of Buffalo,
greatly interested in improved methods of building, Mr. L. Brush, we give a representation of an octagon basement, laid out, in the interior, on a circle, containing fifty-two stalls for cows or cattle, with heads towards the interior. For a fancy breeding establishment, these stalls might be made some 3 feet high, showing all the animals at one view, and with the feeding-car on track (c), and the car for running out manure on track (a), the labour would be made convenient. This leaves a 52-foot interior circle which may be put to any purpose required. The track (c) takes out 6 feet, still leaving a circle of 46 feet diameter. The horse-stalls (d) are laid out on a circle, but would be better placed at right angles with the drive-way. One strong point to be made in favour of the circular plan is, that by means of the cars running across the drive-way, food dropped through the floor above upon the car can be run to every animal in the basement. The horse-stalls would also be very convenient of access from the drive-way. One side of the drive-way might be fitted up with box-stalls for brood mares or colts, or calf-pens. We give this plan merely as suggestive, and not as the best arrangement. Every one may divide the space as he sees fit. Of course, it will be more expensive to fit up on a circle, but to one who fancied it, a few dollars would be, perhaps, no objection.

"The plan of basement given in Fig. 27 would generally be preferred, and if wanted for a large dairy-barn there is room for two parallel floors with two rows of cows to each floor, giving one long and one short row of cows to each floor, affording ample room to drive a cart behind each row of cows to take away the manure. One drive-way would answer for both inside rows of cows; also leaving room for a narrow calf-pen on the outside wall behind each outside row of cows. This would be occupying the basement to its full capacity, but, usually on a 250-acre farm, which this size of octagon would accommodate, not more than fifty head of cattle and horses are kept, and our first plan of basement would be the most convenient, leaving ample space for a great variety of uses."

The octagon barn will probably not— at all events at present — recommend itself to English notions, because it is so totally different from anything we are accustomed to in the way of farm-buildings; but that it possesses certain valuable features will, we think, be generally admitted, and we may venture to hope that some one will try it in this country, so that its merits and demerits may be made known to English dairy-farmers, for whom alone it is adapted.

It will be noticed that there is neither manure-cellar under this barn, nor inclined plane to the second floor; and the manure-cellar is regarded, by many American farmers, as a sine quâ non to a dairy-barn. A manure-shed outside will, however, answer the purpose of a cellar, and could probably be constructed at a less expense; the chief advantage of a cellar is the facility which it affords for a handy disposal and preservation of the manure, with very little labour, until it is wanted for the land. Unless the building is on sloping land, the manure-cellar makes necessary a considerable inclined plane if
vehicles are to have access to the second floor, and a smaller one would be required to enable the cows to get to their stalls; built on a hillside, however, these objectionable features may, the one in part and the other wholly, be dispensed with.

To English notions, which do not favour more than two-storey farm-buildings, it seems somewhat odd that in America, where at all events land is cheap enough, the practice should be to make dairy-barns three storeys in height; and especially odd does it seem that carts and waggons, loaded with hay or straw at harvest-time, should be taken up a plane to the third storey; but we have seen several of these three-storey barns in the United States, and can testify to their compactness and general practicability. The American idea is to have the forage, cattle, and manure all under one roof, and this arrangement, once completed, is decidedly a labour-saving arrangement, and is less ponderous than might have been thought. In England, on the contrary, even two-storey buildings are going out of fashion, and it is considered better to have cattle in buildings which are open to the roof, on account of the superior ventilation which is thereby secured, and to store the hay in "hay-barns" specially constructed for the purpose, while the straw is in the rick-yard adjoining; and that part of the buildings which is devoted to chaffing, pulping, mixing, &c., of food, is so situated as to be contiguous on the one hand to the cattle-sheds, and on the other to the rick-yard. But fashions change, and in course of time it may happen that we shall construct our dairy-barns on the American plan. There are points in both systems that will repay attentive study, and possibly the advantages of each may yet be combined in greater degree than in any plan which has yet come under our notice.

It may be added that the whole of the buildings should, if possible, be so arranged that they can without much difficulty be seen from the farm-house. The house itself will usually be in front of the buildings, facing south, so that the kitchen, dairy, and back offices belonging to the house will be next to the buildings, and the latter should be so arranged that the highest portion of them form a good shelter to the rest from the north and west winds, providing they need it. The doors should all, or nearly all, open where they can be seen from the house, or from the south front of the buildings, so that idlers and vagabonds cannot obtain ingress to the buildings, or egress from them, without affording a good chance of being seen. This is of more importance than it might seem to be at first sight.

As a rule it is better, for the sake of giving the cattle as much as possible of sun and light, that the buildings should have a southern aspect; yet if the buildings are naturally well sheltered on the west and north, and are liable to cold winds and rain from the east and south, then the highest buildings should be placed where they will form the best shelter to the rest. Generally we think it best not to store forage in lofts over cattle, unless on a well-boarded floor that will keep down the smell of the cattle; yet the system answers well in properly constructed buildings, and there is a saving of roof-space. The materials should always be good of their kind, and not scanty. None of the roof-timber should be exposed at the eaves or gables, and the workmanship should be substantial. Building that is worth doing at all is worth doing well.
CHAPTER VIII.

THE ORIGIN OF SOILS.

Soils—Cooling of the Globe—Action of Water—Formative as well as Destructive—Igneous, Aqueous, and Metamorphic Rocks—Formation of Strata—Composition and Properties of Sand, Clay, and Limestone—All Soils more or less Mixed—Humus, or Organic Matter—Essential Conditions of a Fertile Soil—Characteristics and Names of Various Soils—Processes by which Soils are Formed—Geological Formations as found in the British Isles, with their Corresponding Soils and Resulting Systems of Agriculture.

Very long ago—so far back, indeed, that the time which has since elapsed, even were it capable of being expressed in a definite number of years, would be quite incomprehensible by us—the globe on which we live, and which we call the Earth, was in a highly heated condition, the intensity of the heat being so great that the materials composing the rocks which we now see around us were in a molten condition. In the course of ages much of the earth's heat was radiated into space; and this went on till at length the earth became sufficiently cooled for some portion of it to assume a solid state. It was probably in this manner that the first hard rock-masses made their appearance on the earth's surface. As the cooling continued, the water-vapour, or steam, which must have been present in the hot atmosphere, became condensed into the liquid state; the water itself was then subjected to the cooling influence of radiation, and in course of time the earth's surface became inhabited by low forms of life. The effect of the sun's heat in those far-distant ages would be then, as now, to cause the water on the earth's surface to rise up in the form of vapour, and so to form clouds. These clouds, floating about in the higher regions of the atmosphere, would become sufficiently cooled for their water-vapour to be condensed and fall in the form of drops—rain-drops—on the earth. The rain-water would flow over the surface, and percolate through the rock-masses, and the residue would at length find its way into little channels, whence the water would emerge in rills, and by the confluence of a number of rills a larger stream would be formed, the waters of which would in the end empty themselves into some large reservoir, as a lake or sea. Now, what is the effect of falling rain and running water on the land surface of the globe? To answer this question it is only necessary to observe the results produced by a shower of rain. Every one knows that the rain as it drains off the land is by no means clear water, but that it is turbid or muddy, owing to the fact that the running water takes up in its course and carries along with it small particles of earth. Water may either flow off the surface of the land into some small stream, and thence to a river, or it may first trickle through the earth's "crust," and so find its way by a different course into a large stream. All rivers contain a lot of fine mud or sediment in their water, some, indeed, being always plainly muddy, and even those whose waters appear to be bright, clear, and sparkling are only apparently clear, for if a glass of the clearest river water be set aside for an hour, a fine layer of sandy particles will be seen to have settled down on the bottom of the vessel. It is evident, then, that the effect of running water is to wear away the surface of the land; and so water is called a denuding agent because, when in motion, it lays bare the rock-masses on the face of the earth. And this denuding action of water, be it remembered, has been going on in various parts of the earth ever since the time when water first appeared, as such, on the globe.
The work of denudation implies also that of disintegration, by which is meant the breaking up of the rock-masses into small particles, capable of being easily transported from place to place. This process of disintegration having happened, the denuding action of running water easily follows. A moment's consideration will show that, besides running water, there are several other important agents of disintegration. Thus, the great reservoir of water, the ocean, is everlastingly beating with its restless waves upon the rock-bound shore, angular fragments of rock being thereby broken off the parent mass. These, by being continually rolled about, become rounded into pebbles, and the smaller fragments at length form those very small pebbles called sand. And this marine denudation, as it is called, is always going on to a greater or less degree—the huge, angry breakers urged on in their resistless course by the fiercest hurricane, and the gentlest ripple of the ocean wave on a calm summer day, both alike perform slowly but surely their work of destruction. Other causes are not less potent: frozen water in the form of snow and ice, for example, exerts a destructive effect on the land; glaciers grind away the rock surface over which they flow, scratching and polishing the rock itself, and bearing away to the place where the glacier melts the disintegrated particles, which are then further transported by the streams fed by the melting glacier. The river Rhone is fed in this way by the streams from the Alpine glaciers, and before entering the Lake of Geneva is a very muddy river.

The destructive effects of water, then, are produced by both its liquid and solid forms; and not only is this so, but in the very act of passing from the liquid to the solid state—that is, in freezing—this substance exerts an influence which is not less effective. For water, unlike most other substances in nature, instead of contracting, expands when it is being frozen into ice, and the power of this expansion is well-nigh irresistible; consequently, if a rock soaked with water becomes frozen, the water between the particles of rock will, in expanding into ice, force these particles further apart. As long as the ice remains solid it will act as a cement between the disrupted particles, but as soon as a thaw sets in, the crumbling effect will at once make itself apparent, and the particles will be easily carried away in the water that trickles out of the rock. It is in the same way that the bursting of a water-pipe by frost, though it occurs at the time of freezing, yet is only found out when the thaw sets in. The effect of a frost on a soil is to make it lighter, for the freezing water pushes apart the constituent particles. Lastly, the moving currents of air, which produce wind, may be referred to, as transporting agents which carry clouds of fine sand and dust, resulting in marked effects on sandy beaches and loose soils.

It should now be evident that, by means of the various agents indicated, the earth’s surface is being slowly wasted away, and the question naturally arises, How is it that, notwithstanding the waste and denudation which have for so long been going on, the whole of the land has not been reduced to one dead level beneath the sea? Clearly there must be some opposing force, some counter-acting influence, at work; and, as a matter of fact, this opposing force has its origin in that residuum of the earth’s primeval heat which is still stored up in its interior. Geologists have shown that the effect of this internal heat is to cause oscillations in the earth’s surface, so that while it is slowly rising in one place it is slowly sinking in another. Thus, the north of Scandinavia is at present being upheaved, while the west of Greenland is as certainly undergoing depression. These processes are of extreme slowness, but occasionally the earth’s internal heat manifests its existence in a very violent and decisive manner, as in a volcanic eruption, when vast quantities of molten matter, ashes, and gases are ejected from the earth’s interior, or in an earthquake, when the very “foundations of the earth” appear to be shaken, and the surface appears as unstable as that of the ocean.

Though the process of disintegration may appear at first to be solely destructive, it is not really so, for it must be borne in mind that the mud-laden waters of rivers and other streams are, in the end, poured into lakes or seas, and there the same thing occurs as happens when a glass of water is taken from a river—the sediment becomes in time deposited, on account of the velocity of the water being checked. The coarsest, and therefore the heaviest, materials, such as the larger pieces of gravel and the stones rolled along the bottom of the river, are deposited nearest
the mouth, while the lighter particles are carried farther out, and the finest sediment farthest of all. It is because of this deposition of sediment that the Rhone, which, as has already been stated, enters the Lake of Geneva as a muddy stream fed by glaciers, emerges therefrom as a river of clear, pellucid water. Deltas, such as those of the Nile and Ganges, and the delta of the Rhone which forms most of the flat Dutch country, are formed in this way. If, however, the river current be very swift, as is the case with the Amazon, for example, a delta is not formed, nor again when the scouring action of oceanic currents disturbs the water at a river's mouth.

The sediment, as it is deposited on the ocean floor, is at first loose and incoherent—shifting sand or mud—but gradually, owing to the pressure of other sediment deposited on it, and to the percolation through the mass of certain cementing materials, it will in time become a firm, coherent rock-substance, as sandstone or clay. Rocks formed thus by the agency of water are called aqueous rocks, while those produced by the action of the earth's heat are termed igneous. There is an intermediate class, in which are placed rocks which were formed as aqueous rocks, but which by the deposition of other rocks upon them, accompanied by the slow sinking of the ocean-floor, have gradually come to occupy deep positions in the earth's crust, and there under the influence of great heat, pressure, and perhaps steam, have been melted, and subsequently solidifying, have assumed more or less the character of true igneous rocks without really being so; such rocks are said to be metamorphosed or altered, and they are called metamorphic rocks. Gneiss, serpentine, marble, and schists may be mentioned as examples.

Usually, it is not difficult to determine whether a rock is of aqueous or of igneous origin. Aqueous rocks are (1) granular in texture, (2) exhibit planes of bedding—lamination or stratification—due to deposition in layers, and (3) frequently enclose mineralised remains of animals and plants (fossils). Igneous rocks, on the other hand, are (1) crystalline in texture, (2) do not show lamination, and (3) never enclose fossils. Familiar examples of aqueous rocks are sand, sandstone, clay, marl, limestone, coal, rock-salt; common igneous rocks are granite, basalt, and pumice. Aqueous rocks, as they occur in the earth's crust, are usually stratified—that is, arranged in layers; igneous rocks are unstratified.

All the rocks which at any one period appear as dry land are alike subject to the influence of disintegrating agents. Hence, by the continued denudation of the land accompanied by slow upheaval, it would be possible for igneous rocks, which had been buried deep down in the earth's crust, to appear at the surface. Further, although aqueous rocks may, at first, have been deposited horizontally, yet, owing to movements of the earth's crust, caused by its endeavour to accommodate itself to the contracted interior resulting from the radiation of the earth's heat into space (a process which is still going on), the horizontal layers become first tilted, and then thrown into curves, these movements being necessarily accompanied by great straining, tearing, crushing, and contortion of the rocks. The tops of the curves then get planed off by denudation, and so the surface of the land may really consist of the upturned edges or anticlips of the beds. This is to a great extent the case in England, where a rapid succession of beds or strata is passed over in travelling from the west coast of the country to the east (see map and Fig. 31), and these strata are known to dip down into the earth with a gentle inclination to the east.

The section, Fig. 30, represents a series of beds thrown into curves in this way, the upper parts, represented by dotted lines, having been swept away by denudation, the present land surface being denoted by the letters \(a, a, a\). The portion of the curve shown at \(s\), where the strata appear to form a basin or hollow, is termed synclinal, while at \(a\), where the strata rise up into a ridge, an anticlinal curve results. A Boss of igneous rock, \(n\), which was forced up amongst the aqueous strata, is partly exposed at the surface, owing to the denudation of the overlying beds which once covered it up. The
other section, Fig. 31, is a general view of the succession of British strata from the north-west to the south-east of England, and the reader should study it in connection both with the map and with the table on page 97.

As a result of their investigations, geologists have succeeded in making a list of strata in the order in which they were formed. Such a list, as it refers to the British Isles, is now placed before the reader, the youngest rocks being placed at the top, and the oldest at the bottom; beneath all these stratified formations, and usually deep down in the earth's crust, there are, of course, igneous rocks. The thicknesses which are given must only be considered as approximate, all strata varying considerably in this respect; and further, the thickness can afford no indication of the extent of rock exposed at the surface, as this will depend rather on the nature of the outcrop and the angle of dip.

Fig. 31.—General View of the Succession of British Strata, the line S S denoting the Sea-level.

G, a, b, Highly Metamorphosed and Igneous Rocks (G, Granite; a, Gneiss; b, Mica-schist); c, d, e, f, Cambrian and Silurian Rocks; g, Old Red Sandstone; h, Carboniferous Limestone; i, Millstone Grit; k, Coal-Measures; l, Magnesian Limestone; m, New Red Sandstone; n, Lias; o, Oolite; p, Greensand; q, Chalk; r, Tertiary Strata.

In the last column are mentioned some of the useful mineral products derived from the several formations. The names of the various groups are sometimes intended to be descriptive of the rocks themselves (as Cretaceous, Oolite), or they may be of geographical origin (as Permian, Silurian); the former are objectionable, because the same formation may vary considerably in the nature of its rocks in different localities.

The earth's surface is mostly occupied by aqueous rocks, those of igneous origin being more or less covered by these. So long as the aqueous rocks rested beneath the protecting covering of the ocean they were preserved from denudation, but directly they emerged above the sea their destruction was commenced, and is still going on, the result being apparent to every one who is willing to look for it. All the diversified forms that delight the eye of the traveller or the tourist, crags, peaks, and fells; scarps, cliffs, and precipices; gorges and ravines; glens, dells, straths, and valleys; hills and dales; plains and table-lands—in a word, all the varied forms of scenery which, associated with a mantle of verdure, make the face of the earth lovely and beautiful, have been produced by the unceasing action of rain and frost, of rivers and the sea, by nature's two great sculptors, water and ice.

It is necessary now to give some details respecting the composition and properties of those substances which usually occur in soils, notably sand, clay, and limestone.

Sand consists essentially of a substance called silica, which is composed of the element silicon united with the gas oxygen. A very pure sand will contain little besides silica; such is the white or grey sand found on some sea-beaches. Other sands will contain varying amounts of impurities, notably of oxide of iron, to which many kinds of sand owe their red, yellow, or variegated colour. The purest form of silica is called rock-crystal or

quartz; it is found in colourless transparent six-sided crystals, and is harder than steel; other less pure forms are quartzite, flint, and chert, the latter containing carbonate of lime. Sand, if examined by means of a magnifying-glass, is seen to consist of very small water-worn pebbles, not of sharp angular fragments as is often supposed. It is an aqueous rock, and originated in the mechanical disintegration of some pre-existing rock—either a sandstone itself, or an igneous rock containing much silica—and the transport of the broken material to some lake or sea where, after having been water-worn, it was deposited. Beds of sand may become consolidated into sandstone, which is a rock with a firm granular uniform texture, yielding one of the most useful and lasting building stones. Gravel is a coarse sand. If sand contains a considerable amount of carbonate of lime it is called a calcareous sand.

As a soil, pure sand alone would be useless, both physically and chemically. Consisting as it does of hard minute granules, it is necessarily very porous,
and is therefore not retentive of moisture, so that a few days' sunshine would render it dry and arid. Then, again, as the particles have no mutual cohesion, they would easily become the sport of the wind, so that even supposing a plant to be growing on pure sand, it would have no grip or hold on the soil, unless it possessed very long straggling roots like those of some of the seashore grasses. From the chemical side the objections to a soil of sand are even more serious, for it could offer the plant nothing in the shape of food, as very few plants require silicon, and even those that do take up this element, as the grasses and cereals, can be grown quite healthily without it. Yet, notwithstanding these drawbacks, sand, as a constituent of soils, confers on them two important properties; it renders them light, and therefore permeable to air, moisture, and warmth; and it also concentrates and stores up the solar heat.

Clay, like sand, is a mechanically-formed aqueous rock.* But, whereas sand is produced by the disintegration of certain granites, of quartz-rocks, and sandstones, clay results from the wearing away of such rocks as gneiss, slate, and shale. Mud carried down by streams becomes consolidated into clay, and the clay may harden into shale, and under certain conditions this may be converted into slate. Like sand, clay also contains silica, but it differs from sand in possessing as essential constituents two other substances, namely, alumina and water. It is, therefore, said to be a hydrated silicate of alumina. Certain impurities, notably oxide of iron and magnesia, are usually present. The colour varies much; it is almost white in the kaolin or china-clay, obtained from the weathering of the feldspar in certain granites, while in most of the fias clay it is blue. From a chemical point of view, pure clay would be as useless as pure sand as a supplier of plant-food, but clays are always more or less impure, and the impurities present usually contain elements, such as potassium, iron, calcium, and magnesium, which play an important part in the nutrition of plants. The physical properties of clay are, in many cases, the reverse of those of sand. Sand is loose and incoherent; clay is firm, plastic, and tenacious; sand rapidly loses moisture, clay is very retentive of it; sand will easily become hot and dry, whereas clay remains cool, and is well able to resist a drought. It appears, then, that a soil consisting entirely of clay would be very firm, cold, and damp, and if exposed to much rain the surface would become muddy, owing to the moisture not draining away. As one of the constituents of a soil, however, clay is found to possess many valuable properties. Thus, it condenses the oxygen of the air; retains water, thereby keeping the soil moist; gives tenacity to the soil, preserves the useful products of decomposition of manures, and is rich in useful alkaline salts adapted to supply plants with food.

Limestone in its purest form is a compound of lime and carbonic acid gas (carbon dioxide), consisting therefore of the elements calcium, carbon, and oxygen, and known to chemists as calcium carbonate. When limestone is burnt in a lime-kiln, the carbonic acid gas is driven off by the heat, and the residue is lime, the well-known causticity of which is due to the eagerness with which it absorbs and combines with water, thereby forming slaked lime. The purest kind of calcium carbonate that occurs in nature is a beautiful colourless transparent substance crystallising in rhombs, and known by such names as calcite, coke-spar, Iceland-spar. These crystals may frequently be found in cavities in limestone rocks. Limestones are always more or less impure, owing to the presence of small though variable quantities of magnesia, iron, and alumina, in the form of silicates, phosphates, and sulphates, due frequently to the intermixtur of clay or sand in small proportions.

It is a remarkable fact, and one of very great importance in the process of disintegration, that water containing carbonic acid gas in solution has the power of dissolving calcium carbonate. Now the air always contains a small quantity of carbonic acid gas, and rain in falling through the atmosphere dissolves some of it, so that the water which drains off the land is able, owing to the solvent power conferred on it by the gas, to dissolve the calcium carbonate, or carbonate of lime, as it is more usually called, both out of limestone rocks, and out of other rocks in which it may occur as a cementing material. Suppose, for example, a soil contains carbonate of lime, then rain-water with carbonic acid in solution will act beneficially in two ways: by gradually removing the carbonate it will render the soil lighter, more porous, and therefore more

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* The geologist uses the word rock to denote any large mass of earthy matter, whether hard or soft.
### Table of the British Stratified Formations.

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**Useful Products, etc.**

- Pest, lime-nitrate
- River mud at mouth of Thames for Portland cement.
- Loam, flint gravel.
- Phosphatic nodules used as mineral fertilizers.
- Building stones.
- Pottery clay and lignite of Bovey Tracey.
- Clay for bricks.
- Sand for glass-making.
- Ironstone.
- Septaria used for making hydraulic cement.
- White pure Bagshot sands at Sandhurst and in Isle of Wight used in glass-making.
- London clay used for brick and tile making.
- Septaria dregged up off coasts of the London clay.
- Chalk, whiting, lime, building stones.
- Flint for roads and glass-making.
- Chalk and marl for manure.
- Phosphatic nodules.
- Gault clay for bricks and tiles.
- Phosphatic nodules near Pulborough and Godalming.
- Kentish rag building stone, clay, Fuller's earth.
- Speeton clay of Yorkshire yields septaria for Roman cement, and fine, light-coloured clay for Portland cement.
- Purbeck marble.
- Building stone.
- Clay.
- Building stone.
- Road stone.
- Freestone.
- Clay.
- Roofing tiles.
- Bath freestone.
- Iron ore from Fuller's earth. Northampton sands.
- Coarse building stone. Coal in Sutherlandshire.
- Alun, Whitby jet, clay for bricks, tiles, and drain-pipes.
- Cleveland (Yorkshire) iron ore.
- Landscape-marble of Caithness.
- Gypseum (subhydrate of lime); common sorts burnt for plaster of Paris, very coarse kinds used as top-dressing for soils. Rock salt.
- Hunter yields good supply of water.
- Good building stone, Houses of Parliament built of it.Used in manufacture of Epsom salts.
- Building, paving, and road stone.
- Stourbridge clay for fire-bricks. Grindstones.
- Iron pyrites. Lead ore.
- Coal and hard black ironstone in Scotland.
- Flag-stones, paving, and building stones.
- Clay slate in Devon and Cornwall, containing ores of tin, copper, lead, iron, and silver. Mudstone marble.
- Building stones.
- Lime and flux for iron smelting.
- Green slates of Cumberland. [Jasper].
- Limestone burnt for manure. Phosphate of lime.
- Slates, paving-stones, flagstones.
- Roofing slates, slabs for cisterns, and hoses for entarty. Largest slate quarries in the world at Pentrea.
- Plumago. Building materials.

**Note on Water Supply.**—The Chalk, Oolite, Lias, and Carboniferous Limestone yield hard water. The water of the Magnesian Limestone is unusually hard, and that yielded by the Trias generally contains gypsum, and is therefore permanently hard. The softest waters spring mostly from sands and clays, and are derived from the Bagshot Beds, London clay, Wealden Beds, and Upper Carboniferous; the clays and slates of the Cambrian and Silurian series, and the igneous and metamorphic rocks, also furnish soft water.
easily crumbled; and further, by holding the carbonate of lime in solution, it will present calcium in the water around the rootlets of the plants in such a way that the element can be taken up by the plants, for vegetable food must be either liquid or gaseous.

If water containing carbonate of lime and carbonic acid in solution be so exposed that the carbonic acid can disengulf itself and pass off again into the air as a gas, then of course the carbonate of lime becomes deposited. It is in this way that deposits of carbonate of lime are formed in petrifying springs; stalactites, stalagmites, and deposits in boilers and kettles are produced similarly. All the great limestone formations, seen on the earth's surface, have, however, been built up by the agency of marine animals on the floors of seas or oceans, and by the subsequent upheaval of the latter have become dry land. All river-waters contain, amongst other things, carbonate of lime in solution, which the water obtains in the manner already indicated; this carbonate is separated from the sea-water by shell-bearing animals to afford material for their shells, and when the animals die, these shells fall to the bottom of the ocean, and in time they may accumulate in sufficient quantity to form subsequently a thick bed of limestone, consisting chiefly of carbonate of lime. In this manner the chalk, which now forms so large a portion of the south-east of England, was deposited as a deep-sea formation; at the present day such a deposit is in course of formation over the floor of the Atlantic Ocean between Europe and America. Coral reefs, again, consist of carbonate of lime.

As a soil constituent, it is only in the pulverised state that limestone plays an important part; when in the form of gravel it behoves like other granular pieces of rock. Pulverised limestone has two useful agricultural properties: it furnishes plants with mineral manures in the phosphates and sulphates of lime and potash which are usually present as impurities, and it aids the decomposition of organic manures, such as farm-yard and green manure.

Soils consisting entirely of pure sand, or clay, or limestone are never met with in nature. Some soils may consist to a very great extent of one of these, but there will always be certain impurities present, and most likely some admixture of one, and perhaps both, of the other two. If a portion of powdered soil be taken and stirred up in a vessel of water, and the vessel then set aside for a few minutes, a number of clean-looking particles will be found to have settled down on the bottom of the vessel—these are due to the sand in the soil. If the turbid water be then poured off the sand into another vessel, and set aside for a much longer time, a very fine impalpable deposit will at length take place—this is due to the clay. The clay and sand may thus be separated, and if some weak hydrochloric acid be then poured upon each, there will probably be an effervescence due to the escape of carbonic acid gas, and the lime contained in any limestone that may be present will be dissolved.

Besides one or more of the three constituents, clay, sand, and pulverised limestone, and in addition to certain saline substances which are frequently present, all cultivated soils contain accumulations of organic matter which arise from the growth and decay of plants, and from decomposing leaves, twigs, &c., drawn into the soil by earth-worms. This decaying organic matter is variously known as vegetable-mould, leaf-mould, and humus; to its presence is due the dark colour of good garden mould and rich fertile soils. If a portion of soil be heated to redness, the organic matter, which is composed of carbon, hydrogen, oxygen, and nitrogen, passes off in gaseous combinations. The interstitial air of soils always contains more carbonic acid gas than ordinary air; it arises from the oxidation of the carbon of the organic matter, and is, of course, dissolved by water, the effects of which the reader already knows.

A soil cannot be considered perfect for agricultural purposes unless it contains a suitable admixture of the four constituents—sand, clay, limestone, and humus. If there be not enough sand, the soil will not be sufficiently permeable by water, and it will be too cold; if insufficient clay, the soil will be too dry, not tenacious enough, and will allow manures to become too much scattered or diffused; with a deficiency of limestone the decomposition of manures will not go on regularly, and putrefaction will invade the soil; and finally, if the soil be poor in humus, the plants will suffer hunger.

Experience has shown that a soil is best
adapted for general agricultural purposes when it contains of

Sand (siliceous and calcareous) from 50 to 70 per cent.
Clay ... ... ... ... " 10 " 50 "
Pulverised limestone ... " 5 " 10 "
Humus ... ... ... ... " 5 " 10 "

It thus contains enough sand to make it warm and pervious to air and moisture; enough clay to render it moist, tenacious, and conservative of manures; enough limestone to furnish calcareous manure, and to decompose organic manures; and lastly, sufficient humus* to supply the alimentary needs of the plant. A soil of this kind possesses all useful agricultural qualities, and it is only necessary to keep up its fertility by a proper system of culture, and by the judicious employment of manures.—Dr. Mennier.

Such a soil as that just indicated is, however, the exception rather than the rule in nature, most soils being characterised by an excess of one or more of the ingredients. Thus, many soils consist chiefly of sand and clay, and they have been classified according to the proportions of these substances present. When in a soil of sand and clay the latter forms not more than 10 per cent. of the weight, a sandy soil results; with 10 to 40 per cent. of clay, a sandy loam; with 40 to 70 per cent. of clay, a loamy soil; 70 to 95, a clay loam; 85 to 95, a strong clay. With a still higher percentage of clay the soil approaches a pure agricultural clay. A mixture of clay and pulvredised limestone—that is, a calcareous clay—constitutes a marl when the limestone is from 5 to 20 per cent. of the total weight; should the limestone exceed 20 per cent., a calcareous soil is the result. A mixture of sand and pulvredised limestone produces a soil which may be termed, for want of any other word, a calcarenet† (Latin, calx, lime, and arena, sand).

As most soils have a deficiency of some one or more necessary constituents, and a redundancy of others, it follows that a mixing of two different soils will generally effect an improvement. Many instances will be mentioned in the sequel in which this occurs naturally along the common

* The humus itself is not taken up by plants, but it plays an important part in those chemical changes in the soil which result in the formation of plant-food.
† An expressive and appropriate term, for the suggestion of which the writer is indebted to his colleague, Professor A. H. Church.

line of outcrop of two formations dissimilar in their mineral composition; each formation may produce only average crops excepting where the two strata merge into each other, and there the yield will be much enhanced.

Referring to the igneous or crystalline rocks generally, it seems probable that the carbonic acid gas of the atmosphere is the most active agent in the decomposition of their silicates. The potash, soda, lime, magnesia, and iron pass into the state of carbonates, and the silica which was combined with these bases is set free. Now silica in a fine state of division is somewhat soluble in water containing carbonic acid, and thus some of the liberated silica may be removed in solution. The carbonates formed are also soluble in such water, so that the residue will in the end consist of little besides silicate of alumina, capable of assuming the plastic state, but absolutely insoluble, and therefore approaching more and more to the nature of clay. In the case of granite this clay is derived almost entirely from the felspar.

As regards their immediate origin, soils are either formed by the disintegration or weathering of the underlying rock, in which case they are distinguished as sedenary, indigenous, or local; or they are brought from a distance, as in the case of glacial detritus, or the alluvium deposited by a river near its mouth, and are then called transported soils.

The origin of local soils has already been touched upon, and the mode of formation of the soil on the impure oolitic limestone of the Cotteswold Hills may further simplify the matter. Fig. 32 represents the face of a quarry; the soil at the top is merely a superficial bed, between it (a) and the virgin rock (b) are two beds more or less distinct, which manifestly represent different stages in the transformation of the hard solid rock into loose soil. The upper (a) of these two, generally termed the subsoil, differs from the overlying soil in containing more carbonate of lime, being greatly deficient in humus, and abounding in stones the size of which increases with the depth. The other (c) consists exclusively of these stones, which, becoming progressively larger and larger, pass gradually into the continuous rocks below. To account for these appearances, it is only necessary to bear in mind the solvent power of water containing carbonic
acid, and to remember that the deeper such water percolates downwards, the more saturated with dissolved carbonates will it become, and therefore the less capable of effecting further solution of rock-substance. The surface soil will contain the silica and alumina which were present in the impure limestone, some undissolved carbonate of lime, and humus.

Very low forms of vegetable life, such as lichens, and then mosses, first appear on a young soil, and these disturb its chemical composition; thus, lichens which grow on limestone yield on analysis oxalate of lime. The decay of such low plants gradually confers on the soil a small amount of humus, and so it is slowly prepared for the growth and nutrition of other plants higher in the scale.

Fig. 32.

It now only remains to indicate briefly the characters of the soils derived from the various formations, and these will be taken in the chronological order in which they are tabulated on page 97, commencing with the oldest, the igneous rocks being first dealt with. The reader should keep constantly before him the accompanying geological map of the British Isles, which we have endeavoured to make as accurate as possible. Many geographical details have been given, but as the map had to be constructed on a sufficiently small scale to be uniform with the rest of the work, such particulars as rivers, railways, and divisions into counties have, to avoid complication, been omitted. As these, however, may be seen on any ordinary map, their position on the geological map may be determined without much difficulty.

**Igneous Rocks.**—Granite soils owe what fertility they may possess to the decomposable nature of the felspar, and (if present) of the hornblende, the iron and magnesia of the latter contributing especially to make the soil productive, though even these will not avail much if, as is often the case, the soil is at any considerable elevation above the sea-level. In Cornwall and Devon the weathered blocks of granite have been removed from the surface and employed in making walls, and the enclosed fields have been brought into a fair degree of productiveness. Granite (colour 21) will be seen by the map to occur in many isolated tracts in mountainous regions. Trap-rocks, on account of their more varied mineral composition, are more easily crumbled and yield more fertile soils than granite rocks; their decay producing soils consisting of clay, and containing potash, lime, magnesia, and iron. Decomposing trap is used as a mineral fertiliser on other soils. Trap-rocks (colour 20) occur in a few localities in Wales, in various parts of Central and Western Scotland, and in the south-east of Ireland in the counties of Wicklow, Waterford, and Wexford, besides the Miocene basalt of Co. Antrim in the north.

**Cambrian.**—Of the districts indicated on the map as Cambrian and Laurentian (colour 19), only a portion—namely, the extreme north-west of Scotland and the islands of the outer Hebrides—contains Laurentian rocks. The southern part of the north-west coast of Scotland, the Welsh localities, the Charnwood Forest district in Leicestershire, and the two patches on the south-east coast of Ireland are Cambrian. As the Cambrian consists chiefly of hard slaty rocks, it yields either poor thin soils, or cold clays difficult to work and only amenable to high-farming.

**Silurian.**—Nearly the whole of the Scotch Highlands, a great part of the Lowlands, most of Wales, Cumberland, and large patches on the east, west, and north coasts of Ireland are occupied by Silurian strata, which are frequently highly contorted and metamorphosed. Hard grits and slates are prevalent, and these being difficult of decomposition, little soil is formed, especially on the more elevated lands, which are therefore entirely devoted to pasture. At the feet of hills, however, and on slopes where glacial detritus
has been mixed up with the decaying rocks, as in the Scotch Lowlands, the soil is fertile under good cultivation. In Wales the Upper Silurian (colour 17) forms cold muddy clays, difficult to work; but in Shropshire the Ludlow beds, around the town of that name, crumble down into a fertile soil. Arable soils derived from the Silurian are also seen in the counties of Caernarthen, Radnor, Shropshire, and West Herefordshire. Most of the remaining Welsh Silurians are under pasture.

Old Red Sandstone and Devonian (colour 16).—Under this head are grouped two very different kinds of rock, the Old Red Sandstone embracing rocks consisting chiefly of reddish and greyish sandstones, and the Devonian comprising strata which differ but little from the succeeding Carboniferous Limestone. In the British Isles the beds of the Devonian type occur only in the district indicated on the map in Cornwall, Devon, and Somerset. The Old Red is met with in all the other localities —namely, Herefordshire and parts of the adjacent counties in England and Wales, tracts in the Scotch Lowlands, on the southern flanks of the Grampians, and on the north-east coast of Scotland, also in the south-west of Ireland, and at various outcrops in the central plain. In no county is the Old Red Sandstone seen to better advantage as a soil than in Herefordshire; there the lower divisions of the Old Red contain a great number of rounded pieces of impure limestone, called "cornstones," often embedded in marl, and the whole decomposes into a soil of great fertility, its reddish colour being due to the presence of a considerable percentage of oxide of iron. As the cornstones do not allow water to pass through them without difficulty, it sometimes happens that when these form the subsoil the overlying soil is injured by the throwing up and retention of water. The Old Red yields one of the best natural pastures, and is the home of the far-famed breed of Herefordshire cattle; when cultivated the soil gives fine crops of wheat and barley, and in some localities of hops, while its apple and pear trees have obtained for Herefordshire cider and Perry a wide celebrity. The superiority of the Old Red soils over those of the adjacent older rocks is very apparent to the traveller journeying from Herefordshire westward into Wales.

Carboniferous Limestone.—This formation, where it occurs in greatest purity, is a hard bluish limestone, and from the fact that it often rises into bold hills, as in the Peak of Derbyshire, and lends itself to the formation of fine cliffs, scarpers, and gorges, as in the Monmouthshire Wye and the Bristol Avon, it was once termed the Mountain Limestone. It usually occurs in Great Britain skirting the Millstone Grit that surrounds most of the coal-fields (see map, colour 15), and is seen in South Devon, parts of Somerset and Monmouthshire, and in Derbyshire, where it is several thousand feet thick. When traced northwards into Northumberland and to the vale of the Forth and Clyde, it is found to have greatly deteriorated in quality, being split up by intercalated beds of sedimentary material. The Carboniferous Limestone plays the same important part in Ireland as that taken by the Lower Silurian in the Scotch Highlands, for a glance at the map will show that the whole of the great central plain of Ireland is occupied by it. All this area was once covered by coal which has been removed by denudation. Even now, however, the Carboniferous Limestone itself is not generally visible on the plain, as it is mostly covered up by beds of limestone gravel, by boulder-clay, by shallow lakes, or by extensive peat-mosses which occupy the positions of lakes that once existed. The Carboniferous Limestone is dry at the surface, and sends out springs at the base; its local soil is usually thin, and consists of a fine vegetable mould mixed with broken fragments of limestone. The natural herbage, amongst which the sheep's fescue-grass (Festuca ovina) is prominent, is very good, sheep showing a marked preference for it, and nibbling it close to the ground. For this reason, and because of its great elevation in some districts, as in Derbyshire, it is mostly left in natural pasture. As it is favourable to the growth of timber, it is frequently well wooded. It is largely cultivated in the Mendip Hills, where it yields good crops of oats, barley, clover, and roots, the situation being too high for the profitable growth of wheat. Lower down, however, where the limestone and the underlying shales crop out together, the mixed soil produces good crops of oats and wheat.

Millstone Grit.—This deposit fringes most of
the coal-fields, as may be well seen on the map in the case of the South Wales coal-field. It occurs also in Devonshire (colour 14), and in the district occupied by the Pennine Chain, separating the coal-fields of Lancashire and Yorkshire, likewise in a few localities amongst the Scotch coal-measures. It occupies several large tracts around the Carboniferous Limestone of Ireland, notably in the south-west. The soil of the Millstone Grit is of a poor gravelly character, and where the subsoil is of clay the overlying gritty beds become swampy. This formation is usually covered by worthless heaths, the appearance of which contrasts anything but pleasingly with that of the adjacent Carboniferous Limestone.

**Coal-measures.**—The shales, clays, and sandstones that crop out as the partings between the beds of coal form at the surface a wet yellowish clay, the natural produce of which is sedges and heaths with but little grass. Where, however, there is a large proportion of sand the soil becomes fairly productive, and is better employed as arable land than for pasture. These soils, as well as those of the underlying Millstone Grit, require, after draining and cultivating, the application of lime, which assists to bring the soil into sufficient condition to yield fair crops of wheat, oats, turnips, and clover. A glance at the map will indicate at once the localities of the British coal-fields (colour 13). In the immediate vicinity of coal-pits, the conditions which exist are utterly inimical to vegetation, as will be evident to anybody who has passed through, for example, the "black country" around Wolverhampton.

**Rothliegende.**—To this group belongs a series of marls and sandstones of Permian age seen in the Vale of Eden (colour 12), in a few localities in the south of Scotland, on the Cumberland coast, in Shropshire, and in the vicinity of the coal-fields of the English midlands. Their soils are similar in most respects to those of the Trias which are described below.

**Magnesian Limestone.**—This, also of Permian age, forms a narrow strip of land, on the east side of the Coal-measures, extending from Nottinghamshire up to the north side of the Tyne, there being a break in the continuity in Yorkshire. Magnesian differs from ordinary limestone in containing, besides carbonate of lime, a variable quantity, even as much as one-half, of carbonate of magnesia. Excess of magnesia in a soil is bad for plants. The Magnesian Limestone soils are thin, light, and easily crumbled, and are mostly under the plough, good crops of wheat and barley being the reward of high-farming.

An inspection of the map will show that the Palaeozoic strata, a description of the soils on which has now been given, are practically confined to certain parts of the British Isles. Thus, both Ireland and Scotland are almost exclusively occupied by these old rocks, the most notable exception, perhaps, being that of the fertile basaltic plateau of Co. Antrim in the former country. In England and Wales, again, the counties of Devon and Cornwall, the whole of Wales with Monmouth, Herefordshire, and Shropshire, and that major portion of the six northern counties which lies west and north of the Pennine Chain, are likewise entirely occupied by the outcrops of Palaeozoic strata, with bosses of igneous rocks rising up here and there just as they do in Scotland and Ireland. Now it is a noteworthy fact that most of these Palaeozoic areas are under permanent pasture, and this is due not only to the nature of the soil, but also to considerable elevation above the sea, as in the natural pastures of Wales, Cumberland, and Derbyshire, and likewise to the excessive humidity of climate to which the Irish, Welsh, and Cumbrian grazing lands are subjected. The nature of the soil and the prevalent moisture combine to make Ireland, for example, essentially a grazing, and therefore a stock-breeding, rather than an arable country. The statement made respecting the general character of the Palaeozoic strata must, however, not be received in too wide a sense, as there are certain exceptions, notably in the case of the Old Red Sandstone, and of the red and yellowish sandstones and marls (Rothliegende) of Permian age, as witness the Old Red arable soils which attain their highest perfection in the fertile county of Herefordshire, and the excellent soils which have resulted from a commingling of boulder-clays and Permian rocks in the beautiful Vale of Eden. Again, in the central valley of Scotland, watered by the Forth and Clyde, and extending from the metamorphosed rocks of the Highlands on the north down to the uprising Silurian Lowlands on the south, the commingling of Old Red sandstones and marls, Carboniferous shales and
limestones, fragments of igneous rocks, and glacial detritus, have resulted in the formation of an arable soil which, under judicious cultivation, has attained a remarkable degree of fertility.

In giving an account of the soils lying on rocks of Mesozoic and Cenozoic age, the description will, of course, apply almost exclusively to England alone, and, roughly speaking, to that part of it which lies to the east of a line that may be drawn on the map from the mouth of the Tees to that of the Severn, the only notable portion west of this line being the Cheshire Plain. Beneath these younger rocks the older Palæozoic rocks of the west dip away eastwards (see Fig. 31, page 95), so that if a sufficiently deep boring were made in one of the eastern counties it would probably pierce, at last, the underlying Palæozoic beds. The Carboniferous strata which contain the coalfield of South Wales appear, in this way, to dip down under the younger beds of the counties between South Wales and Kent, and then on the other side of the North Sea to rise again in the Belgian coal-fields, thus forming a great synclinal curve. The strata now under consideration have not been violently contorted and disturbed like the older ones of the west, nor do they show indications of metamorphism.

Trias.—The Bunter Sandstone, or New Red Sandstone, as it is also called, is seen in parts of Yorkshire, Cheshire, Lancashire, and Central England (colour 10). The reddish and variegated sandstones often yield a deep, dry, sandy soil, the fertility of which varies according to the nature of the subsoil. When the latter is of clay, the overlying soil becomes cold and wet, and requires draining; when the underlying subsoil consists of marl or marly sandstone, it is worked in with the soil to form a rich red loam productive of luxuriant crops of every kind. The Keuper or New Red marls (colour 9) form fine rich meadow land. The Trias, taken as a whole, is the most extensive formation seen on the surface in England; it extends, with some interruption, from Devonshire, through Somerset, Gloucestershire, and Worcestershire, to Warwickshire, where it divides into two branches, one stretching away through Staffordshire, across the fertile plain of Cheshire into Lancashire, and the other ranging northwards through the Trent Valley in Nottinghamshire, and along a strip of land in Yorkshire, to disappear beneath the sea at the mouth of the Tees.

At its widest part in the midlands the Trias is eighty miles across from east to west. The sandy soils on some parts of the formation are much improved by the application of marl from other parts, hence the number of old marl pits in the Keuper. The general fertility of the Trias may be estimated from the fact that the three highest rented counties in England rest chiefly on it, and it has the reputation of forming the best arable land in the country. In some parts of the New Red Sandstone, however, there are beds of conglomerate (pebbles cemented together into hard rock), and when these appear at the surface they break up into barren, gravelly soils, which are only brought under cultivation with extreme difficulty, and even now in some localities form waste land, as in Sherwood Forest. Other parts of the formation, again, have been overspread with glacial detritus, and in this case also the character of the soil has suffered; in the Vale of Clwyd, in Denbighshire, however, where the New Red Sandstone is so overlaid, the result is a very fertile soil. As to the Old Red Sandstone, so to the New, do orchard fruit-trees seem specially addicted, and the cider produced by the Trias of Devonshire and Gloucestershire rivals that from the Old Red of Herefordshire.

Lias.—This formation consists of thick beds of blue and yellow clay, with partings of sandy limestones and shales. The clay and shales are impervious to water; hence, near the outcrop of the porous strata of the overlying Oolite, the surface of the Lias is cold and wet, so that rushes, sedges, and other water-plants are its natural produce. Atmospheric influences cause the clays, shales, and limestones to break up into a soft but retentive clay soil, which resists the plough, and therefore is frequently unsuited to arable culture, even when drained. Nevertheless, though expensive to work, persevering industry has brought much of the Lias under the plough, and cereal crops may, in such cases, be raised to advantage. In some localities, as in Somerset, the flaggy limestones are so near the surface as to impede the plough. From the very stiff character of the soil, and its persistent retention of moisture, however, much of the Lias is devoted to grass land, and it supports some of the oldest pastures in the country, which, producing as they do fat sheep and oxen, rich cheese and butter, may well be termed "cheesy" pastures.
The Lower Lias soil is brashy, and frequently of a rich brown colour. On it are raised wheat, barley, oats, cabbages, turnips, mangolds, beans, and occasionally teasels. The ground is mostly flat or gently undulating. Stilton cheese is yielded by cows grazed on the Lias clays near Melton Mowbray, in Leicestershire; double Gloucester cheese is the product of the Lias clays in the Vale of Gloucester, where they form the rich fertile meadows on the Severn side; Cheddar cheese, again, is obtained from cows fed on the pastures resting on the Lias clay, New Red marl, and Alluvium of Somerset.

The Middle Lias yields a rich soil formed by the decay of the Marlstone, which is a mixture of clay and sand with a considerable quantity of limestone. It forms, therefore, a strip of very fertile land overlooking the grazing lands of the Lower Lias. Apple-trees thrive on the Middle Lias of Somerset.

The Lias extends as a very irregular strip from Lyme Regis, on the Dorset coast, to the mouth of the Tees, on the North Yorkshire coast. It extends, then, from Dorset, through Somerset, to Gloucesteshire, in which county it forms, under the shadow of the Cottswolds, the dairy districts in the Vale of Berkeley, Gloucester, and Evesham; thence it stretches away through Worcestershire and Warwickshire into the counties of Northampton, Leicester, Nottingham, Lincoln, and York. Much of the milk which arrives daily in London is off the Lias.

Oolite.—This formation consists of beds of limestone, interstratified with bands of clay, which may become very thick, as is the case with the Oxford and Kimeridge clays, which spread over considerable areas. The Lower Oolites form the Cottswold Hills, which were long in a state of natural pasture, and chiefly grazed by sheep; much of this district is now under the plough, roots, clover, and cereals being grown even on the summits of the Hills, though the soil generally is thin, poor, and brashy. The prevailing timber-tree on the Cottswolds is the beech; the ash and the elm grow less freely, while the oak, which luxuriates on the Lias clays, is scarce on Oolites of the Cottswolds. The Northampton sand yields a fair soil. The ground occupied by the Inferior Oolite is hilly and occasionally barren, but the brownish brashy soil is fertile where it has sufficient depth. The Lincolnshire limestone, a section of the Inferior Oolite, yields a light soil, not of much value. The Great or Bath Oolite supports a thin stony soil, not difficult to work, but too elevated and not deep enough for productive cultivation. The Forest Marble and Cornbrash soils are of a clayey nature, due to partings of clay between the flag-like beds; though poor, they may be greatly improved by draining and cultivation, and then yield fair crops of cereals, pulses, and roots. The clays of the Oolite form close, sticky, sometimes calcareous soils, scarcely adapted for arable land, but forming, after thorough drainage, rich pastures not unknown for the quality of their dairy produce. The Oxford clay, which in some localities is twenty miles wide, joins the Kimeridge clay in Huntingdonshire. The Aylesbury dairy district rests chiefly on the Kimeridge clay. The Upper Oolites are mostly in old pasture, being too expensive to work, good arable land only resulting where clay and sandy limestone crop out together. The Oolite (colour 7) occupies a strip of land very similar to the Lias, and lying on the east of the latter; commencing on the Dorset coast it extends through parts of the counties of Somerset, Wilts, Berks, Gloucester, Oxford, Bucks, Beds, Hunts, Rutland, and Lincoln, and dies away on the south side of the Humber, the clays re-appearing in the North Riding of Yorkshire, west of Scarborough. In Northamptonshire the nature of the outcrop is such that the Lias and Oolites ramify amongst each other very curiously, producing the fertile districts around Rockingham and Kettering. In the Oolitic strip, thus stretching from Dorset to Yorkshire, the younger or upper members of the series, notably the clays, are on the east side; thus, Huntingdon is occupied almost entirely by clay.

Wealden and Purbeck Beds.—The Purbecks are merely local in the Isle of Purbeck. The Hastings beds consist chiefly of fine sand, interstratified with lesser beds of clay; they produce a fine dry sandy loam, which in dry weather becomes quite a dust. Where the clay and calcareous sandstone weather down together, a light productive soil results. But where the fine siliceous sand contains nodules of iron ore, a poor wet soil, producing naturally heath and furze, prevails. The Hastings sand occupies the middle of the Weald district in Kent and Sussex. The Weald clay forms a fringe round
the Hastings beds on the north, west, and south; its width varies from five to twenty miles, and it is seen (colour 6) in Kent, Surrey, and Sussex. The soil it supports is a damp, stiff, siliceous clay, which is used in some localities for making bricks; indeed, so well is it adapted for this purpose, that it sometimes dries in the sun as hard as a brick, and therefore it requires a considerable outlay to bring such a soil into good condition, thorough drainage being the first requisite. Nevertheless, some parts form a very active arable soil, yielding wheat, oats, beans, and roots, and here and there deep loams support some of the finest hop-gardens; much of it, however, is in pasture. Down to within recent times most of the area occupied by the Wealden and Hastings beds was covered by forests, some of which still remain. From this circumstance the district received its name of Weald or Wold, meaning a woodland. The district is noted for its oak-trees.

Greensand and Gault (colour 5).—The Lower Greensand forms a very narrow fringe along the north, west, and south of the Weald clay, just as the latter surrounds the Hastings sand; it also extends as a narrow strip on the east of the Oolite from Dorset up to Norfolk, and occupies a similar position in Lincolnshire and Yorkshire. Its soil is generally very siliceous, and frequently mingled with silicate of iron; it is therefore often barren. Where it becomes calcareous, as near Hythe, it is dry and productive, hops especially yielding good crops. The Gault and Upper Greensand form yet another border round the Wealden area, separating the chalk on the outside from the Lower Greensand on the inside; these beds are also seen in Dorset, in the southern half of the Isle of Wight, and as a fringe on the east side of the strip of Lower Greensand which, as already stated, extends from Dorset to Norfolk, and through parts of Lincolnshire and Yorkshire. The Gault is generally a bluish, sometimes greyish, calcareous clay, forming a strong, tenacious, stubborn soil, which is best subdued by draining and applying some of the overlying Greensand, when useful crops of cereals and pulses may be obtained. Much of it is in pasture, and it is known in some localities as “blackland.” The soil is driest where it is covered by drift or alluvium; in some places it is so very impervious that the water remains on the surface, as in the Vale of White Horse, Berks. The Upper Greensand consists of soft, friable, calcareous sand of a dirty green colour, and it yields a dry soil, excepting where the underlying Gault clay throws up water. The soil, especially where it is the joint product of the Upper Greensand and the overlying Chalk Marl, is one of the richest in the country, and is easily cultivated. Where it becomes too light, an addition of Gault clay is the natural remedy. Its great fertility is due to the presence of phosphatic nodules, called “coprolites,” which provide a supply of phosphorus, for which most soils are dependent on expensive manures, as superphosphate of lime, bone-dust, and guano. The hop-district of Farnham, in Surrey, is on this soil. There is a rich tract in Beds, and others in Bucks, Oxon, Wilts, and Somerset.

Chalk (colour 4).—The lowest member, the Chalk Marl, especially where it approaches the Upper Greensand, supports, like the latter, a most excellent soil, which produces fine crops of roots, pulses, and cereals. To the chalk itself less praise can be given, as its soils at the best are only of moderate fertility. The limestone of the Lower Chalk is of a dingy white colour, owing to the presence of iron and clay; the upper Chalk beds are whiter, and are freely interspersed with flints, which are usually of a black colour. The Chalk produces naturally short, thick pastures, to which sheep are addicted. In the north it forms the Yorkshire and Lincolnshire Wolds; in the south it rises into the North and South Downs, the soil being very thin, so that the Chalk itself is within one or two inches of the grass. A good illustration of the difference between transported soils and indigenous or local ones is afforded by a comparison of the Chalk of the Lincolnshire Wolds with that of the North and South Downs. In the former locality it is mostly covered with superficial deposits; in the latter this is not the case, consequently the Chalk of Lincolnshire has not the bare and arid appearance associated with this formation in the southern districts, and most of it has been converted into useful arable land. The Upper Chalk is more especially the region of sheep-walks, the Lower member yielding more arable land. In some localities water has dissoluted out much of the carbonate of lime from the soil, and left on the Upper Chalk a loose, flinty soil, and on the Lower a cold, stiff clay, such as may be seen in the counties.
of Kent, Surrey, Hertford, Berks, and Wilts. The soil resulting from a mixture of the Lower with the Upper Chalk is said to yield good root crops, especially of carrots, after deep forking. In Suffolk, West Essex, and East Hertfordshire, as in Lincolnshire, to which reference has been made, the agricultural qualities of the soil are entirely altered, owing to the surface of the Chalk being covered by glacial detritus. Besides the counties already mentioned, the Chalk is seen in those of Sussex, Hants, Dorset, Oxon, Bucks, Cambridge, and Norfolk, the lowest rentable counties in England being on its soils. On account of the porous character of the rock, many of the ponds used to supply animals with water in Chalk districts require to be lined with clay.

Eocene.—The metropolis stands on this formation (colour 3), which stretches from the Essex coast, far up the Thames valley, to the borders of Wiltshire. Another tract on the south coast occupies parts of Dorset, Hants, and Sussex, and the northern portion of the Isle of Wight. The lowest member of the Eocene series, comprising the Woodwich and Reading beds and Thanet sands, was once known as the Plastic clay, and it forms wide heaths in Hampshire and Berkshire. The light sandy soil suffers from the presence of alternating beds of clay, which throw up much water; to bring the soil into condition requires thorough draining, subsoil ploughing, and addition of some of the neighbouring chalk. The natural produce is heather, furze, and a poor grass almost valueless. The London clay has a bluish or brownish tenacious soil, which splits in dry weather, and so assists drainage. Much of it is in pasture, and it serves this purpose well, but is too strong for roots, though it yields, after marling or liming, fair crops of corn and beans. As the London clay is impervious to water, the wells in and around London have to be sunk into the basement beds; they are therefore deep, excepting where the water is derived from superficial gravels lying on the London clay. It forms the London basin, and stretches from Windsor, in the west, to Harwich, on the Essex coast, and to Reculver, on the coast of Kent; and from north to south it extends from Barnet, in Hertfordshire, to Croydon, in Surrey, its greatest width being about twenty miles.

Miocene.—This formation is so very slightly represented in Great Britain as to require no notice here. In Ireland the basaltic plateau of Co. Antrim is of Miocene age, and yields, as trap-rocks generally do, good soils, which are under thorough cultivation.

Pliocene.—The Pliocene crags and Bagshot sands are represented under one colour (2) on the map. As a matter of fact, the Bagshot sands are of Eocene age, and they appear next above the London clay; they occur to the south-west of London, on the sterile Bagshot Heath, and on the coast of Hampshire. Their soil is poor, light, and sandy, and is little cultivated. The crags occur in the extreme east of England, extending along the coasts of Norfolk and Suffolk, and partly into Essex. The soils are sometimes so loose that after ploughing they become drifted by the wind, and after hot dry weather the crops are light and almost scorch'd. These crags form the repository of phosphatic nodules similar to those of the Upper Greensand, and as much as £70 an acre has been given for the right to dig over a two-acre field in search of these valuable mineral fertilisers, the land itself reaping much benefit from the process. The eastern counties are essentially the corn-producing districts of England.

Much of the surface of the counties of York, Lincoln, Norfolk, Suffolk, Essex, and Hertford is covered by Boulder-clay, which was formed during a comparatively recent geological period when most of Britain was covered by ice, as Greenland is at the present day. It partakes partly, though not entirely, of the nature of the subsoil; thus, in Suffolk, it is decidedly chalky in character, and when drained forms a very fair soil. Further allusion is made to this subject below.

Alluvium.—Alluvial deposits are usually formed on the banks, and at the mouths, or estuaries, of rivers. They consist of the silt and mud, gravel and sand, brought down by the waters of the river, and being thus composed of the well-mixed detritus worn from the various formations which the river-system drains, they are usually very fertile, forming rich meadows and pastures. In Lincolnshire the process termed warping consists in allowing the waters of the rivers to flow over the land for the sake of the fertilising deposit. In Egypt, again, the cultivation of the soil is entirely dependent on the
periodic overflow of the Nile, for there is no
rain. In England alluvial soils occur on the
banks of the Ouse, Derwent, Trent, and Humber,
in the York and Lincoln district; on the banks
of the Thames; and on those of the Bristol Avon,
Monmouthshire Wye, Usk, and Severn, terminat-
ing in the broad flats bordering the Bristol
Channel. Under this head mention must be made
of vegetable accumulations, such as peat-masses,
bogs, and swamps. The flat, undiversified country
round about the Wash consists partly of peat
in the south towards the Fens, but chiefly of
silt. It extends from Flamborough Head south-
wards, through the district of Holderness, to the
south of the Humber, and thence along the Wash
to the Norfolk coast, the total area being upwards
of 1,800 square miles. The drainage is pumped
up into the rivers, which are enclosed by stout
dykes, after the Dutch custom. On the west
coast of Lancashire, in the estuary of the Ribble,
the Fylde plains somewhat resemble those of the
Wash. One of the greatest difficulties experienced
in reclaiming alluvial tracts is that of drainage,
as in the case of the unmanageable peaty soils of
Scotland and North-west Ireland. If, however,
this has been successfully accomplished, a fertile
soil is the almost certain reward. Thus the flat
country known as the Bridgewater Levels, in
Somerset, consisted, at the beginning of this
century, of wet useless bogs; by efficient drainage,
and top-dressing with river-mud, it has been
gradually reclaimed, and now forms grazing-lands
of the richest description, clovers and pasture-
grasses thriving where once the bog-plants held
undisputed sway. When a peaty soil is drained,
the heaths disappear, and the soft grass, Holcus
lanatus, takes, at first, their place. Under alluvial
soils must also be classed the brick-earth, or wash,
consisting of the detritus worn from hill-sides,
down which it rolls to produce fertile accumu-
lations in the plains below.

Drift.—This term is used to denote, amongst
other things, the detritus which was scattered
broadcast over much of the British area during the
latest Glacial Period. The ice in its progress may
have eroded some of the rock on which the drift—
Boulder-clay, for example—rests, and a mixed
soil then results. And further, as the glaciers
ground up the surface of the land over which
they flowed, the detritus of one formation was
mingled with that of another, and the result
of this is usually beneficial. The drift necessarily
forms transported soils; and, as the reader must
have noticed, the soil in such cases differs more
or less from the subsoil. In some, more especially
the southern, parts of Britain, the drift is absent,
and then there is a close and intimate connection
between the nature of the soil and that of the
rock below—the subsoil. But in nearly all cases,
even where the formation in a given locality,
as represented on the map, is masked by super-
ficial accumulations, it must be evident that there
is a more or less intimate relation between soil and
subsoil, and hence the bearing of a knowledge of
scientific geology on practical agriculture. One
and the same formation may, it is true, vary much
in character in different localities; owing then
to this cause, and to the existence of superficial
coverings, a geological map can only convey an
imperfect idea of the nature of the soils borne
by the respective formations.

To obtain a trustworthy map of soils, a
much closer knowledge than is at present
possessed of the “surface-geology” of the
country is requisite. As the Geological Survey
of the United Kingdom becomes further ad-
vanced, this knowledge will doubtless be ac-
quired, but even then it is questionable whether
it will easily pass into the possession of those
who are most interested in the soil, for the price
at present charged for the published records of
the Survey is so excessive as to be practically
prohibitive. The officers of the Survey include
men of world-wide fame as geologists, and for
the very useful and interesting results of their
zealons and arduous labours to be withheld from
the mass of the people, on account of the exorbitant
price of the publications, is a condition of things
which urgently needs alteration. The system
adopted in the United States of America is very
different to ours, and there can be but little doubt
that if the memoirs of the British Geological
Survey were published in a cheap form, and sold
at a trifle over cost price, the larger number
of copies sold would provide against any possible
loss.

W. F.
CHAPTER IX.

SOILS AND CLIMATES SUITABLE FOR DAIRYING.

General Nature of Soils Most Suitable for Dairy Farming—Main Point the Quality of Pasture—Mixed Husbandry Suitable for Medium Soils—Unsuitable Soils—Importance of Climatic Conditions—Why Draining alone often Deteriorates a Soil.

The practice and experience of ages have hitherto determined the conditions of soil and climate which are naturally best adapted to dairy-farming, and under which it can be conducted with the greatest success; and though modern science, recent inventions, improved appliances, draining, artificial shelter, and the greatly improved systems of farming which have become general in these later days have had the effect of extending the range and area of dairy-farming, the natural advantages of soil and climate, which are found in a high degree in certain districts, still remain in force, and ever will. Whatever improvements modern husbandry, aided by scientific research and experiment, have effected already, or may effect in the future, it will always remain true that the soils best adapted to dairying are those included in the terms "loamy," "marly," and "alluvial." The last are found in valleys, plains, and low-lying districts generally, and they are best adapted to dairy-farming simply because the best natural pastures are found on them. They are usually formed of particles of various rocky and vegetable substances, so blended that all the elements of plant-food are present in them in well-balanced proportion. All the mineral portions of soils have been derived from the decay and disintegration of rocks—a process that has been going slowly on through limitless ages, and is going on still; and as the value of a soil depends in a very large degree on these mineral constituents—their quality, kind, and variety—it follows that alluvial soils are most commonly the richest ones, because in the process of their formation and deposition, mainly by river action, a great variety of mineral fragments have been collected from the different strata through which the rivers forming them have run for ages.

Though tillage and dairy-farming districts are now less distinctly separated from each other than they formerly were, it is none the less true that where the finest natural pastures are there will the most profitable dairying be found. Thus the flats of Cheshire, the undulating plains of Leicestershire, the valleys and lowlands and plains of Derbyshire, Gloucestershire, and Somersetshire are, and ever will be, the natural homes of dairying in England. In these, and in portions of other counties having similar advantages, dairying has been carried on from the earliest, and will be to the latest, days of our civilisation; and it is to them in the future, as it has been in the past, that we naturally look for our best and largest supplies of milk, cheese, and butter. Still, dairy-farming is not by any means confined to these districts and soils, but is practised by many farmers in localities where the soil and climate are not too obviously adapted to tillage rather than to grass-land farming. It is, however, more or less disappointing to attempt dairy-farming on soils which, thin and light in their physical character, and situated in a climate which is dry at all times and subject to periodical droughts, are ill adapted to the growth of grasses of any kind, except the most temporary ones, which, for one year only, are taken in rotations.

But a mixed system of dairy and arable farming—the latter made to be subsidiary to the former—
on mixed and medium soils, which admit of and combine many of the good qualities of both systems, has long been practised in many parts of both England and Scotland; and this mixed practice, viewed in the light of its influence towards an increased production of milk, can hardly fail to continue spreading so long as the demand for country milk in our cities and towns, which has sprung up in so wonderful a manner in the past few years, remains in its present active state, and more especially so if the demand goes on increasing, of which there seems to exist more than a probability. Nay, the mixed practice has penetrated extensively into those districts, on the one hand, where tillage was aforetime held to be almost a sacrilegious encroachment on dairy-farming; and, on the other hand, it is already far from uncommon in many localities which, for generations past, have been almost wholly given up to the growth of cereals.

There are, however, some soils—to wit, our wettest and stiffest clays—on which a mixed system of arable and dairy farming cannot, with our present knowledge of the laws of husbandry, be easily or profitably carried out, and these are necessarily left in permanent pasture, the quality of which is always inferior, or are devoted wholly to wheat, beans, and other tillage crops suitable to stiff soils; they do not, with either pleasure or profit, admit of alternate tillage and semi-permanent pasture. And, on the other hand, there are certain fine-quality alluvial soils, so excellently adapted to permanent pasture and meadow, that it is pretty certain the plough, if used on them, would be one of the farmers' greatest enemies. Fine old-turf land, wherever found, is well worth preserving, and to reduce such land to arable cultivation would be a piece of agricultural wantonness which could not easily be too much condemned.

In the present day, when the area of permanent grass land is rapidly increasing in this country, and when tillage is decreasing in a corresponding degree, a school of agricultural writers have sprung up who cry out loudly against the tendency of the age in favour of grass, and who declare their belief that land under tillage will produce more food for the people than land under grass. This is true as to some kinds of land, and untrue as to others. The late Sir H. M. Thompson, of Kirby Hall, York, than whom we had no better authority as to the relative productiveness of grass and arable land, laid down the proposition:—"That our grass lands, if properly managed, would be easily able to meet the demand made upon them for an increased production of meat, even if the supply required were greatly in excess of the present rate of consumption." And, again:—"That money judiciously laid out in improving grass land makes a better return than money laid out on arable land." The fact of the matter is, there is truth in both these opposing opinions. The question is one of climate and kind of land. If the land is of a very light or of a very heavy character, and situated in a dry climate, it is best kept under arable cultivation, because it is not naturally adapted to be good grass land; but it would be a great mistake to plough up the deep loams and alluvial soils found in the valleys in so many parts of England, and especially so if they are in a moist climate, which is so essential to the growth of grass.

The farms on which are found the mixed system already mentioned are most commonly those which, in hilly districts, stretch from the valleys to the uplands, including a portion of both, the valleys being left in permanent grass, and the uplands being more or less devoted to tillage; those which are situated on loams varying from clayey to sandy; and those whose soils are on carboniferous or magnesian limestone, or on sandstone foundations, moderately deep, of good quality, and withal sound and firm. For dairy-farming especially, though also for other purposes, the best soils are the deep alluvial loams and drifts which, though situated in damp climates having a considerable rainfall, need little or no artificial draining—soils of considerable thickness, of an open texture, though firm, and withal sound and healthy. Very light, thin, dry soils, of any character whatever, are ill adapted to carry dairy-stock; of these the light blowing sands are the worst for that purpose, because, though sound enough and healthy, they do not and cannot be made to contain within themselves in sufficient quantity the nitrates and phosphates which, on the one hand, are necessary to the production of milk in paying quantities, and, on the other, to the production of bone and flesh in young stock. These soils are best given up wholly to tillage-farming and to sheep-husbandry.

There are, however, between the rich alluvial soils of the one part, and the thin sedentary ones of the other part, a great variety of soils which,
as they vary in richness and in substance, and as they are favourably or unfavourably situated with respect to climate and to water privileges, are more or less adapted to dairy-farming; and it is on these soils, in varying degree, that a mixed system of dairy and tillage farming will be found to yield the best returns. On such soils it may be accepted as a truism that the plough and the milk-pail are by no means opposed to each other, but rather that they are calculated to supplement each other's efficiency and profit. Cereals, interpersed with clovers, rye-grasses, and other forage crops, with roots and with other green crops for "soiling" purposes, including a due area of permanent pasture and meadow, are calculated to work so well hand in hand together, that dairy-farming, by their united aid, may be as profitably followed as it may under, perhaps, any conditions whatever. And in the present day, artificial manures and purchased feeding-stuffs enter so largely into all farm practice and economy that they greatly modify some of the natural conditions which have aforetime had paramount influence. But, in any case, the soils which, either with assistance or without it, will produce the largest and best crops of green food of one kind or another are far better adapted to dairying than are those whose speciality is the growth of cereals. Grass, either natural or artificial—that is, either permanent or temporary—is naturally of the first importance in dairy-farming; it is the foundation, in its capacity of green food in summer and of dry food in winter, on which the whole system of operations must in a greater or lesser degree be built. The question, then, to be asked and answered in selecting a farm for dairying as, "Are the soil and climate well adapted for the growth of grasses?" The one is almost as important as the other, for, however well adapted the soil itself may be, grasses will not flourish as they ought—more particularly in permanent pastures—if the climate is very hot and dry; but if the soil and climate both are well suited to the growth of permanent and rotation grasses, it follows that they are also well suited to the growth of any cultivated crops which may be regarded as valuable accessories to dairy-farming—to wit, cabbages, turnips, rape, clovers, oats, &c.

The climates best adapted to dairying are naturally and essentially those which best promote the growth of grasses and of green crops generally. In the varying states of the weather they are cool rather than cold, warm rather than hot, and damp as opposed to dry—mild, humid climates, in fact, of which there are many shades and degrees in these islands, all of them more or less suited to dairying; and these variations include the range of climate wherein dairy-farming can be practised to the greatest advantage. A mild, humid climate, with a copious rainfall supplying an abundance of water to pools and running streams, not too burningly hot in summer nor too bitterly cold in winter, supplies, in conjunction with suitable soils, the best conditions for profitable dairying. Intense heat in summer, and correspondingly intense cold in winter, are so far detrimental that the yield of milk and, consequently, of cheese and butter is considerably less than it is under temperate climatic conditions; and as man can only, by such means as the draining of wet land and the planting of forest-trees, modify within limits the climate of a given district, it becomes necessary that he should counteract it as far as possible by providing adequate summer and winter shelter for dairy-cattle. The latter is, of course, always the more necessary of the two, but summer shelter, in the months when the sun's rays are commonly very powerful, is a more valuable thing than we are in the habit of thinking.

It is not cruel only, but it is unprofitable, to expose milch-cows to extremes of heat in summer and of cold in winter. Shelter, especially against cold, stands in place of a given quantity of food which would otherwise be required. It is expedient to remember that one kind of food, having a definite composition, produces flesh and restores the waste of it which is continually going on in the animal system; the elements composing this kind are known under the names of albumen, fibrin, casein, gluten, &c., and are generally termed "albuminoids." Another kind, consisting of fats, oils, starch, sugar, gum, &c., supplies the materials by which the heat of the animal body is produced and sustained; and it follows that if animals are overmuch exposed to cold there is a corresponding waste of the latter class of food-elements.

The first limit is placed on dairying by climate, and the next by the character of the soil, coupled with the supply of water. If the climate is either too hot or too cold to keep cows
in a healthy, comfortable, and thriving condition, dairying cannot be carried on with a full measure of profit and success; and if the character of the soil is unsuitable, and there is a meagre supply of water, even though the climate be suitable, the objection of only partial success is sure to come in. It is true that dairying may be carried on outside these natural limits, but additional expense both of shelter and food will be incurred, and the profits will be correspondingly diminished; yet are there but few natural disadvantages which the ingenuity and energy of man cannot remove, or at all events greatly modify; the question of profit in so doing is another, but not a separate consideration.

The characteristics of a naturally good dairy district will generally be found to be a rolling, undulating, somewhat hilly surface; a soil not too heavy and damp, nor too light and dry, but deep, loamy, and moderately retentive of moisture; a sweet and nutritious herbage of natural grasses, that springs up early, and continues to grow vigorously late on in the season—a herbage whose vigorous and luxuriant growth tends to shorten winter at both ends; a rather low average temperature, with frequent showers rather than periodical droughts in summer; and a never-failing supply of good water in springs and running streams. There are many districts in the British Islands which answer well to this description.

Another limitation to dairying—but this depends on the foregoing ones—is the supply of food; and it is not quantity alone, but quality also, which must be taken into consideration. The pastures may be very full of grass, but if it is of a poor, sour, and inferior kind, dairy-cows will milk badly on it, the milk, cheese, and butter will be inferior, and the whole business will result in disappointment. But where the characteristics of a good dairy district are present, where soil, water, and climate are all that need be asked for, there is no description of farming that promises quite so good a prospect of remuneration as the dairy. So long as the production of milk continues to be one of the most profitable objects to which the English farmer can devote himself, the area of dairying will continue to extend into districts which have been hitherto deemed more or less unsuitable to it, and the natural causes which have so far confined it within certain limits will be removed or diminished. Where it is a question of climate, shelter will be provided; where of water, artificial supplies will be prepared; and where of soil, a system of tillage husbandry and extensive soiling with green crops will be the method practised.

It must not here be assumed that we consider nothing has been done already in this direction. Though the land in these islands is undoubtedly capable of producing very much more food for the people than it does produce at present, it is none the less true that many and great improvements, some of them of a very comprehensive character, have been made in the past half-century. A very large amount of draining, fencing, cultivation, reclaiming, planting, and general improvement has been done; and some districts have been completely changed in character by the process, as the inevitable "oldest inhabitant" can testify. But very much yet remains to be done. In many cases land has been not so much improved as prepared for improvement by such operations as draining, fencing, and planting. It is not enough to merely drain land, or fence or plant it. These operations, where necessary, are but the required foundations for subsequent improvements. If wet land, for instance, is merely drained, it will commonly do worse for the farmer—at all events for some years—than it did in its undrained state. By merely draining wet land you change the natural conditions under which the herbage has been for generations subsisting, and you do not provide the new conditions which the change has made necessary to the new class of herbage which, sooner or later, must take the place of the old. You have removed the elements which have mainly sustained the class of herbage you found there—herbage, of course, of a wretched kind, but suited to the then state of the land—and you have not provided the new elements which the altered herbage requires; hence there is, for the time, a falling off in quantity, and also in quality, of production. The grasses—coarse as they undoubtedly were and unprofitable—which the wet land produced must necessarily die out after the draining; but the new order of things, the fresh and different grasses which must take their place, require, unless properly assisted, some time to establish themselves. In land recently drained there is
commonly a large amount of acidity, which comes of decayed and decaying vegetable matter, and of the miret state in which the land has for so long a time remained; this acidity needs to be immediately neutralised by lime, in order that the better grasses may gain a root-hold, and the land generally requires a supply of nitrogen, phosphoric acid, and potash, that they may not only obtain a root-hold, but flourish as well.

Thus the draining of wet land is but the foundation of good husbandry, and such land is commonly very grateful for further improvements of a manurial character—improvements which may be expedited by the sowing of the seeds of such grasses as are calculated to flourish under the new conditions. In many cases it may not be absolutely necessary to sow such seeds, for the better grasses will commonly spring up spontaneously after a time, and the sooner if they are encouraged by judicious manuring; but you save time by sowing them, and time is money to the farmer, as to any one else. To a genuine lover of agriculture there is no pleasanter occupation than to create the marvellous transformation which comes to land of draining and subsequently improving it; while there is nothing appertaining to the farmer’s calling which is more productive of profit when judiciously carried out.

But on all wet soils no improvements can be made to pay until the primary one of draining has been done; and draining alone in many cases effects greater changes for good than any other single improvement that can be named. It completely changes the mechanical state of the soil, and greatly improves the climate. So long as water cannot percolate through the subsoil and pass away by subterranean ducts of one kind or another, through a stratum of sand or gravel, or through the crevices of rocks, the soil will be dense and plastic, and the climate cold and damp; and the water must needs pass away by one or both of two other means: over the surface of the land, or by evaporation, otherwise the district will become and remain a swamp. Now, to evaporate the 30 inches of rain which falls in a year in this part of the world, it has been calculated that a quantity of heat would be required equivalent to what would be produced by the combustion of ten times as many tons of coal per acre, so that an amazing volume of the sun’s heat is thus wasted before any of it can be applied to the warming of the soil and the growth of vegetation. It is of course true that in very few cases does the whole of the rain-water pass away by evaporation; yet such a large proportion of it does so pass away from our flat and low-lying undrained soils, that the summer’s sun is to a large extent thrown away. This fact alone is enough to show up the immense value and importance of draining, to which subject accordingly our next chapter will be devoted.
CHAPTER X.

Draining.


N all land that is not naturally dry and sound, artificial draining is the foundation of good husbandry; no other improvements can be effective without it, and no system of cultivation satisfactory. Hence it follows that all water-logged land, and also other land which, though perhaps not exactly water-logged, is still too wet, must be drained as a first operation. As a rule, the landlord will do this, charging the tenant a fair interest on the outlay; or, if the tenant does it, the landlord will charge a smaller rent for a given term of years, in consideration of his tenant's outlay. There are a variety of arrangements entered into between landlord and tenant as to the draining of land. In some instances the landlord provides draining-tiles, and the tenant lays them down, no subsequent claim for payment of either principal or interest being afterwards advanced by either party. In cases where a tenant has a lease for nineteen or twenty-one years, he will commonly do the draining at his own cost entirely, and will have been well repaid long before the end of the lease. But, as a rule, the most satisfactory system, the simplest, fairest, and most straightforward, is for the landlord to do the draining, charging the tenant an increase of rent equivalent to a fair interest on the outlay. It is always to the advantage of a tenant to take a farm whose draining is done, and pay a corresponding increase of rent, rather than one which needs it—no matter on what terms he will have it drained subsequently. In the former case the land is all in a fit state for work, and there is no time lost; in the latter there is a considerable delay, to say nothing of a large expenditure of work and money, before the land is fit for either cultivation or manuring.

Many kinds or systems of draining have been in vogue at different periods for hundreds and even thousands of years, and some have been peculiar to certain districts of this country. The ancient Romans were well acquainted with the art of draining, for their writers on agriculture—Cato, Palladius, Columella, and Pliny—all mention it, and some of them give very minute directions for the formation of drains and the direction in which they should be carried. The materials of which they were formed were stones, branches of trees, and even straw; and Palladius, in his De Aqva ductibus, mentions earthenware tubes that were smaller at one end so that they might fit into each other. It is probable, however, that these tubes, though they appear to have been in some respects similar to modern draining-pipes, were used rather for the conveyance of water than for draining land. So long ago as 1652, Captain Walter Bligh not only gave directions for the systematic drainage of watered meadows, bogs, and marshy ground, but founded his rules on principles which modern science and experience have shown to be eminently correct. In the latter part of last century a system of draining was introduced by Mr. Elkington, a Warwickshire farmer, which, however, dealt only with the water arising from springs, leaving untouched the greater evils arising from an excess of rain-water held in suspension by retentive soils; yet his system attracted so much attention that
the Government of the day presented him with £1,000 as a reward for describing the principles on which his practice was founded.

In various parts of England, particularly in Essex, a system of "land-ditching," as it was termed, had long been practised. Shallow drains were formed at short intervals, and filled in to a certain depth with brushwood, straw, and even weeds, over which the soil was replaced; this system, however, could only be practised in stiff soils, which would retain the form of the drain after the materials had decayed away, and even in these soils the drains were constantly liable to become useless. A somewhat similar system to this is "plug-draining" (Fig. 33), which is also confined to clay soils. Wooden plugs, of the size and shape required for the drain, and joined together by links of iron, are placed in the bottom of the newly-excavated drain; the clay is then pounded firmly over them, so as to retain its position, after which the plugs are drawn out, leaving a well-formed passage for the water; these drains, though more lasting than their prototypes, are but temporary. Many centuries ago drains were formed of broken stones (Fig. 34), indiscriminately thrown in, to a depth of some 6 to 12 inches, in the bottom of the drain, and the upper portion filled in as usual with soil; these drains, some of them of great age, are sometimes still found in working order, but as a rule they are liable to early stoppage, on account of collections of sediment among the stones. "Mole-draining" (Fig. 35) is performed by a plough specially constructed for the purpose, and pulled along either by steam or horse power, or by a windlass. That portion of the plough which forms the drain consists of an elongated piece of iron, termed a "mole" of circular form, pointed at the end, and placed at the bottom of a long and powerfully-formed coulter, which has a sharp cutting edge; on stiff clay pastures this method of draining remains effective for a long period, but on arable land it is liable to derangement. Open ditches of various kinds are probably the oldest method of draining, whilst pipe-drains are the most recent and, at the same time, the most lasting and satisfactory.

In mountainous districts, where a more expensive method of draining would not yield an adequate return on the outlay, and where the soil is of such a retentive nature that it remains, after rain, for some time saturated with water which needs removal, it is a common practice to cut out a system of open drains, called "sheep-drains," by means of which the surface-water is conveyed...
away from the hill-sides. Fig. 36 gives a general idea of their arrangement—the various drains at a leading into a main channel at b, and the whole falling into the nearest water-course at c. The cost of them is small. With a little scouring out at times they may be regarded as a permanent improvement, and they have the effect of reducing the ravages of the "rot," which is so common to sheep on wet land.

In draining bog land, the subsoil of which is too unstable and treacherous to carry either a tile or stone drain, it is the practice to cut out, first of all, a spit of some 18 inches, which is then left until the sides have become moderately dry and firm; then another spit; and so on until the drain is deep enough. During the cutting out of the drain, and the drying process which is the result of it, the surface of the bog sinks in proportion to the quantity of water that is withdrawn, and due allowance in depth of drain has to be made for this. Last of all, a spit, narrower than the others, leaving a shoulder on each side, is taken out of the bottom of the drain, and on the shoulders so left the first sod taken from the drain is placed, leaving beneath the opening represented in the annexed woodcut (Fig. 37). When bogs are deep this is the best and, in fact, only way of draining them successfully; but where they do not exceed 6 or 8 feet in depth, the best plan is to cut right through them to the firm subsoil on which they rest, and in this pipes will lie securely.

Not many tools are required in draining by a man who understands his work. Those figured in the annexed woodcut (Fig. 38) are all that are, as a rule, found necessary in ordinary draining. The broad spade is necessary for cutting off the first sod, and for clearing up the fragments left by the two narrower ones; the shorter of the two narrow ones is used next for the intermediate spit; and the long narrow one (No. 5) last of all. The two remaining implements are used for different purposes: No. 1 is for cleaning out the bottom of the drain after the spades have done their work, and No. 2 for placing the pipes in their bed.

Draining-tiles of various shapes and patterns have from time to time been introduced. Perhaps the earliest shape was the "horse-shoe" pipe (Ω); having no bottom, this pipe must either be placed on flat stones as a foundation, unless the subsoil were of a very firm and hard character, or its sides would gradually sink downwards.
and the drain be destroyed. This form of tile was afterwards improved by putting a sole or bottom to it; thus, $\Omega$; but the round tile (O) is now in general use, and it is very much better in all respects than either of the others; it is effectual in excluding vermin, the wash of the water through it constantly tends to carry all sediment away, it is much easier to lay down than they are, and it is always the "right side up."

The depth at which drain-pipes should be placed is a matter on which a great difference of opinion still exists. Whilst some advocate shallow, others pin their faith to very deep draining; thus drains vary, according to fancy, from $\frac{1}{2}$ to 5 and even 6 feet in depth. Much depends on the kind of land, whether it be free or retentive, the latter needing deeper drains than the former; but it would appear that less than 2$\frac{1}{2}$ feet is too shallow, whilst 4 or 4$\frac{1}{2}$ feet is deep enough in any kind of soil. The reason why drains must be deeper in clay soils than in any other kind lies in the fact that water percolates much more slowly and reluctantly through them; hence the drains must be deeper, in order that they may "draw" more effectually. In these soils it is not an uncommon practice to place a deep layer of broken stones or of friable soil next over the drain-pipes, thus increasing the efficacy of the drain. In some parts of the country, where stone is plentiful, and where drain-pipes are costly, it has been, and still is, the practice to make stone drains (Fig. 39). In this method the drains are cut out in the bottom much wider than in pipe-draining, so as to admit of two side-walls of stone, with a space between them, being built; these side-walls are built of narrow stones, to a height of 4 or 6 inches, and flat covering-stones, occupying the whole width of the drain, rest upon them. If well done, this method of draining may be taken to be almost as permanent as pipe-draining; its chief objection is that it does not exclude such vermin as rats and rabbits, and these mischievous animals soon choke up the drains by scratching soil into them. Pipe-drains, on the contrary, are not liable to derangement from such a cause, because vermin cannot get into them; and in the case of round pipes the wash of the water running down them tends to clear them of any sediment which may percolate into them from the soil above. In porous, free soils, a drain will lay dry fully 7 feet wide for each foot it is in depth; thus, drains 3 feet deep may be placed 21 feet apart. In a partially retentive soil it will drain 5 feet wide for each foot in depth—that is, drains 4 feet deep may be placed 20 feet apart. In a heavy clay soil, 4 feet drains should be placed about 16 feet apart—that is, 4 feet wide will be drained for each foot in depth.

The theory of under-draining may be considered under four heads—viz., First, the removal of surplus water from the soil by giving motion to it where it was previously stagnant; second, the mechanical or physical changes produced in the soil; third, the chemical influences brought to bear on the soil; and fourth, the improved temperature resulting to the soil.

The wetness of soils may be considered to be the result of one or other of three several causes:—First, rain-water falling directly on the surface surcharges the retentive soils by virtue of their retentive character, and free soils by virtue of their position, when they happen to rest on a substratum which does not admit of a free passage away of the overplus of water; second, springs which rise from underground channels to the surface, and, spreading over it, cause a considerable portion to be continually surcharged with water; and third, that wetness which, from higher lands near or distant, filters through free soils of a lower level, and rises to the surface some distance below, drowning more or less of it. The first cause operates wherever such soils are situated; the second generally on limestone formations, in the rocky substrata of which such subterranean channels are not uncommon, and the affluent stream may emerge in almost any position, even on the top of a hill, providing its source is on still higher lands; and the third in districts where the soils vary in character, but the effect is usually produced in valleys and lowlands with higher lands adjacent.

And wet soils may be classed in four divisions,
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viz., First, free soils in peculiar situations; second, clay soils; third, peaty soils; and fourth, mixed soils, consisting of different proportions of the other three.

Each kind of soil must have applied to it the appropriate method of drainage, and each cause of wetness demands a special mode of removal; but the atmosphere plays so important a part in bringing about the desired mechanical changes in clay soils, which are naturally retentive in character, that it is necessary to regard the art of draining them as distinctly different from that of draining free soils, which are not retentive. The surcharged free and peaty soils, being naturally free and percolative, are not wet, as clay soils are, from any inherent tendency that way, but simply so by accident of position, and they merely require an outlet for the water pent up within them to immediately change its character from stagnation to motion; to create, in fact, a kind of sub-irrigation which will benefit the roots of the plants, and a single drain in such soils will not uncommonly lay dry an astonishingly large area of surface; they do not need, as clay soils do, any modification of physical condition, because they are naturally free, open, and friable enough in texture, except that they are water-logged; nor does it always follow that they are too wet, but rather that the wetness they contain is stagnant where it needs to have motion.

It is not, indeed, easy that such soils should be too wet, providing only that the water in them has enough of motion; and the true art of draining them is less to deprive them of water than to keep the water in motion, for it is an easy matter to err on the side of over-draining them. When once drained to the proper degree they possess the same properties and characteristics as those which are naturally dry, and they are equally capable of absorption, the only difference being that in the case of the naturally high-and-dry soils the water in a dry time commonly sinks beyond the reach of the laws of evaporation, while in the case of the drained free soils the water, though sunk by the operation of draining some 3 feet below what its level was before, still remains within reach of the atmosphere, in which case evaporation is not totally suspended in the event of a dry summer; and it not uncommonly follows that the drained soils suffer less from drought than do some of the soils which are naturally dry.

Some naturally dry soils, however, suffer less than others during an unusually dry summer. Among these may be mentioned the soils on carboniferous or mountain-limestone formations. In these cases, as it would seem, the substratum of limestone, being of a damp and retentive character, possesses the faculty of supplying the soil above with some moisture from beneath, through the influence of evaporation or capillary attraction. But in the case of other naturally dry soils, which are so by virtue of their resting on a sandy or gravelly drift of considerable extent, the water finds no resting-place until it is far beneath and away from the surface, and utterly beyond the reach of evaporation. These soils suffer early and most seriously in a dry summer.

Clay soils, though made permeable by under-drainage, still retain their peculiar properties of retention, contraction, and expansion, which limit their capacity of absorption of water, and cause them to resist, in the absence of proper and deep draining and cultivation, the admission of falling rain. These soils hold in suspension the moisture they absorb, and give it out gradually to the drains, except in the case of heavy downpours of rain, when, after their own capacity of absorption and retention has been satisfied, they freely discharge the excess. They cannot be over-drained, nor can they be aerated too much; they lay in a store of water sufficient for their own use for a long time, and it is only by aeration that their retentive nature can be kept within bounds. All the draining in the world will not radically change the constituents of these soils—it merely modifies or alters their condition. But the more perfectly the aërating action of the drains influences the mass of soil between them, the quicker and more uniform is the percolation of the surplus water through the soil. The true practical object of draining these soils is not the mere removal of the surplus water in the readiest way which is possible by an artificial process, but embraces also the no less important principle of aëration of the soil which is drained. By giving motion to the water in a wet soil numberless vacuities are formed, and these must be filled with air. Thus is aëration accomplished; and by this agency soils are not only
improved in temperature by the admission of air into them, but they are chemically acted upon by it, to their great advantage. In free soils, which are not subject to expansion and contraction as clay soils are, and through which water percolates most evenly and freely, providing it has an outlet, it is easy to understand how simple a matter artificial drainage is; but even to those who have minutely watched the effects of drainage on clay soils it is not so easy to comprehend that air as well as water permeates them throughout. Their qualities of contraction and expansion, always at work as water is withdrawn and re-absorbed, are peculiarities which make them wholly different from free soils. In a free soil of even texture, rain-water is instantly absorbed, and percolates quickly and evenly through it; but not so in clays; and were it not a fact that natural sand and gravel veins, more or less minute, are interspersed through most clays, and that there are no clays that do not crack as they contract, the theory of those who believe in the impermeability of these soils would gain popularity. This theory, indeed, would hold good in respect of pure clays, but these are seldom found. But, in point of fact, no water can be withdrawn from clay soils, by drainage or evaporation, without causing contraction of the soils, and there can be no contraction of soils in a lateral direction without cracks and rents. The space previously occupied by water is then occupied by air, and these cracks and rents multiply and ramify in every direction to an extreme degree of minuteness, and thus the disintegration of a previously compact and plastic clay becomes year by year more nearly complete, and the soil throughout becomes more susceptible to the laws of gravitation of water downwards to the drains, and of capillary suction or attraction upwards to the surface. Some think that if clay soils are thoroughly drained they become as ductile and friable as free soils, but this is not the result, for they always retain their peculiar properties; but the microscope reveals that both the texture and colour of clay soils undergo a marked change in course of time after draining, and this is good evidence of the improvement which has taken place in their condition.

But the object of draining is not to create large cracks and rents down which rain-water may pass quickly to the drain-pipes, and if this were the result the water would have comparatively little fertilising effect on the land; but it is rather to cause the soil to become more porous and minutely divided, in order that the water passing through the soil shall wrap round every atom of it, and not merely wash the cracks and fissures in its journey downwards. In passing through a soil, water carries air along with it, and it is essential that the one as well as the other should be made to permeate the entire mass of soil, touching every particle of it. The striking effect which rain has on land in warm weather, and especially after a dry period, is by no means attributable to the water alone, but in no small degree to the warm air which is carried by the rain into the soil, and to the fertilising properties which the air contains. The increased or created porosity of a clay soil, which is brought about by draining, means the reducing of the soil to a finely-divided state, through every part of which the fine, tender, filamentary roots of plants may spread themselves in search of new stores of food.

In commencing to drain a farm it is expedient, first, to see that the water-courses are in good form, because they must receive the drainage water; and, next, that a plan be made which will embrace the whole of it, and not to lay one field after another dry, on plans possibly proper to each individual field, but not conceived with a view to the requirements of adjoining fields. This refers more particularly to main drains and outfalls. As a general rule, the drainage operations will commence in the lowest-situated field on the farm—the one nearest to the streamlet or river into which the outfalls of the main drains must be conducted; and it follows that the direction of these main drains, and their capacity, should be so laid out and calculated that they may serve for as many fields as come properly within their scope. It may happen in some cases—as where springs come to the surface and saturate a considerable area of land—that by draining an upper you lay dry a lower field; in such a case as this the draining of the lower field would be superfluous, and it would be advisable to try Elkington’s system of tapping the effluent waters of the spring at its outlet, to see whether or not it was necessary to drain the lower field at all; yet even in this case the main drain would have to pass up the lower in order to get to the upper field, and it would be advisable to
carry it in such direction, and to make it of such capacity, that, if afterwards found necessary, it would serve to convey away the drainage water of both lower and upper fields, as well as of any others that lie within its reach. In other cases it might be that the upper field is periodically swampy and wet on account of false springs, which only flow in winter or in a wet time at another period, and that the lower field is permanently wet on account of the real spring to which the upper one is only subject in a wet time. In such a case as this the tapping of the real spring in the lower field would lay the upper field dry without a spade being put in it. The deciding where to tap a spring; the determining which are the real and which are merely the overflow springs; the ascertaining whether the swampy wetness is owing to springs at all, or to the accident of a basin-like, impervious subsoil, or to percolation through a free subsoil from some higher level—these are matters which require considerable skill and experience, skill which books can only suggest, not give.

The direction of the main drains being decided on, the next thing is to lay out the minor drains in such a manner that undulations of surface may be taken due advantage of in the way of securing a free and easy descent of the water, and that, if necessary, certain depressed portions of the field may be laid dry by draining the higher portions adjoining. It must always be borne in mind that, in draining land whose surface is undulating or unlevel, special care must be taken that the bottom of each drain—the pipe-bed—has a uniform and even descent, whatever the surface may be, and that there are no depressions in it where the water could lodge, eventually decomposing the pipes and filling up the drain with sediment. No man ever wrote more wisely and wittily on agriculture than the late Chandos Wren Hoskyns, Esq., and we cannot here do better than quote from his "Chronicles of a Clay Farm," where he speaks of "the unaccountable and ever new difficulty of getting proper attention paid to the levelling of the bottom of a drain, and the laying of the tiles in that continuous line, where one single depression or irregularity, by collecting the water at that spot year after year, tends to the eventual stoppage of the whole drain, through two distinct causes—the softening of the foundation underneath, and the deposit of soil inside the tile from the water collected at the spot, and standing there after the rest has run off. Every depression, however slight, is constantly doing this mischief in every drain where the fall is but trifling; and if to the two consequences above mentioned we may add the decomposition of the tile itself by the action of the water long stagnant within it, we may deduce that every tile-drain laid with these imperfections in the finishing of the bottom has a tendency towards obliterating, out of all reasonable proportion with that of a well-burnt tile laid on a perfectly even inclination, which, humanly speaking, may be called a permanent thing. An open ditch, cut by the most skilful workman in the summer, affords the best illustration of this underground mischief. Nothing can look smoother and more even than the bottom, till that uncompromising test of accurate levels, the water, makes its appearance. All on a sudden the whole scene is changed, the eye-accredited level vanishes as if some earthquake had taken place; here there is a gravelly scours, along which the stream rushes in a thousand little angry-looking ripples; there it hangs, and looks as dull and heavy as if it had given up running at all as a useless waste of energy; in another place a few dead leaves or sticks, or a morsel of soil broken from the side, dams back the water for a considerable distance, occasioning a deposit of soil along the whole reach, greater in proportion to the quantity and the muddiness of the water detained. All this shows the paramount importance of perfect evenness in the bed on which the tiles are laid. The worst laid tile is the measure of the goodness and permanence of the whole drain, just as the weakest link of a chain is the measure of its strength."

Mr. J. C. Morton writes:—"The frequency of drains ought to depend not so much upon the quantity of rain-water which they have to remove (because that should be met rather by increasing their capacity than their frequency), but by the degree of facility given to its passage by the porosity or the stiffness of the soil and subsoil. On very stiff land they should be nearer to one another than on lighter soil. In the former the passage of the water is necessarily slow, and it should not have far to travel to a drain, or the land will remain sodden for an injuriously long time; and so, in case of wide
intervals, the middle of those intervals remains unbenefted.

"It appears to me that the only reasonable argument for the shallower draining of a stiff clay soil arises out of its greater richness in matters which the plant requires as food. There is no doubt that plants will make use of a very great depth of soil and subsoil if it be laid open to them; but, on the other hand, it is plain that a smaller depth of clay soil, with its larger quantity of internal surface—owing to the smallness of its particles, and its richer composition, too—will contain as much available food for plants as a much greater depth of sandy soil. It thus amounts to this, that the maximum which it is desirable, as a supply of food, to lay open to plants is smaller in clays than in sands; while the minimum depth—that at which the drains must be laid, if the capillary attraction of the soil for water is to be overcome at all—is greater in clays than in sands. The capillary attraction of the clayey soils is greatest; it is in them that water will be lifted highest from the level of the drains, and it is in them, therefore, that the drains must be laid lowest before any drainage at all is effected by them.

"On the arrangement of the drains upon the land, it would seem plain that, as we have already provided for the exit of spring-water, and as our object now is merely to remove from below the soil the water which falls upon its surface, the channels for that purpose should be placed as uniformly below as the water to be removed is supplied above. And this, as a general rule, does accordingly guide the practice of the drainer. Nevertheless, the structure of the subsoil does to some extent justify a departure from that uniform arrangement of drains which would at first sight seem to be justified by the uniform abundance of rain-water supplied and by the uniform luxuriance of vegetation desired. There is a propriety in placing drains at varying intervals within the soil, so as to meet those variations in the quantity of water accumulated there which have arisen from a varying structure, or even, I may add, from a varying surface of the land, notwithstanding the uniform supply of rain-water on its surface. Take a single field, and you often find that it is not altogether of uniform consistency to any considerable depth. No doubt, the portion acted on by tillage (the soil) is very different in its consistency from the subsoil; but this is a uniform want of uniformity. Go deeper, and you will find the subsoil, which also must be drained, varying in its consistency. It may be a sand or gravel of varying depth, lying on a floor of clay, which has been water-worn and furrowed before this gravelly subsoil was brought upon it; or it may be itself a clay, with porous partings or rocky beds here and there within it. All these things influence the passage of the water downwards; so that, while in a soil and subsoil of perfect uniformity it is plain that the absorbent points on which we depend for ensuring the percolation of the rain-water downwards ought to be perfectly equidistant, in an unequally constructed soil these absorbent points (or the drains which represent them) should be more frequent where the water naturally tends than where, after a shower, less of it will be found. Of course, as the object and the result of perfect cultivation is to bring about a uniform consistency to a greater depth than naturally exists, we ought not to accommodate our practice slavishly to the conditions which have arisen out of, or have been effected by, imperfect cultivation.

"In Fig. 40 there is the plan of the drains (1) parallel drains down the fall of the land; (2) drains for the removal of water from springs and from flats, or lateral slacks or furrows in the general slope; and (3) main drains, uniting at wells (5), and delivering
their water at final outfalls (a). In this figure the regular drainage of a homogeneous clay upon the gridiron system is hardly represented. In the map, however, (Fig. 41), in which the position of the drains on an estate on the Oolitic formation, drained under Mr. Bailey Denton's direction, is given in detail, the uniform parallel drains on the more level fields upon the Oxford clay are fully represented at the foot of the map. The occasional drains, intended for the removal of spring-water, and the lateral drains, rendered necessary by the configuration of the land, and intended for the removal of water lodging in slacks upon the surface, are also recognizable in some of the middle fields. There, too, and elsewhere, the less frequent—generally parallel—drains needed for the tapping of the more porous water-bearing strata are to be observed. Too great a stress cannot be laid on the necessity of such a plan of executed drainage—of course, on a larger scale than is adopted in Fig. 41—being preserved. There are many instances in proof of this, where large sums of money have been lost entirely for want of a record of the operation. The tenants have changed, and the outfalls have been ruined and have disappeared.

Discharge of Drains, compared with the Rainfall.

To ascertain the law which governs this matter, Mr. J. Bailey Denton, in the year 1856–7, caused observations of rainfall and discharge from drains to be taken during the months of October, November, December, January, February, March, April, and May. The area experimented upon consisted of two kinds of soil—first, soil of a mixed nature, consisting of clay, gravel, and sand, and second, a very stiff clay, considered hard and almost impenetrable. The mixed soil was drained by occasional and wide parallel drains sufficient to discharge the rainfall and deep enough to relieve the pressure of subterranean water. The clay soil was drained uniformly by a parallel system.
of drains, 4 feet deep and 25 to 27 feet apart. The total cost of draining the 800 acres included in the area experimented on was £5,537 10s. The discharge from the open soils was more regular and continuous than that from the clays, probably because of the greater distance apart of the drains.

The rainfall per acre was 227,240 gallons, and the discharge per acre on the mixed soil was 160,920 gallons, or about 71 per cent. of the rainfall; on the clay soil it was 59,836 gallons, or about 21 per cent. of the rainfall. The reason why clay discharges less than loam is doubtless found in the fact that it has greater power of retaining water by capillary attraction. Thus, Professor Schubler, of Tübingen, found that 100 lbs. of dry soil would retain the following amount of water that would not flow off:

Sand ..... 23 lbs.
Leaney soil ..... 40 lbs.
Clay loam ..... 50 lbs.
Pure clay ..... 70 lbs.

Observations conducted by Mr. John Dickinson for eight years gave the following mean values of the discharge as compared with the rainfall:—October to March, 75.5 per cent.; April to September, 7.1 per cent.; average 42.4 per cent. Mr. Tracey, in 1849, made some experiments in regard to the drainage of certain valleys near Boston, and concludes that the discharge varies from 45 to 44 per cent. of the rainfall.

Computation of Table for Drainage.

Tables of rainfall tell us that showers exceeding 1 inch are rare, but that about one-fourth of our rain falls in heavy showers. From that it is safe to conclude that if the drains are capable of conveying away the water that reaches them during the twenty-four hours next after a rainfall of 1 inch, little or no surface-water will remain on the land during any portion of the year.

The amount of discharge, as compared with the rainfall, depends upon so many conditions that it cannot be accurately stated; but it probably will, during the next twenty-four hours, seldom or never exceed 50 per cent. of the rainfall, under any conditions. In order to produce thorough drainage—that is, to so drain land that surface-water shall not exist on it on an average longer than six or eight hours after the rainfall—it is necessary to assume that the capacity of the drains should be sufficient to carry off, during twenty-four hours, one-half the water that fell the previous twenty-four hours. The probability of the rainfall in any day exceeding 1 inch is so slight that we shall be safe in assuming the greatest ordinary rainfall to be 1 inch in twenty-four hours, and the necessary carrying capacity of the drains ½ inch for the same time. One inch of rainfall produces 3,630 cubic feet per acre; consequently, our drains, to produce under all conditions thorough drainage, should be able to convey 1,815 cubic feet of water for each acre drained.

For ordinary farm drainage, where the drains are simply to run under the low places on the surface of the fields, the water will be longer in reaching the drains, and consequently the area drained by a given-sized tile may be increased with perfectly satisfactory results. Again, if flooding is of little moment for a few days at a time, it may receive another corresponding increase. The areas in the following table should be doubled for ordinary farm drainage, but they must be changed with caution if thorough drainage, such as a gardener would need, is desired.

**Table for Size of Tile of Main Drain.**

<table>
<thead>
<tr>
<th>Rate of Inclination</th>
<th>2-inch Tile (Average Discharge)</th>
<th>3-inch Tile</th>
<th>4-inch Tile</th>
<th>6-inch Tile</th>
<th>8-inch Tile</th>
<th>10-inch Pipe</th>
<th>12-inch Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 foot in 20</td>
<td>6.7</td>
<td>18.6</td>
<td>26.8</td>
<td>7.4</td>
<td>15.0</td>
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To afford a simple rule for those who wish to construct drains merely through the low places of a farm, and who do not possess means of ascertaining the fall, the following will probably be sufficiently accurate:—On the average, the fall
usually secured is about 1 in 200, and for ordinary farm drainage, doubling the results given in the table, we find that a drain of 2-inch tile will drain 4 acres; 3-inch tile will drain 11 acres; 4-inch tile will drain 17 acres; 6-inch tile will drain 45 acres; 8-inch tile will drain 96 acres; which rule does not differ essentially from the one given by Waring in his work on "Farm Drainage." The above rule is for casual, not thorough drainage.

**Fall of the Drain.**

From what has already been said in reference to the capacity of a drain, it is seen that the greater the fall, the greater is the amount of water that will pass through in a given time, other things being equal. For this reason the fall should be as great as possible, within certain limits. It is possible to have drains so steep that the water, instead of entering the drain at the joint, will run along the outside of the tile, and finally undermine and destroy the drain; this danger is to be anticipated only for large drains, where there is a great deal of water, and never for small drains, which serve only as feeders. The limits of steepness for main drains that convey much water we may put at from 1 in 10 to 1 in 30, depending on the tenacity of the soil. The least gradient admissible depends entirely upon the mechanical execution. Drains cannot be laid like water-pipes, alternately descending and ascending, but they must descend continuously from their commencement to their outlet. If laid with any portion ascending from the commencement, even though that portion may not rise above the head, the drains, not being tight, will let out at their joints much of the water from above them, the ground at that point being constantly wet, and the objects for which the drains were laid will entirely be destroyed. It is not material that uniformity of descent be preserved, but although it makes little difference how much the grade changes, it is absolutely necessary that it always changes in the same manner. That is, as we leave the outlet we must continually go up, though we may ascend at times much faster than at others. Now, the greater the ascent in a given distance, the less danger is there of giving any portion of the drain an inclination in the wrong direction; but if the ascent is small, any mistake of this kind becomes exceedingly difficult to detect. Probably any one could see that an inclination of 1 in 50 was not a level line, but an inclination of 1 in 500 is quite a different thing, and there are few persons that could detect the difference from a level line, or even tell which end was the highest. Great care is necessary to keep a continual descent or ascent, whichever the case may be; and with a less inclination than 1 in 500, the difficulty becomes so great that, except in cases of extreme necessity, it should not be resorted to.

**The Location of Drains.**

For the economical construction of drains nothing is more important than their location, compared with the land they are expected to drain; for a bad location can never be remedied. No definite rules can be laid down for the location of drains in all cases. Usually the outlet must be at the lowest point in the area to be drained, and from this the main drain must be laid up the depressions or valleys, and from the main, at various points, branch drains or laterals are to be laid. That is, the main drains usually follow the lowest portions of the field, and receive the feeders or laterals, which minor drains make a right angle with the main drain, and run from it directly up the slopes to be drained. This method of running the laterals is now universally conceded to give the best results, though in the early days of drainage a considerable number of agriculturists advocated and practised the method of laying their minor drains obliquely across the slopes. After the drain is constructed, the outlet (Fig. 42) should be built so as to be a permanent record of the existence of the drain. It is best to build, at right angles to the direction of the drain, a stone wall laid in masonry, and with foundations below the reach of frost. Through this stone wall should pass the last or outlet tile of the drain; this tile should have a diameter 1 inch greater than the remainder of the drain, so that its end may be
granted to keep out vermin without obstructing the flow of water in the remainder of the drain.

The depth at which the generality of soils can be most profitably and effectually drained varies from 3 to 4 feet; the more clayey the soil the deeper the drain, until 4 feet is reached. The deeper the drain, and the more it "draws" the water; hence free soils need shallower draining. At the same time, 4-feet drains will as a rule be found deep enough for the stiffest clays, and it is better to have them nearer together than to deepen them.

The cost of draining, including pipes and carriage thereon, will vary according to depth of drain, diameter of pipe, and cost of labour in the district. The following statements are for actual draining done:

1.—Depth, 3 feet; width apart, 19 feet.
   93 roods, at 3d. per rood of 8 yards, 3 2 9
   cutting out and filling in of drains 3 9 0
   2,300 pipes, 2½ inch diameter, at 30s. per 1,000 0 10 0
   Carriage on pipes 0 10 0
   Total cost per acre 3 8 9

2.—Depth, 4 feet; width apart, 24 feet.
   82 roods, at 3½. 2d. per rood of 8 yards 4 15 8
   2,000 pipes, 3 inch, at 40s. per 1,000 4 0 0
   Carriage on pipes 0 0 0
   Total cost per acre 49 5 8

The foregoing statements of cost are for work effectually done, in a district where wages are higher than in most parts of England.

If the water-level in wet land be lowered by draining to a depth at which the water may, without injury to the land, be allowed to remain stagnant—lowered, in the case of free soils, by as few drains as are necessary to simply give motion to all water in the soil above the level at which they are placed, and in the case of clay soils by as many drains as are found necessary not only to drain but to thoroughly aerate a like mass of soil—then the mechanical improvements secured are ample for all agricultural purposes. In the first place, the land becomes capable, if its form and slope admit of it, of absorbing the rain that falls upon its surface; in the second, the improvement of condition and temperature, and the disintegration of the hitherto dense and compact mass of the soil, are secured by the infiltration of rain-water through it, and by the admission of air which accompanies the water; in the third, the passage of the rain-water vertically and evenly through the soil, moistening as it goes every particle of earth, is obtained; and, in the fourth, the rising to the surface of the diffuent water, coming through free soils from a higher level, is prevented, and the effluent water of springs is confined within safe limits. Following in the wake of these mechanical improvements in the soil are chemical effects, which produce an increased fertility, and a better adaptation of the land not only to tillage operations, but also to the growth of all kinds of agricultural plants.

Every one will have noticed how poorly, if at all, cultivated plants and trees thrive where stagnant water abounds in the soil, and how the land, under such circumstances, is given up to the growth of ill-conditioned aquatic plants, which, in an agricultural sense, are wholly worthless. To cultivate such land profitably is out of the question until it is drained. Air beneath the surface is as essential as air above it to the growth of all kinds of vegetation which are of value to the farmer, and we may therefore understand how necessary it is to drain all wet soils in order to make them permeable, free, and open. This is necessary, not only because the roots of plants will not penetrate into a soil which is a constant quagmire on account of stagnant water, but also because there are in such soils both organic and inorganic substances which require to be changed by the action of atmospheric gases before they can become available as food to vegetation. For every inch in depth of such soil that we lay dry by draining, we give to vegetation nearly 100 tons of additional earth per acre to feed upon; we correct the influence of the noxious constituents which are always present in such soils; and we introduce into the deepened staple of useful earth those fertilising elements which are always associated with fresh air and moving water.

The draining of land that is wet because of an impervious subsoil that will not admit of the percolation downwards of the rain-water that falls on the surface is a simple matter enough; but when it is wet on account of effluent or diffuent water, either of which rises to the surface from beneath, the task is one which involves more nicety. Mr. Mechi, of Tiptree, to whom
agriculture is very greatly indebted, says:—"I consider it most important that, for spring-water" (effluent water) "rising from below, draining should never be less than 4 feet from the surface, in certain cases even deeper than that, so that capillarity should not counterbalance gravity. In pure, stiff clays, free from spring water, I found that the land has become gradually free from stagnant water by draining at 4 feet deep, and I have always there had good crops. I know a case near a river where a wet field adjoining the river was drained 4 feet deep to take off the 'winter water;' but in summer the drains were occasionally stopped to cause the under water to 'head back' until the surface soil was moistened, and then the drain-mouth was opened again. The result was marvellous in the increase of the grass crop. It proved that while a constant wetness of the soil was most injurious, an occasional supply was most beneficial and profitable." The surcharging of the soil with water, by stopping the mouths of the drains, had a twofold effect—the moistening of the too dry soil, and, as the water sank again, the bringing by suction of a volume of fresh warm air into the soil.

Forest and hedgerow trees frequently do great mischief to drains; their roots, with unerring instinct, find their way down to the drains, in search of moisture, in a dry time, and they will go long distances in search of it; once arrived there, the roots send out an innumerable quantity of tendrils, whose object is to absorb as much water as possible and transmit it upwards to the tree. These rootlets or tendrils form a complete mass in course of time, and stop up the drain as effectually as if a fleece of wool had been crammed into it. Tree-roots also find crevices in rocks in the same manner, sometimes a considerable distance from the surface; and it not uncommonly happens that they divert the course of a small current of water which they may find there, in some cases causing it to come out at the surface—a thing it would never have done without their interference. In an instance of this kind they make land wet which would not otherwise have been so, and draining it then becomes necessary. In the case of drains which are stopped up by the roots, the only thing to be done is to open the drain, cut the offending roots clear away, replace the drain, and make it as secure as possible, with the aid of large flat stones well mortared together, against a second invasion. Anyway, trees are not an unmixed good on land that is drained.

In the draining of land we are too commonly in the habit of regarding the earth as a compact mass of inert and unsympathetic matter. But this is a great mistake, for in some instances the subsoil has shown extreme sensibility to the action of the atmosphere after draining, and the extent to which air will penetrate a drained free soil is not yet determined; but the retentive and expanding properties of clay soils do impose a limit. A singular phenomenon has frequently been noticed, which demonstrates in a striking manner the fact that soil is not so inert and unsympathetic as we have been in the habit of considering it. Drains previously dry have been known at times to re-commence discharging a perceptible stream of water without any rain falling on the surface of the land; this occurs sometimes in a dry season, when the barometer is falling and the atmosphere is dense, and they will cease again to run water if the barometer begins to rise and the air to lighten. Facts of this kind will help us to understand the effect of aération and the circulation of water in disintegrating, comminuting, and warming a soil which is either naturally or artificially drained; and we must bear in mind a common law of hydrostatics, which rules that water in draining can only be put in motion by forming a vacuum beneath and by the admission of air to the surface, and that no water can be withdrawn from the soil without its place being taken up either by air or by a fresh supply of water; in any case, motion is given to the water in the soil, and all the other benefits quickly follow. The withdrawal of water causes air to enter the soil at all its numberless pores, and to permeate it thoroughly as great a depth as circumstances admit of; and, as air contains besides oxygen, which is essential to vegetable vitality, and vaporised moisture, which serves to maintain that vitality in dry seasons, a variety of fertilising substances, to wit, ammonia and carbic acid, which have been exhaled from the sea and from decomposing animals and vegetables, and such as come from the breath of living creatures, from combustion, and other causes, it must be borne in mind that to introduce plenty of air
into a soil from which it was previously excluded is to perform one of the most important, as it is one of the most beneficial, acts that can be done in aid of agricultural progress. It will be clearly perceived how true is the saying that "draining is the foundation of agriculture."

The upward action of water from the level of the drains, by capillary attraction, is an important factor in considering the effects of under-draining; for it is said to be of sufficient force in some soils to almost counterbalance gravitation. It is in clay soils that capillary attraction is most powerful. Some thoroughly practical men go so far as to say that draining increases the volume of evaporation by which moisture is exhaled from the soil; but as an increase of evaporation would inevitably have the effect of making the land colder, and as this is not the effect which is popularly understood to follow draining, and is not by any means the result which draining is intended to produce, we may venture to doubt the correctness of the inference. The power of soils to absorb and retain water does not, however, in any way interfere with the required action of drainage, nor is the quantity of water which a soil has the power to soak up necessarily the measure of the height to which the water will rise by capillary attraction from the level to which the drains have reduced it. It is, however, true that, among the other benefits which draining secures to land, the prevention of excessive evaporation, by means of which wet land is continually kept at a low temperature, is not the smallest. And this evaporation is most active in hot weather, so that the land is deprived of the warmth which is indispensable to vegetation in the very time when that warmth would be of the greatest service and when it is most available. The only way by which stagnant water can escape from land is by evaporation, or, in other words, by exhalation into vapour; and, though perhaps not equally well known, it is equally true that heat is dispersed or becomes latent by the conversion of water into vapour. It is in obedience to this law that human beings catch cold when their clothes are wet through and they expose themselves to the air; evaporation immediately commences, the system is chilled, and a cold is the result; and precisely the same evils play on a wet soil which is exposed to sun and wind. The cooling effect is well illustrated by swathing a bottle of water in wet flannel and placing it out in the sun: if the flannel is kept moist, the more will be the evaporation and the colder will be the water inside the bottle. To reduce the effect of evaporation to tangible figures, it may be stated that in the process of carrying off a gallon of water by evaporation the soil is deprived of as much heat —heat, remember, that is indispensable to vegetation—as would raise 5½ gallons of water from freezing to boiling point; it is not surprising, therefore, that everywhere wet land is known to be cold land. Heat, again, will pass only a very short distance downwards in water, because water is a bad heat-conductor, and if a soil is saturated with water, the warmth of the atmosphere cannot penetrate it.

Rain is of immense benefit to land in summer, but on retentive soils, or on soils which are wet from other causes, the rainfall requires to be kept under control by an efficient system of under-draining, otherwise it will do more harm than good. The part played by dew and atmospheric moisture in underground circulation cannot be precisely stated, but it may safely be taken for granted that when air highly charged by moisture is caused to pass through the soil, it must give up to vegetation a large portion of its moisture. In his work on "Farm Drainage," published in New York, Judge French says:—

"Dew is one of the most ordinary forms in which moisture is deposited in and upon the soil in its natural conditions. The absorbent power of artificially dried soils seems to depend much upon their chemical constitution. The soil absorbs moisture from the air, when both are of the same temperature, the amount absorbed depending also upon the physical condition of the soil and upon the comparative moisture of the soil and atmosphere.

"The deposition of dew results from a different law. All bodies throw off, at all times, heat by radiation, as it is termed. In the daytime the sun's rays warm the earth and the air is heated by it, and that nearest the surface is heated most. Evaporation is constantly going on from the earth and water, and loads the air with vapour, and the warmer the air the more vapour it will hold.

"When the sun goes down, the earth still
continues to throw off heat by radiation, and soon becomes cooler than the air, unless the same amount of heat be returned from other surfaces. Becoming cooler than the air, the soil or plants cool the air which comes in contact with them; and thus cooled to a certain point, the air cannot hold all the vapour which it absorbed while warmer, and part of it is deposited upon the soil, plant, or other cool surface. This is dew; and the temperature at which the air is saturated with vapour is called the dew-point. If saturated at a given temperature with vapour, the air, when cooled below this point, must part with a portion of the vapour in some way; in the form of rain or mist if in the air; in the form of dew if on the surface of the earth.

"If, however, other surfaces at night radiate as much heat back to the earth as it throws off, the surface of the earth is not thus cooled, and there is no dew. Clouds radiate heat to the earth, and, therefore, there is less dew in cloudy than in clear nights. If the temperature of the earth sinks below the freezing-point, the aqueous vapour is frozen, and is then called hoarfrost. Dew, then, is an effect, not a cause, of cold. It imparts warmth, because it can be deposited only on objects cooler than itself."

Some practical men think it necessary to give a direct admission of air to drains by connecting the upper ends of minor drains with the surface of the land, and they do this by putting two or three of the ordinary pipes in a perpendicular or in a sloping position. It is true that no, or very little, harm is done by this method, but it is a superfluous thing to do; for if the soil was not easily permeable by air after draining, the draining itself could not possibly do any good, and if soils were air-tight they would also be water-tight. It is also supposed that water enters the drain-pipes only at the joints; but if this were true, the pipes would not be nearly as effective as they are. The fact is that the water soaks slowly through the pipes over their entire surface; if this were not the case it would be unnecessary to glaze sanitary earthenware pipes, and if these were left unglazed they would leak water all along, except at the glazed sockets.

All practical men agree in this—if draining is worth doing at all it is worth doing well. We have known people try to economise money by placing the drains a yard or two farther apart than they ought to be, with the result of having afterwards to put in additional drains midway between the first, because the land was found to be only partially drained; and these supplementary drains make the number greater than there was at first any necessity for, while they have caused an extra outlay of money, which, being unnecessary, might have been avoided if at the onset the drains had been properly and not parsimoniously laid out. Some err in not putting drains deep enough, especially in heavy clay soils; and instances are on record where shallow drains have had to be taken up to be replaced by deeper ones. There are, however, some clay subsoils so dense and impervious that deep draining has little effect on them; and if the excavated subsoil is replaced over the pipes it settles down into a compact mass, through which water passes very slowly or not at all. These drains should be filled in over the pipes, not with the dense subsoil that was taken out, but with loose stones, or with free soil, to within one foot of the surface. It is better to drain ten acres perfectly than fifteen imperfectly, and to leave the five until they can be properly attended to.
CHAPTER XI.

MANURING AND TREATMENT OF THE SOIL ON DAIRY-FARMS.


The exhaustion of soils is a process with whose effect every farmer is familiar, though but few farmers are familiar with the details of the method by which the effect is produced. It is evident that, with an exhaustive system of cropping, or from want of that periodical assistance which the bulk of land requires, soils gradually become poorer, until at length they cease to yield a profitable return. It is not only on arable land or on meadow land which by manuring. The following tables, by Mr. J. Jekyll, of Louth, show at a glance the composition of fertile and of barren soils on the one hand, and on the other the percentage of silica, lime, and potash which are found in the ash of various cultivated plants.

In respect of these, Mr. Jekyll remarks:—"One kind of crop requires a heavy amount of soluble silica, while some other crop requires little or none of that compound. By taking a crop not requiring silica, time is given for its accumulation in the soil. Some plants rob the land of its nitrogen, others increase it.

### Composition of Fertile and of Barren Soils.

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<th>Good Loam</th>
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<tr>
<td>Sulphuric acid</td>
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<td>Lime</td>
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### Ash of Some Cultivated Plants.

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<th>Sulfates of Lime and Magnesia</th>
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<td>34:00</td>
<td>62:00</td>
<td></td>
</tr>
<tr>
<td>Wheat-straw</td>
<td>22:00</td>
<td>61:00</td>
<td></td>
</tr>
<tr>
<td>Barley-straw with corn</td>
<td>19:00</td>
<td>55:03</td>
<td></td>
</tr>
<tr>
<td>Rye-straw</td>
<td>18:03</td>
<td>63:89</td>
<td></td>
</tr>
<tr>
<td>Lime plants:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pea-straw</td>
<td>27:82</td>
<td>63:74</td>
<td>7:81</td>
</tr>
<tr>
<td>Bean-straw</td>
<td>31:00</td>
<td>61:51</td>
<td>6:78</td>
</tr>
<tr>
<td>Clover</td>
<td>39:20</td>
<td>56:00</td>
<td>4:20</td>
</tr>
<tr>
<td>Potato-harlm</td>
<td>4:20</td>
<td>59:10</td>
<td>36:10</td>
</tr>
<tr>
<td>Potash plants:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turnips</td>
<td>81:00</td>
<td>18:10</td>
<td></td>
</tr>
<tr>
<td>Beetroot</td>
<td>88:00</td>
<td>12:00</td>
<td></td>
</tr>
<tr>
<td>Potato-tubers</td>
<td>85:81</td>
<td>14:19</td>
<td></td>
</tr>
</tbody>
</table>

is not adequately manured that this exhaustion occurs, but the great bulk of pasture land, especially that which is depastured by young stock, also becomes impoverished in course of time, unless it is periodically restored to condition suitable for cultivation again.
One class of agricultural plants requires for its well-being an excess of silica; a second an excess of the salts of lime and magnesia; while a third will not flourish without an extra amount of the salts of the alkalies. Every sack of corn, pound of beef, mutton, or bone, truss of hay or straw, carried off from the farm, reduces the productive capabilities of that land by exactly the amount of nitrogen, phosphorus, potash, &c., which has been extracted from the soil by those agricultural productions; and every load of manu-
rial matter returned to the farm restores productiveness in exact proportion to the amount of these chemical substances which it contains. It matters not from what source is the nitrogen, lime, potash, or phosphorus, so long as these substances are in an available form, or readily become so in the soil; but they must be returned to the soil, or sterility will sooner or later overtake the best land ever cropped."

Professor Anderson writes:—"In order that we may have definite data to go upon, let us, in the first instance, consider the cause of the exhaustion of soil and the different modes in which it may be brought about. It is to be observed, then, that all plants require for their growth an adequate supply of carbonic acid, ammonia, nitric acid, sulphuric acid, chlorine, and silicas, which are all indispensable, although some of them are required in larger quantities than others. They are divisible into two classes—one including the first four substances, which, being all either gaseous or volatile, are found not only in the soil but in the atmosphere; the remainder are confined, at least in quantity, to the soil. These two great classes are usually distinguished as the organic and inorganic elements of the plant-food, by which it is to be understood that the former, though they are in a chemical sense inorganic, are the source of the organic or combustible part of the plant, while the latter supply the constituents of the ash. They may also, however, and with more advantage, be described as the movable and the immovable elements of the plant, because the former, existing in the air, are conveyed backwards and forwards by the wind; while the latter, being fixed in the soil, cannot be removed and replaced by ordinary natural causes. It is sufficiently obvious that if a crop be grown for a succession of years, and be systematically removed from the soil, the quantity of these substances must be gradually diminished, and if this course be persisted in, the soil must eventually become incapable of supporting the life of plants. The period at which this will occur must necessarily differ very greatly in different soils, and depend on the quantity of available plant-food; for the air, constantly shifting, is always prepared to yield a practically inexhaustible supply of the movable elements, so that the exhaustion must in all cases be due to the removal of the fixed or mineral substances; and, consequently, when it is wished to restore to the soil its power of supporting vegetation, it is not necessary to add to it all the elements of the plant, but it will suffice to give those which it cannot otherwise obtain—that is, the fixed substances—and leave it entirely to depend on the air for a supply of those which can be derived from it. We do not mean here to discuss whether this method would reproduce the highest degree of fertility, but only to point out that a soil thus treated would regain, more or less completely, the power of supporting plant life, of which it would have been deprived by the supposed system of management.

"In point of fact, then, the complete ex-
haustion of a soil in its natural state must always be due to the want of mineral matters, because, practically, no method of treatment can deprive it of those which the air supplies. As far, also, as these matters are concerned, it must be ob-
vious that they would rarely, if ever, be exhausted simultaneously, but that in general, some one substance being present in relatively small pro-
portion, the soil becomes incapable of supporting the life of plants when it is entirely withdrawn, although there may be still an abundant supply of all the others. If, for example, a soil con-
tain a sufficient quantity of potash to yield, say, twenty full crops of wheat, and of the other con-
stituent parts of that plant enough to yield forty crops, the excess of the latter would be unavailing, and the soil would be exhausted by twenty crops. If now we added to such a soil a supply of potash, it would again become capable of produc-
ing a crop, and would go on doing so until some other substance had been entirely consumed, when it also would have to be added; and so on, until all being removed, the soil would at length end in a complete infertility, which would only be retarded, and not be prevented, by this mode
of operation. To maintain during an unlimited series of years a uniform amount of produce, it would be necessary to add, year by year, a quantity of the elements of plant-food equal to that which the crop removes; and the necessity for doing this is so obvious that it cannot be controverted, and it may safely be asserted that it is a point on which all scientific and practical men are entirely at one.

"This being the principle on which the exhaustion of the soil is to be avoided, we have only to carry it out a little further to draw the conclusion that if we add to it a larger quantity of the elements of plant-food than is requisite to replace what has been removed, its productive capacity must be increased, and it will become capable of yielding a larger crop than it did in its original state. This is, in fact, the foundation of the use of manures; and if it were possible to carry out these theoretical principles in their integrity, the soil might be made to produce, during an unlimited succession of years, a crop greatly exceeding anything known in actual practice. Practically, however, there is a limit which cannot be exceeded, and this depends upon several circumstances. In the first place, the effect of a manure is not due to its composition alone, but is dependent, to no small extent, upon the different constituents existing in it in a state in which they are readily available to the plant. And, in the second place, the composition of manures is not entirely under our control. Although farm-yard manure, which is, and will always continue to be, the foundation of agricultural practice, is a mixture containing all the elements of plant-food, and generally in proportions not very far removed from those in which the plant requires them, yet it is impossible not to recognise the fact that differences occur in it, and that part of its constituents are not directly available to the plant, but only become so by virtue of certain changes which occur in it after it has been deposited in the soil, and do not necessarily proceed exactly as we could desire. It is a familiar fact that, owing to these decompositions proceeding in an imperfect manner, manure may, and often does, accumulate in the soil, and remains there in an inert and dormant condition. If from this or any other circumstances the supply of one or more of the substances required by the plant is deficient in the manure, then either the crop is thereby limited, or it is forced to derive the requisite supply of that substance from the natural resources of the soil itself. In fact, a manure which is deficient in any one element of the crop does not improve the soil; and though it may produce a greatly increased crop, its effect is merely temporary, and eventually it only causes its more rapid exhaustion. In the case of farm-yard manure, which necessarily contains all the elements of plants, this is, of course, less likely to occur than in special manures, containing only one or two of these substances. Thus, for example, the opposite effect would be conspicuously seen in the case of a soil manured during a series of years with a salt of ammonia. In that case, though the crop might be greatly increased in any one year, the total amount of produce would be no larger than it would have been without that addition, but it would have been obtained within a shorter period of time.

"The general conclusion to which all these considerations lead is, that we can only maintain the fertility of the soil by returning to it all the substances which the crop removes, and that we can increase it by applying these in larger quantity; but when the mixture supplied is deficient in any one substance, it does not prevent but hastens exhaustion."

The question has often been raised whether, in the use of artificial manures, which in recent years has become so extensive, we not only do not restore all the elements of fertility, but only those which enable the crop to draw more largely than it would otherwise do on the natural productiveness of the soil. It is a question which can be satisfactorily answered by nothing less than a series of carefully conducted experiments, extending over a long period of time. The application of partial manures, and the constant selling off of the crops, would no doubt in course of time so impoverish the soil of those constituents which the manures did not contain, that it would cease to yield good crops; but where the crops are consumed on the farm, and the farm-yard manure, liquid and solid, is all returned to the soil from which it was derived in the form of a crop, no exhaustion, but a gradual, and in some cases a rapid, improvement will ensue. When used to supplement the manure produced on a farm, artificial manures are of great benefit;
### Tables for Calculating the Exhaustion of Soils by Crops and Enriching by Manures, Average Quantities of Water, Organic Matter, Ash, Nitrogen in Organic Matter and Potash, Lime, Phosphoric Acid, and other ingredients in Ash, of Fresh (Green) and Air-dry Materials.

#### A. PLANTS.

<table>
<thead>
<tr>
<th>VEGETABLE MATERIALS</th>
<th>1,000 LBS. CONTAIN</th>
<th>INGREDIENTS OF ASH</th>
<th>1,000 (or 100) LBS. CONTAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat, grain</td>
<td>143 lbs.</td>
<td>840 lbs.</td>
<td>169 lbs.</td>
</tr>
<tr>
<td>Wheat</td>
<td>162 lbs.</td>
<td>118 lbs.</td>
<td>209 lbs.</td>
</tr>
<tr>
<td>Rye, grain</td>
<td>145 lbs.</td>
<td>837 lbs.</td>
<td>179 lbs.</td>
</tr>
<tr>
<td>Rye, straw</td>
<td>154 lbs.</td>
<td>826 lbs.</td>
<td>205 lbs.</td>
</tr>
<tr>
<td>Oats, grain</td>
<td>140 lbs.</td>
<td>809 lbs.</td>
<td>207 lbs.</td>
</tr>
<tr>
<td>Oats, straw</td>
<td>141 lbs.</td>
<td>835 lbs.</td>
<td>204 lbs.</td>
</tr>
<tr>
<td>Indian Corn, grain</td>
<td>136 lbs.</td>
<td>848 lbs.</td>
<td>190 lbs.</td>
</tr>
<tr>
<td>do. stalks and leaves</td>
<td>140 lbs.</td>
<td>823 lbs.</td>
<td>191 lbs.</td>
</tr>
<tr>
<td>Buckwheat, grain</td>
<td>141 lbs.</td>
<td>814 lbs.</td>
<td>178 lbs.</td>
</tr>
<tr>
<td>Buckwheat, straw</td>
<td>160 lbs.</td>
<td>870 lbs.</td>
<td>213 lbs.</td>
</tr>
<tr>
<td>Beans</td>
<td>141 lbs.</td>
<td>827 lbs.</td>
<td>213 lbs.</td>
</tr>
<tr>
<td>Bean straw</td>
<td>160 lbs.</td>
<td>865 lbs.</td>
<td>207 lbs.</td>
</tr>
<tr>
<td>Peas</td>
<td>128 lbs.</td>
<td>832 lbs.</td>
<td>193 lbs.</td>
</tr>
<tr>
<td>Pea straw</td>
<td>143 lbs.</td>
<td>846 lbs.</td>
<td>204 lbs.</td>
</tr>
</tbody>
</table>

#### B. HAY.

<table>
<thead>
<tr>
<th>HAY.</th>
<th>1,000 LBS. CONTAIN</th>
<th>INGREDIENTS OF ASH</th>
<th>1,000 (or 100) LBS. CONTAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Meadow Hay</td>
<td>141 lbs.</td>
<td>811 lbs.</td>
<td>515 lbs.</td>
</tr>
<tr>
<td>Timothy Hay</td>
<td>143 lbs.</td>
<td>888 lbs.</td>
<td>521 lbs.</td>
</tr>
<tr>
<td>Red Clover Hay</td>
<td>167 lbs.</td>
<td>888 lbs.</td>
<td>507 lbs.</td>
</tr>
<tr>
<td>Lucerne (Alfalfa)</td>
<td>167 lbs.</td>
<td>829 lbs.</td>
<td>506 lbs.</td>
</tr>
</tbody>
</table>

#### C. GREEN CROPS.

<table>
<thead>
<tr>
<th>GREEN CROPS.</th>
<th>1,000 LBS. CONTAIN</th>
<th>INGREDIENTS OF ASH</th>
<th>1,000 (or 100) LBS. CONTAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young Grass</td>
<td>800 lbs.</td>
<td>194 lbs.</td>
<td>237 lbs.</td>
</tr>
<tr>
<td>Timothy Grass</td>
<td>700 lbs.</td>
<td>238 lbs.</td>
<td>211 lbs.</td>
</tr>
<tr>
<td>Fodder Rye</td>
<td>700 lbs.</td>
<td>260 lbs.</td>
<td>213 lbs.</td>
</tr>
<tr>
<td>Red Clover</td>
<td>800 lbs.</td>
<td>196 lbs.</td>
<td>120 lbs.</td>
</tr>
<tr>
<td>Red Clover in blossom</td>
<td>800 lbs.</td>
<td>197 lbs.</td>
<td>137 lbs.</td>
</tr>
</tbody>
</table>

#### D. ROOTS (tubers) & TOPS.

<table>
<thead>
<tr>
<th>ROOTS (tubers) &amp; TOPS</th>
<th>1,000 LBS. CONTAIN</th>
<th>INGREDIENTS OF ASH</th>
<th>1,000 (or 100) LBS. CONTAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potatoes, tubers</td>
<td>750 lbs.</td>
<td>248 lbs.</td>
<td>94 lbs.</td>
</tr>
<tr>
<td>Turnips</td>
<td>770 lbs.</td>
<td>229 lbs.</td>
<td>19 lbs.</td>
</tr>
<tr>
<td>Carrots</td>
<td>807 lbs.</td>
<td>381 lbs.</td>
<td>17 lbs.</td>
</tr>
<tr>
<td>Hops, entire plant</td>
<td>140 lbs.</td>
<td>778 lbs.</td>
<td>81 lbs.</td>
</tr>
<tr>
<td>Hops, the cones</td>
<td>120 lbs.</td>
<td>813 lbs.</td>
<td>60 lbs.</td>
</tr>
<tr>
<td>Tobacco, leaves</td>
<td>180 lbs.</td>
<td>769 lbs.</td>
<td>151 lbs.</td>
</tr>
</tbody>
</table>

#### ANIMAL EXCREMENTS.

<table>
<thead>
<tr>
<th>ANIMAL EXCREMENTS.</th>
<th>1,000 LBS. CONTAIN</th>
<th>INGREDIENTS OF ASH</th>
<th>1,000 (or 100) LBS. CONTAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable manure, fresh</td>
<td>710 lbs.</td>
<td>260 lbs.</td>
<td>44 lbs.</td>
</tr>
<tr>
<td>do. moderately rotted</td>
<td>750 lbs.</td>
<td>192 lbs.</td>
<td>58 lbs.</td>
</tr>
<tr>
<td>do. thoroughly rotted</td>
<td>730 lbs.</td>
<td>145 lbs.</td>
<td>59 lbs.</td>
</tr>
<tr>
<td>Dung liquid</td>
<td>820 lbs.</td>
<td>107 lbs.</td>
<td>15 lbs.</td>
</tr>
<tr>
<td>Urine, human, fresh</td>
<td>665 lbs.</td>
<td>21 lbs.</td>
<td>13 lbs.</td>
</tr>
<tr>
<td>Night-soil, fresh</td>
<td>355 lbs.</td>
<td>5 lbs.</td>
<td>12 lbs.</td>
</tr>
</tbody>
</table>

#### COMMERCIAL FERTILISERS.

<table>
<thead>
<tr>
<th>COMMERCIAL FERTILISERS.</th>
<th>1,000 LBS. CONTAIN</th>
<th>INGREDIENTS OF ASH</th>
<th>1,000 (or 100) LBS. CONTAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazilian Guano</td>
<td>14 lbs.</td>
<td>314 lbs.</td>
<td>38 lbs.</td>
</tr>
<tr>
<td>Dried Blood</td>
<td>110 lbs.</td>
<td>79 lbs.</td>
<td>10 lbs.</td>
</tr>
<tr>
<td>Bone-meal</td>
<td>62 lbs.</td>
<td>33 lbs.</td>
<td>7 lbs.</td>
</tr>
<tr>
<td>Bone-meal, from hard parts</td>
<td>50 lbs.</td>
<td>16 lbs.</td>
<td>4 lbs.</td>
</tr>
<tr>
<td>Bone-meal, from soft parts</td>
<td>70 lbs.</td>
<td>23 lbs.</td>
<td>4 lbs.</td>
</tr>
<tr>
<td>Bone-black, fresh</td>
<td>60 lbs.</td>
<td>10 lbs.</td>
<td>2 lbs.</td>
</tr>
<tr>
<td>Bone-black, spent</td>
<td>100 lbs.</td>
<td>6 lbs.</td>
<td>1 lbs.</td>
</tr>
<tr>
<td>Bone-ash</td>
<td>100 lbs.</td>
<td>9 lbs.</td>
<td>1 lbs.</td>
</tr>
<tr>
<td>Baker-Guano</td>
<td>100 lbs.</td>
<td>9 lbs.</td>
<td>1 lbs.</td>
</tr>
<tr>
<td>Jarvis Guano</td>
<td>118 lbs.</td>
<td>8 lbs.</td>
<td>1 lbs.</td>
</tr>
<tr>
<td>Navassa Phosphates</td>
<td>25 lbs.</td>
<td>9 lbs.</td>
<td>0 lbs.</td>
</tr>
</tbody>
</table>

#### SUPERPHOSPHATES.

<table>
<thead>
<tr>
<th>SUPERPHOSPHATES.</th>
<th>1,000 LBS. CONTAIN</th>
<th>INGREDIENTS OF ASH</th>
<th>1,000 (or 100) LBS. CONTAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectified Guano</td>
<td>150 lbs.</td>
<td>62 lbs.</td>
<td>78 lbs.</td>
</tr>
<tr>
<td>Baker-Guano, supersop</td>
<td>150 lbs.</td>
<td>62 lbs.</td>
<td>78 lbs.</td>
</tr>
<tr>
<td>Navassa, ditto</td>
<td>150 lbs.</td>
<td>25 lbs.</td>
<td>5 lbs.</td>
</tr>
<tr>
<td>Bone-black, ditto</td>
<td>50 lbs.</td>
<td>8 lbs.</td>
<td>0 lbs.</td>
</tr>
<tr>
<td>Bone-meal, ditto</td>
<td>110 lbs.</td>
<td>38 lbs.</td>
<td>0 lbs.</td>
</tr>
</tbody>
</table>

#### MISCELLANEOUS.

<table>
<thead>
<tr>
<th>MISCELLANEOUS.</th>
<th>1,000 LBS. CONTAIN</th>
<th>INGREDIENTS OF ASH</th>
<th>1,000 (or 100) LBS. CONTAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphate of Ammonia</td>
<td>49 lbs.</td>
<td>2 lbs.</td>
<td>0 lbs.</td>
</tr>
<tr>
<td>Nitrate of Soda</td>
<td>22 lbs.</td>
<td>1 lbs.</td>
<td>0 lbs.</td>
</tr>
<tr>
<td>Plaster, Gypsum</td>
<td>80 lbs.</td>
<td>3 lbs.</td>
<td>0 lbs.</td>
</tr>
<tr>
<td>Gas-Lime</td>
<td>7 lbs.</td>
<td>0 lbs.</td>
<td>0 lbs.</td>
</tr>
<tr>
<td>Sugar-knoe Scour</td>
<td>2 lbs.</td>
<td>0 lbs.</td>
<td>0 lbs.</td>
</tr>
</tbody>
</table>
but it is open to grave doubt if they can be successfully made to take the place of farm-yard manure wholly through a long series of years. Properly compounded and genuine artificial manures, when used alternately with farm-yard manure on meadow land, give to the grasses a fillip which is very beneficial; and when used as an occasional top-dressing to pasture land, supplementing thereon the excrata of cattle, the result is equally satisfactory. The question of the exhaustion of soils, however, resolves itself into ascertaining whether, throughout the country, there is a proper balance maintained between the crops removed from the soil and the manure returned to it. This can only be decided by carefully comparing the amount of fertilising matter removed by various crops with that contained in the manure which is returned to the soil. Though not an impossible, it certainly would not be an easy task for a practical farmer to accurately determine this point, but he may, sufficient for all practical purposes, approximately ascertain it by the aid of the foregoing tables. By comparing the composition of the manures with that of the crops, an idea may be formed how nearly the former restore what the latter take away from the soil, and how much of different fertilising materials will be needed for the production of a given crop.

In a six-course rotation, consisting of turnips, wheat, clover, hay, oats, potatoes, and wheat, average crops of each, the quantity of fertilising elements removed from an acre of land has been calculated to be as follows:—

<table>
<thead>
<tr>
<th>Element</th>
<th>lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potash</td>
<td>319.4</td>
</tr>
<tr>
<td>Soda</td>
<td>66.6</td>
</tr>
<tr>
<td>Lime</td>
<td>100.9</td>
</tr>
<tr>
<td>Magnesia</td>
<td>39.9</td>
</tr>
<tr>
<td>Chlorine</td>
<td>58.9</td>
</tr>
<tr>
<td>Sulphuric acid</td>
<td>78.7</td>
</tr>
<tr>
<td>Phosphoric acid</td>
<td>122.3</td>
</tr>
<tr>
<td>Silica</td>
<td>36.4</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>274.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1429.4</strong></td>
</tr>
</tbody>
</table>

The quantity of the ingredients in the foregoing table, when compared with what exists in most soils, is so small that the exhaustion of the soil does not appear, under fairly good conditions of farming, to be a result at all likely to occur. But the other point in the solution of the question—the estimating of the elements of fertility restored to the soil by the application of farm-yard manure—is not so easily determined, because it is difficult to always tell the exact quantity of manure which is ordinarily applied to crops, and especially so because it varies much in composition. The following quantities, however, may be taken as the average amounts of fertilising materials contained in a dressing of 12 tons of farm-yard manure per acre:—

<table>
<thead>
<tr>
<th>Element</th>
<th>lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potash</td>
<td>291</td>
</tr>
<tr>
<td>Soda</td>
<td>67</td>
</tr>
<tr>
<td>Lime</td>
<td>337</td>
</tr>
<tr>
<td>Magnesia</td>
<td>35</td>
</tr>
<tr>
<td>Chlorine</td>
<td>12</td>
</tr>
<tr>
<td>Sulphuric acid</td>
<td>81</td>
</tr>
<tr>
<td>Phosphoric acid</td>
<td>108</td>
</tr>
<tr>
<td>Silica (soluble)</td>
<td>269</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>165</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1273</strong></td>
</tr>
</tbody>
</table>

The elements of fertility which, if any, farm-yard manure would fail to return to the land in sufficient quantity, as compared with the remainder, are nitrogen, phosphoric acid, potash, and chlorine; and it would appear to be expedient—in practice we know it to be beneficial in a high degree—to occasionally supplement farm-yard by an application of artificial manure which is specially compounded in reference to those elements in which farm-yard manure is more or less deficient. The nitrogen is specially contained, in a most readily available form, in nitrate of soda; the phosphoric acid in superphosphate of lime or bones; the potash in kieslite; and the chlorine in common salt. The first three are the elements on which plants chiefly subsist, and the soil is naturally very grateful for an artificial supply of them, over and above what farm-yard manure contains. But farm-yard manure, if produced in part by the consumption by animals of various kinds of cake and corn—of which decorticated cotton-cake is the richest in manurial residue—may be so much improved that it will contain sufficient of every element that the land requires for its fertility.

There is a steady exhaustion of the soil going on upon a dairy as well as upon an arable farm, but it is much less rapid. It consists chiefly of phosphates, but also of nitrogen and potash, which are carried away in the milk, and these may be restored by an application of ground bones, superphosphate or lime, nitrate of soda, and
kainite. Prof. J. F. W. Johnston says:—"Every 40 gallons of milk contain 1 lb. of bone earth, besides other phosphates. Estimating a cow to yield 750 gallons per year, it will require 19 lbs. of phosphate—equivalent to 30 lbs. of bone dust. If the calf is sold off we may assume there is a loss of 20 lbs. of bone, and the waste of phosphates in the urine equals 4 lbs. And thus, for every cow a dairy-farm maintains, it will lose of earthy phosphates as much as is contained in 56 lbs. of bone dust." Dr. Voelcker says:—"In the cultivation of remote districts, in the reclamation of wastes, and in the restoration of fertility to the worn-out pasture lands, which had been exhausted by the constant removal of milk, butter, &c., from their surface, bone manure has been scarcely less beneficial than in turnip husbandry."

Where much young stock is reared the phosphates in the soil diminish more rapidly than where the pastures are kept for the production of milk only; they serve to build up the bony and muscular structure of the young animals, and a smaller proportion of them is returned to the soil, in the form of animal excreta, than is the case with adult animals which are in milk or are being fattened for the butcher; hence it follows that to young-stock pastures the phosphatic elements require to be more frequently restored than to milking pastures, and more frequently to the latter than to fattening pastures. There are, however, some pastures that are so rich in all the elements of plant and of animal nutrition, that for generations no, or very little, exhaustion has become perceptible, and they are as rich now as any one would wish them to be. The excreta of the animals grazing on them, together with the genial climate in which they are usually situated, are to all appearance amply sufficient to maintain them in a very high state of fertility. On these soils farming is always a simple, pleasant, and profitable occupation, so far, at all events, as the land itself is concerned. But the quantity of such land is very limited.

Professor S. W. Johnson, of Yale College, Connecticut, U.S.A., author of "How Crops Grow" and "How Crops Feed," two excellent works, writes on "Guiding Ideas in the Use of Fertilisers":—"We do not know positively, as yet, all the processes or arrangements by which nitrogen is made accessible to our crops. We have got a great deal of valuable knowledge, but there is still much to be learned. The atmosphere contains an immense store of nitrogen gas—four-fifths of its bulk and weight—but this free nitrogen is, so far as our present information enables us to decide, of no use as food to vegetation directly. It is only capable of feeding plants after it has been brought into combination with other elements, as ammonia, or as a nitrate. (It will be remembered that ammonia and nitric acid are compounds of nitrogen, and that compounds of nitric acid with bases, as ammonia, lime, &c., are called nitrates.) The atmosphere will furnish a limited but variable supply of these compounds, enough to be of essential service to well-developed vegetation, having great absorbent surface of leaf and root, but not enough to bring annual plants to great development, so that agricultural plants, if planted in a soil destitute of available nitrogen compounds, can never make a crop without the help of manure containing suitable nitrogen compounds.

"Nitrogen is the most costly element of our ordinary fertilisers, because it is the most generally and strikingly useful, and because it is the most difficult to obtain; or, in other words, the demand is great and the supply small. "The soil, if it contains little nitrogen, must be enriched by that element; if it contains abundance, it is obviously not needful to add more. By natural processes the soil is constantly losing and gaining nitrogen, or is liable to such loss and gain, and these changes are intensified under the artificial conditions of agricultural practice. Nitrogen enters the soil from the atmosphere, by direct absorption of ammonia, especially when moisture condenses in it, as happens in the night-time, and loses ammonia again, or may lose it, as the water exhaled. The rain that falls upon the earth brings both ammonia and nitrates in varying quantity, equivalent to from two to twenty-one pounds of nitrogen to the acre per annum in the dozen instances where chemists have taken the immense trouble necessary to ascertain its quantity for an entire year. On the other hand, the nitrates, and ammonia after being oxidised to nitrates, wash from the soil in the outflowing water, and are lost in the streams. Again, the soil itself is not passive to nitrogen, but on the one hand appears to be able to render a portion of the available nitrogen inert, and on the other, to assimilate nitrogen
from the air, and make it available to plants. But with regard to these processes we are very much in the dark. Another source of loss of nitrogen is when its compounds, which are so precious as plant-food, are to a greater or less extent broken up in the soil by cultivation, and the nitrogen let loose as free nitrogen, which is not directly useful as plant-food.

"Nitrogen, then, is somewhat exceptional among the elements of fertilisers. It comes to our soil in an unseen atmospheric stream, sometimes larger and sometimes smaller, but always so small that the current quantity is not adequate for the current crop. It is always wasting, or liable to waste, and it wastes the more the greater the volume of rain-water which our soil is unable to retain in its pores, but permits to leach through and away. The natural accessions of nitrogen to the land, though not enough for a grain or a green crop while that crop is growing, are yet enough to help it essentially when its absorbent surface of leaf and root has become large. And by judicious alternations of the large-surfac ed and deep-rooted plants of the perennial class, or of perennial habit, like clover, we can save and store up in the soil nitrogen of atmospheric manurings, to use for those crops which are active consumers of this element, either of themselves or by the culture they require.

"In brief, nitrogen is the most valuable because the most scarce of all the ingredients of plant-food; the immense stores of free nitrogen in the air are not available to plants because they can use it only when combined with other substances. But plants do seem to have the power to take some nitrogen compounds from the air by their leaves; clover and like large-leaved plants seem to absorb more in this way than grain crops. The main supply of nitrogen to plants must come from the soil, and to be useful to the plants this nitrogen must be in available forms. In vegetable remains and manures it is in more or less available forms, and is gradually made more available. This change is facilitated by right manuring and tillage. At the same time, the soil is continually gaining more or less nitrogen from the atmosphere, and is losing more or less by escape in a free state, entering into unavailable combinations, or, especially, by leaking off in drainage water.

"As to the other elements of plant-food—lime, magnesia, potash, iron, sulphuric acid, phosphoric acid, and chlorine—we know that they belong to the soil, and while they may be removed from our fields in the crops, or may some of them wash out of the land in the drain water, they cannot return of themselves, but must be returned in the manure we apply, unless the overflow of some water-course may chance to bring them back. Of the elements just named, there are some which are especially liable to waste in drainage waters, or waste easily and rapidly, while others are practically fixed. Lime and sulphuric acid, next to nitrates, are the substances which water dissolves and removes most copiously from our fields. Phosphoric acid and potash, it is noticed, are found in but the minutest quantities in these drain waters. We need not fear, then, that these substances are wasting from our lands, unless, indeed, they are over-manured and under-retentive. But lime and sulphuric acid wash out more freely, and hence, probably, one reason of the wide-spread advantage of gypsum as a fertiliser; it must be constantly applied to make up the constant loss of its elements."

Experiments in Water-Culture.

The two following engravings, with the explanations belonging to them, relate to the results of an experiment in water-culture made by Dr. Nobbe, at the Agricultural Experiment Station in Tharandt, Saxony, and to one in sand-culture made by Professor W. O. Atwater, Director of the Connecticut Agricultural Experiment Station, U.S.A. The experiments were made with buck-wheat and oats, and were undertaken to demonstrate the effect of withholding certain elements of plant-food separately, noting the difference in effect, and comparing each case with an example in which the plant was supplied with every ingredient necessary to its development. It is to these and similar researches that the discovery of what constitutes the food of plants is due. The number of these researches is very large, and years of patient work, by many investigators, have been expended in the chemical analysis of plants, soils, and manures, in the culture of plants in the greenhouse and of crops in the field, in order to demonstrate the different materials that are required in perfect plant-nutrition. These labours have thrown a flood of light on problems the solution of which had previously been made
by conjecture only, and they have demonstrated the incorrectness of some of the old theories on this subject. The researches have been made principally in the Agricultural Experiment Stations of Germany and America, and they have given to the world a large amount of definite knowledge, which, if properly put into practice, is of incalculable value. In order to the better understanding of the significance of these results, it will be necessary to mention, in connection with this subject, a few important facts in chemistry, for the terse description of which we have to thank Professor Atwater, who is a well-known American specialist.

"Phosphoric acid combined with lime, as phosphate of lime, makes up most of the mineral matter of all bones. Sulphuric acid (oil of vitriol), with lime, forms sulphate of lime, otherwise known as 'plaster,' or gypsum. Silica is the chief ingredient of ordinary sand. It occurs nearly pure in flint and quartz, and, combined with other substances, in many minerals. Nitrogen constitutes four-fifths of the air, the other fifth being oxygen; and nitrogen also makes up about seven-eighths of ammonia, the rest being hydrogen. Charcoal and lampblack are nearly pure carbon. By potash it is to be understood the compound of potassium and oxygen, and by soda, sodium and oxygen."

Bearing these facts in mind, we quote the following tersely expressed statement, by Prof. S. W. Johnson, of some of the substantial results referred to:—"In respect to the food of plants, it has been settled that potash, lime, magnesia, iron, phosphoric acid, and sulphuric acid must be furnished to all agricultural plants through their roots and by the soil, in order to their growth. It has also been shown that soda, silica, and chlorine are not needful for the early growth of grain crops, but that chlorine is essential for the perfection of the seed, and that silica is probably necessary to uniform blossoming and ripening. It is further proved that water must enter crops through their roots; that carbon, which constitutes more than half their weight, is superabundantly furnished by the air; that air and water together yield the materials out of which fully 90 to 98 per cent. of crops is built up; and that the soil has to give for their nourishment only the two to eight per cent. of mineral matters which remain as ashes when they are burned, and the one and a half to two per cent. of nitrogen which they also contain."

In order, then, that any agricultural plant may grow, it must have at its disposal, in the soil, besides water, a certain list of substances, viz., potash, lime, magnesia, iron, phosphoric acid, sulphuric acid, and some compound of nitrogen. Besides these, chlorine, certainly, and silica, probably, are necessary in many, if not in all cases, for the perfection of the plant. If any one of these substances be wanting, the plant will not thrive. With an abundant supply of all, and other conditions favourable, its growth will be luxuriant. How has all this been learned? In the first place, in every analysis that chemists make of any plants, be it corn, or grass, or turnips—and thousands of these analyses have been made—each one of these substances has always been found. It is fair to suppose, then, that, being always present, they have each a work to do in the plant. Still, this is not positive proof. As every ordinary soil contains all of these substances, is it not possible that the plant may take up some of them in the water it absorbs from the soil, just as a towel, one end of which has fallen into a dish of water, will absorb the water and whatever it holds in solution? This question might be tested by growing plants in soils with one of these substances absent from it, potash for example. But it is difficult to find a soil entirely free from potash. It is easy, however, to dissolve in pure water any or all of these substances in any desired proportion, and it is well known that plants will grow with their roots in water.

"Experiments in 'water-culture' consist in raising plants without any soil at all, but with their roots immersed in water, in which are dissolved the soil-ingredients of plant-food. The seeds are germinated, or 'sprouted,' in pure sand or moist cotton. At the same time, the ingredients of plant-food which are to be supplied to the plants are dissolved in water in the desired proportions, and these solutions put into glass jars. At the tops of these the just germinated plants are placed, properly supported, with their roots dipping into the solutions, and thus allowed to grow. Solutions containing all the soil-ingredients or plant-food are called normal solutions. In these, plants are raised as large, as healthy, and in every way as perfect as those
grown in the soil. Dr. Wolff raised in such a solution four perfect oat plants, with 46 stems and 1,555 well-developed seeds. Dr. Nobbe obtained a Japanese buckwheat plant, 9 feet high, its roots had been immersed only in watery solutions. The above were obtained in the "normal solutions." What would result if one of the necessary food ingredients were omitted?

This is answered in Dr. Nobbe's experiments. The engraving (Fig. 43), with the explanations, shows that in the normal solution the buckwheat was vigorous and healthy, and grew to be nearly 3½ feet high. Another plant (II.), grown under

Fig. 43.—Experiments in Water-Culture.

(By Dr. Nobbe, at the Experimental Station in Tharandt, Saxony.)

The above engraving is copied from photographs of buckwheat plants, grown with the roots immersed in jars containing various solutions of the ingredients of plant-food in water. The plants were supported by perforated corks resting on the covers of the jars, and by upright sticks. In jars I. and La was a normal solution, that is, a solution containing all the essential ingredients of plant-food, including potassium as chloride. The plant in La was nearly 3½ feet high. The solution in II. was the same as normal solution in I. and La, except that potassium was omitted in the jar II. The plant was scarcely 3 inches high. The jar II. commenced as II., that is, without potassium, but potassium chloride was afterwards added. VI. contained the normal solution, except that sodium was substituted for potassium. IX., X., XI., and III., same as I., except that IX. contained no lime, X. no chlorine, and XI. no nitrogen, and III. had nitrate instead of chloride of potassium.

weighing, air-dry, 1,786-fold the weight of the seed, and bearing 796 ripe and 108 imperfect seeds. And Dr. Knop used to delight in showing his friends a young oak-tree, very small indeed, but the growth of which had been normal, though

DAIRY FARMING.
precisely the same circumstances, except that no potash was supplied, led a starving and sickly life, and attained a height of scarcely 3 inches. Without potash no full development was possible. When this was added later (in II.), the plant revived, pushed out with some vigour, but was unable to overtake its better-fed neighbours. Nor did the plants grow well in lack of either lime (IX.), or chlorine (X.), or nitrogen (XI.). These are the results, not of single, but of many repeated trials. Dr. Nobbe made, in this case, a number of different series of experiments, each corresponding to the numbers I., II., &c. There were, for instance, several of series I., some larger, and others smaller. From these, I. and I.a were selected as of average size and development. So II., III., &c., were each selected as fair average samples of the plants of those series. The selected plants were photographed, and the result is shown in the picture.

"Many such series of experiments have been carried on with various plants by Nobbe and numerous other investigators, and they all agree in this one general conclusion. No agricultural plant can attain full growth without a sufficient supply through its roots from the soil of potash, lime, magnesia, iron, phosphoric acid, sulphuric acid, and some compound of nitrogen. Besides these, chlorine, and perhaps silica, are sometimes, if not always, indispensable to complete development. If any one of these essential ingredients be lacking, the plant will suffer in growth and development."

The results of these experiments, which should be clearly stated, and which should be especially remembered, are that—1st. No agricultural plant can grow without an abundant supply, in an available and appropriate form, of each of the essential ingredients of plant-food. 2nd. Of these, potassium is necessary to the formation of starch in the chlorophyll grains of the leaf. 3rd. No other ingredient can fulfil the office of potassium in the plant. The same is also known to be true of nitrogen, phosphoric acid, and each of the other essential ingredients. Each has its own work, which no other can perform.

The practical application of these principles as to the chief office of fertilisers may be stated as follows:—Crops can no better grow without a sufficient supply of each of these essential elements in the soil than could the plants in the solution. In removing crops from our land we carry away great quantities of plant-food. By continued cropping the available supply of one...
or more of the essential ingredients becomes too small for profitable production, unless by some means they are replaced. The ones most generally deficient are nitrogen, phosphoric acid, and potash. The chief use of manure is to supply these lacking materials. Stable manure is a complete fertiliser, as it furnishes all the ingredients of plant-food, and improves the land besides. Superphosphates, bone manure, guanos, potash salts, and other like artificial fertilisers are valuable chiefly for their nitrogen, phosphoric acid, and potash. In their use we should first learn what materials the plant needs, and then select the fertilisers which furnish these in the largest quantity, best form, and at the lowest cost. The needs of a given soil can be best learned by experience and experiment. The only

as Professor Atwater says, "several solutions were prepared by dissolving the proper chemical salts in water. One of these contained all the materials which plants require for their food from the soil. This 'normal solution' was the same as was used in the experiments in 'water-culture,' previously described, and was applied to No. V. of each series. Another solution, containing the same ingredients, except that nitrogen was omitted, was used to water the plants in No. IV. A solution, with everything but phosphoric acid, was applied to No. III. of each series. Potash was in like manner omitted from No. II. Finally, each No. I. received only rain-water. The plants came up and grew. Those supplied with the complete fertiliser, No. V., were healthy,

<table>
<thead>
<tr>
<th>BUCKWHEAT</th>
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<tbody>
<tr>
<td></td>
<td>I.</td>
<td>II.</td>
<td>III.</td>
<td>IV.</td>
</tr>
<tr>
<td>Number of plants</td>
<td>23</td>
<td>23</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Average height, Centimeters</td>
<td>30</td>
<td>30</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Weight of seed, Grams</td>
<td>1.2</td>
<td>1.3</td>
<td>4.1</td>
<td>4.1</td>
</tr>
<tr>
<td>Weight of straw</td>
<td>4.9</td>
<td>4.1</td>
<td>8.7</td>
<td>2.9</td>
</tr>
<tr>
<td>Weight of roots</td>
<td>4.6</td>
<td>6.6</td>
<td>2.4</td>
<td>4.6</td>
</tr>
</tbody>
</table>

* 2½ Centimeters = about 1 inch.  
† 1 Gram = 15½ grains.

Dry Weight of Plants Grown in Barren Sand, Fertilised with Different Solutions.

<table>
<thead>
<tr>
<th>OATS</th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I.</td>
<td>II.</td>
<td>III.</td>
<td>IV.</td>
</tr>
<tr>
<td>Number of plants</td>
<td>23</td>
<td>23</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Average height, Centimeters</td>
<td>20</td>
<td>20</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Weight of seed, Grams</td>
<td>6.3</td>
<td>4.5</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>Weight of straw</td>
<td>1.8</td>
<td>1.8</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Weight of roots</td>
<td>2.3</td>
<td>7.7</td>
<td>4.6</td>
<td>5.9</td>
</tr>
</tbody>
</table>

safe guarantee for the composition of commercial fertilisers is in chemical analysis.

In applying artificial manures to grass land some discrimination is necessary to avoid loss. On heavy land, the soil of which is close and retentive, they should be applied before or soon after Christmas, if the weather is suitable, because such soil is longer in absorbing them; but on light, naturally dry land they should be applied in the early spring, and in all cases in damp weather; this last consideration applies in a special manner to guanos.

The second experiment (Fig. 44) was made in barren sand, and with buckwheat as before. Ten wooden boxes, each one foot square, were filled with the sand, and arranged in two rows of five each, the boxes in each row being numbered I., II., III., IV., V. In the first row buckwheat was sown, and in the second oats. "To fertilise these," did well, and gave a fair crop. Where potash was omitted, No. II., the plants were about as tall, but thinner, and the yield of seed was only about half as large. Without phosphoric acid, No. III., the plants looked about as well, but the amount of seed was extremely small. Where nitrogen was left out, everything else being supplied, the plants were stunted, spindling, and sickly. They yielded almost no seed, and were in fact no better than those which had nothing but rain-water.

"When the plants were ripe they were harvested, the roots being freed from sand by careful washing, and the different parts measured and weighed. The picture represents buckwheat plants of average size from each lot. The table above gives the measurements and air-dry weights of both buckwheat and oats.

"This sand evidently needed a complete fer-
THE APPLICATION OF MANURES.

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tiliser. The omission of each one of the more important ingredients of plant-food brought the yield down, but in very unequal proportions. In lack of potash, everything else being supplied, the crop suffered badly. Leaving out phosphoric acid injured it still more; while without nitrogen, even though everything else was furnished, the growth was no better than with rain-water. This soil could supply considerable potash and some phosphoric acid, but its stock of available nitrogen was extremely low.

"It is, we believe, a principle of military science that a fortification is no stronger than its weakest point. The crop cannot rise above the level of the lowest element in the food-supply. If all come up to the required standard, and other conditions are favourable, a good yield is certain; but if any one falls below this standard, the crop must fall with it. Now this food-supply varies in different soils. It varies not only as a whole, but in its different parts. Sometimes one element, sometimes several, may be lacking. A soil may have a proper texture, amount of moisture, and a full supply of everything the crop needs, except phosphoric acid, for example. Add phosphate in available forms, and the yield will be bountiful.

"If we have made our meaning clear, it will be seen that the main point in economical manuring must be to economise what the soil can supply, and to add what it cannot. The proper use of special fertilisers is to fill up these deficiencies, to bring the food-supply into equilibrium. As Mr. Lawes says, 'soils were meant to be exhausted,' that is, the material they furnish was meant to be used. The point is to utilise it most economically, and add what is needed to bring the most largely and permanently profitable results."

There are several valuable facts brought out in these experiments, the chief of which is that highly satisfactory results were obtained by the application of a fertiliser which contained all the elements necessary to the growth of the plant. The next fact is that a soil which lacks nitrogen, or the means of obtaining it, as supplied by decaying organic matter, must have it supplied by artificial means, if a full crop is to be obtained. They prove, further, that if all the elements except one be supplied, the lack of that one will imperil the crop. It is therefore necessary to ascertain, by analysis of the soil, or by carefully conducted experiments with manures, in what element or elements the soil is most deficient, and then to supply these more abundantly than those in which the soil is already rich enough for all practical purposes. There can be no doubt that many farmers waste money in one or both of two ways—either in supplying elements of plant-food in which the soil abounds, or in not supplying in sufficient quantity those in which it is deficient. And it must be borne in mind that in an over-supply of manure, not only is the surplus more or less thrown away, but the crop will be smaller than if a proper quantity be supplied to it. Crops cannot be indefinitely increased in quantity—there is a limit beyond which nature cannot be induced to go.

USE OF LIME.

Mr. Falconer King writes as follows on the use and abuse of lime in agriculture:—"It is an old, and to a certain extent a true saying, that

'Much lime and no manure
Will make both farm and farmer poor.'

The converse, however, is also true, and is worthy of remembrance by those who are desirous of making the most of their farms. If much lime and no manure make poor farmers, it is no less true that much manure and no lime will have precisely the same effect. It appears to me, however, that the majority of Scotch farmers err in this matter neither by liming their land too liberally nor yet too scantily, but if they err at all in the operation of applying lime it is by doing so at an unseasonable time, or by relying too much upon lime to the exclusion of other manure. This last-named error, however, if it ever is committed in the present day, is by no means a common one, at all events with the better class of farmers.

"In considering the part played by lime in agricultural operations it should always be remembered that that substance acts in the soil in two perfectly distinct and separate ways. First, lime acts as a manure by supplying necessary calcareous food directly to the plant; and second, it acts by supplying food indirectly to the plant, either by unlocking the storehouses of plant-food already existing in the soil, or by converting useless or even deleterious ingredients thereof into substances useful, or at all events harmless, to vegetation.
Lime, as is well known, is required directly by all cultivated plants as food, and therefore a soil which is totally devoid of lime is simply barren, and the obvious remedy by which to render such a soil fertile would be, of course, a dose of lime. Such a case as this, however, is extremely rare. Of all the suspicious soils which I have analysed, I cannot recall one to mind which was proved to owe its barrenness to being completely devoid of lime.

In most cases, therefore, in which lime acts beneficially when applied to the soil, it does so either by supplying food to the crop indirectly, or by destroying some noxious constituent already existing in the soil.

The plant-food which lime supplies indirectly may be divided into two classes—first, mineral or inorganic, and secondly, vegetable or organic.

The principal members of the first class seem to be silica and potash. These substances, however, it should be borne in mind, are not in any way contributed to the soil by the lime—they are merely changed by its action from their hard, stony, insoluble nature into a condition in which they are available to plants as food. These two substances, silica and potash, are found in greater or less proportion in almost all fertile soils, but in some soils they exist principally in an insoluble or locked-up condition, if I may use the expression, and are therefore of no use as plant-food until they have been set free, either by the action of lime or by some other suitable agent.

The principal members of the second or vegetable class of food materials which lime prepares for the use of plants is nitrogen. Now this substance nitrogen, as is well known, is an indispensable and most valuable ingredient of plant-food, and therefore any substance which can apply it to plants in a readily available form is an agent of very great utility. This office is performed, and performed very satisfactorily, by lime. The lime does not, indeed, add or contribute nitrogen any more than it adds potash to soils, but it converts the nitrogen, which, though it already exists in the soils, is present in a comparatively inert state, into a form in which it is easily assimilated by plants. In these different ways, therefore, may lime be used with great benefit, viz., on soils which contain a large quantity of undecomposed mineral matter, and on soils which contain an excess of vegetable matter.

Lime, however, is useful in another way, and that is by destroying substances hurtful to vegetation, such as, for example, certain compounds of iron and certain acids, which are alleged to be the cause of the peculiar evil known as sourness. A soil, it is well known, may contain all the ingredients necessary for supporting plant life, and yet be infertile, in consequence of containing some deleterious or poisonous ingredient. Lime may act, therefore, very beneficially on some soils, not by providing an increased supply of plant-food, but merely by neutralising or destroying some such hurtful substance which may be present.

In all the instances I have mentioned, lime, we have seen, acts beneficially; and it now remains for me, before concluding this short note, to point out, in a very few words, how lime may act prejudicially—so act, indeed, that its continued application may not only be useless, but actually be hurtful. It is an old idea that lime is a very exhausting substance, and that its continued and extensive use must sooner or later greatly impoverish a soil, or even reduce it to perfect sterility. This idea is not altogether erroneous, but it is only true in a certain sense.

I don't mean, of course, to assert that a soil may not be over-limed. Such an occurrence, although not, I should think, by any means a common one, is not impossible. It can be done; and the immediate effect of over-liming is to cause a great diminution in the amount of the organic constituents of the soil, thereby rendering grain crops grown on it uncertain. When I say, however, that there need not be much fear of rendering a soil sterile by means of lime, I refer to the impossibility of destroying the natural or mineral constituents of a soil, such as potash, silica, phosphoric acid, sulphuric acid, &c. When lime is added to the soil, it does not eliminate or destroy these substances; it merely effects certain changes by bringing some of them into a more valuable condition; so that as long as we do not remove, by injudicious cropping or by some similar method, these valuable constituents of plant-food from our soils, we may apply lime as freely as is deemed necessary without incurring any danger of thereby rendering them sterile—at least, of doing so by exhausting the mineral food elements. The principal evil to be apprehended from over-liming is too great a destruction of organic matter, which, as I have already
pointed out, unsuits the soil for the growth of grain crops. It should also be borne in mind that lime almost always produces the most profitable and marked effect on new land, or on land which has not been fully exposed to the air, or on such land as is rich in organic remains, as, for example, on peaty or boggy land, and that it may be of very little use if applied alone to arable land which has just been cropped. The greatest mistake, though, which I have ever seen committed in connection with the employment of lime is that of mixing it with manure before application. In these days of enlightenment it is almost incredible that such an egregious error as this should be committed, and yet I myself have actually seen the perpetration of this species of absolutely inexcusable wastry. When farm-yard manure, at least after it has been kept for some time, is so treated with lime it is almost entirely destroyed, and the value of many other manures, by similar treatment, would be very much lessened. Lime should never be allowed to come in contact with the manure at all; and if it could be arranged conveniently, these two substances should be applied to the land at different times.

"As I have been frequently asked to give an opinion as to the value of waste products containing lime, such as the so-called gas lime and the refuse lime from paper-works, it may be of some use if I state here that none of these substances are of any great value, except for the lime which they contain; and I should say, further, that neither of these substances should on any account be used for agricultural purposes in their fresh state. Gas lime, when it is newly made, contains certain compounds of sulphur which are positively injurious to plant life; and much the same may be said of the waste lime from paper-mills, which, when it is new, is apt to contain some caustic soda, a substance which may seriously injure a plant, and even destroy entirely the vitality of seeds. By sufficient weathering, however, the noxious constituents of both of these substances may be rendered quite harmless, and either or both of them may then be safely used as a means of applying lime to the soil."

In many old pastures mosses are formidable enemies to the farmer. They are to be found thriving more or less in almost all situations and in every description of soil, but more particularly are they to be found in all their luxuriance on moist, inferior soils. Where it is inconvenient or undesirable to plough up and crop land thus overrun with coarse grass and moss, something may be done to eradicate them by going over the surface with sharp, close-toothed harrows, crossing and re-crossing till the moss is thoroughly scratched up; clean off the rubbish, and thereafter apply a good top-dressing of lime or lime compost. Unquestionably, pure lime is preferable, and put on as hot as it can be conveniently applied, at the rate of from five to six tons per imperial acre. The month of February and up to the middle of March would seem to be the best time for this operation. After the lime has got a good shower of rain, brush or chain harrow it well into the ground, removing all rubbish gathered up by the harrows, refuse of the lime, &c. In about a month afterwards, and not later than the middle of April, sow a mixture of the best permanent grass seeds, at the rate of from twenty to thirty pounds per acre, which can be obtained mixed and ready, and suitable to the nature of the soil, from the seedsman with whom you are in the habit of dealing. If there be any tufts or tussocks of coarse grass, it would be well to root them out. Brush harrow again, and finish up by rolling with a heavy roller.

**Improvement of Grass Land.**

The improvement of grass land—not alone of land that has been drained, but also of other land that has not required it—is a subject of deep interest and importance. While arable land is, as a rule, fairly well attended to with periodical dressings of manure of one kind or another, and is commonly cleared from weeds more or less thoroughly once at all events in the course of the rotation, grass land is too generally left to take care of itself; and this wide-spread neglect, being the rule rather than the exception, is a matter which causes but little surprise. Though it is, no doubt, true that there is some grass land in our best districts which, so far as manuring with anything beyond what the cattle leave upon it in grazing, may safely be left to take care of itself—land which is naturally so rich in all the elements of plant nutrition that to manure it at all in an artificial manner would do more harm than good, so long as it is kept for grazing purposes—such land is very scarce, and is found only in the most favoured localities.
It may be laid down as a truism that the great bulk of our grass land not only needs improving, but would pay well for it; and in view of the prices which the products of arable and of grass land relatively bear to each other, and which they are likely to bear for a long time to come, it may be said that the neglect of our grass land cannot with impunity be suffered to go on much longer. Dairy-farming, in conjunction with the rearing of young stock and the fattening of cattle and sheep for the butcher, is, beyond a probability, the most profitable occupation which the English farmer can follow, wherever the land is adapted to it.

The finest dairy land is undoubtedly, for the most part, confined to the alluvial deposits, forming rich, slightly undulating flats, which have in the course of ages accumulated in the neighbourhood of the existing or former outlets of our tidal rivers, formed in some instances by rivers which have long ago dried up or have been diverted into some different direction. The slow upheaval or subsidence of the earth's crust in some localities has caused, and is still causing, these diversions in the flow of rivers. Next to the alluvial soils, the best natural pastures are found on the carboniferous or mountain limestone formations, and especially in the adjacent valleys where beds of drift-gravel, partly composed of the débris of these formations, are commonly found. These last, however, may almost be regarded in the light of alluvial soils, the chief difference being that, instead of by river action extending for a long distance, they have been formed by rills and streamlets, in the periods of heavy rain, running down the hill and mountain sides, carrying with them to the valley below the particles of rock which are continually becoming detached by atmospheric agency, by dews and rains, by frosts and snows. The Valley of the Dove, which for a long distance separates Derbyshire from Staffordshire, is a well-known instance of this nature, and it has long been famous for its dairy productions.

In the Valley of the Derwent, in Derbyshire, and those of the Wharfe and Ribble, in Yorkshire, and in other parts of England, mainly in the northern counties, the same sort of thing is found. In Ireland, also, a considerable portion of the flat country is overlaid by these drifts, on which grow an abundance of sweet, nutritious, wholesome grasses, well suited to stock of all kinds, to pasture and to meadow alike, to dairy purposes and to fattening, as well as to the growth of oats and turnips. Better districts than these need not be desired for the purposes of dairy-farming. A cool and humid climate; soil of excellent quality, sound and healthy, and seldom in want of artificial draining; grasses of the best description, tender, succulent, nourishing—these qualities stamp any district where they are found with a high order of merit in the domain of dairy-farming.

The late Sir H. M. Thompson, from whom we have previously quoted, wrote so well and wisely "On the Management of Grass Land," that we cannot do better than quote verbatim from the able paper which he contributed in 1872 to the Journal of the Royal Agricultural Society:—"It may seem a work of supererogation to make suggestions for the improvement of pastures which already produce great results, but the holders of first-class land may learn something by observing the practice of those skilful and experienced graziers who find it worth their while to give extreme prices for the occupation of land. In order to reimburse themselves it is necessary that every yard of land should be productive, and the greatest care is taken to mow the thistles whilst still young and succulent, in which state they are (when mown) readily eaten by all kinds of stock. Coarse patches of grass, too, are occasionally switched over with the scythe, or, if necessary, an old horse is tethered in the worst places, until they are cropped down sufficiently to be again grazed regularly by the feeding stock. The loss of grass caused by neglecting to mow thistles and other large weeds would never be permitted if farmers would only consider how largely the fertility of the soil is taxed to nourish these intruders, and how cheaply they may be kept down. An old man and a hard-worn scythe, neither of them fit for regular work, will keep a large acreage of grass free from this constant source of loss."

* Mr. Thompson, of Barrame, Tipperary, whose experience with the thistle-pest is a long one, and whose habits of observation and reasoning are singularly close and accurate, never commences his "thistle-harvest," as he terms it, before the month of August. He has found cutting thistles thus late in the season the most promising way of eradicating them. By this period many of them have already come to seed, and others will perfect it after they are cut, but he does not mind the seeding; he says thistles, at all events on
"In addition to these preservative measures, something may be done to increase the produce on even the best land. If the question be asked why such and such a field is worth more to the occupier than the adjoining ones, the reply will frequently be that the field in question grows early and late, and even the most unobservant are occasionally struck with the brilliant green of some favoured fields, or portions of fields, when the rest are all brown. But a closer inspection will show that even the brown pastures have green patches in them. Wherever the droppings of cattle have fallen in spring the grass is green in autumn, even after a moderate amount of frost and biting winds; showing that it is not the fault of the soil or climate that the grass is not still fresh and succulent, but that want of condition produces a feeble vitality, easily affected by cold, which stops the growth of the herbage much earlier in the winter than is at all necessary. There are also patches of land in most pastures where the stock do not like the grass, the deficiency in this case not being in bulk but in quality of herbage. Unless this is caused by defective drainage, a dressing of the mixture to be subsequently described will generally restore the quality and cause those neglected parts to be as well eaten as the rest.

"I have ventured to define first-class grass land as that which will produce twenty imperial stone of meat per acre without artificial assistance. Next in order must be placed the land which will produce about the same quantity of beef and mutton, with the aid of a moderate allowance of cake or corn. This quality of land may be found, to a greater or less extent, in almost all parts of the country, with the exception of the chalk, the light sands, and the strong clays. The practice of giving artificial food to cattle at grass is rapidly gaining ground. It is already apparent that 9d. a lb. for beef and mutton will produce a perfect revolution in the management both of live stock and of grazing land, and the advantages of the improved system are such that it may be safely expected to outlive any reasonable decline in the price of meat. The easiest kind of food to give in the field is linseed or cotton-cake. The mixture I prefer to any other is linseed and decorticated cotton-cake in equal quantities. Bean-meal, too, moistened and rolled into balls, is easily given and very effective. Many other kinds of feeding-stuffs, either singly or in combination, will recommend themselves, according to their relative prices in the market. Where mixed linseed and cotton-cake are given, the cost of the mixture, at present prices, would be about 1s. 4d. per stone; and supposing it to be unnecessary to commence its use during the first ten weeks of the grazing season, whilst the grass is at its best, if 5 lbs. be given daily to each fattening bullock at the commencement of the last ten weeks, increasing the allowance to 6 lbs., and for the last few weeks to 7 lbs. per day, averaging 6 lbs. for the whole ten weeks, the cost of the artificial food would be 40s. per head. If the land will carry a beast per acre, this will add 40s. to the farmer's expenses, and reduce correspondingly the value of the land when compared with that which will fatten the same number of beasts without artificial aid. Hence, if the very best grass land be supposed to be worth a rent of £5 per acre, the land which requires cake for finishing the beasts ought not to be rented at more than £3 per acre. These general figures will, of course, require adapting to each individual case to suit the great variety of qualities of land and other modifying circumstances.

"One of the advantages of giving cake to finish beasts which, on the unassisted grass, would come out in October only half beef, is that the grazier is thus enabled to send his beasts to the butcher at full prices instead of fattening them in the yards at great cost, or of selling them as store beasts when many others are doing the same, and the markets are crowded and depressed. In cases where farmers occupy land not well suited for the growth of roots, and do not attempt to fatten beasts in the winter, but give cake in
the straw-yards to improve the manure, and bring out their beasts in spring in a forward state, it often answers well to give cake in the early part of the grazing season, and so push on their cattle as to get them to market in June and July, when beef is the dearest, to be followed by younger beasts to eat up the rough grass in the autumn and early winter. This is excellent practice, as there is no time when cattle make such rapid improvement, and when the expense of attending them is so light, as when they are having cake or corn on a good pasture. The grazier, too, who has fat cattle in June has the command of the market, and is to a great extent independent of the season, as, should the weather be dry and his stock heavy, he can at any time lighten his pastures by draughting a few forward beasts for sale.

"Another advantage which arises from giving artificial food to grazing cattle is that the pastures themselves are gradually improved, until land that is only fit for rearing store cattle becomes capable of fattening stock with a moderate amount of help toward the end of the season.

"Hitherto I have spoken of good land only, but, unfortunately, the larger portion of the pasture land of the United Kingdom may be classed either as moderate or inferior. I will not attempt to describe the various gradations by which land descends from the highest quality to that which requires some aces to keep a yearling steer, and which was once described by a disheartened occupier as of that kind on which the grass only began to grow on Midsummer Eve and gave up growing on Midsummer Day. The various shades of land worth from 40s. per acre downwards require very similar measures for their improvement, and, before making any special suggestions respecting them, it is necessary to declare open war against the time-honoured fallacies that pasturage land can be profitably occupied by leaving it to itself, and that a farmer consults his own interests by allowing the arable land to rob the grass. Any one who mows his grass without return robs his land quickly, and he who pastures it without return robs it slowly; but the process is sure as well as slow, and, when persevered in long enough, produces the splendid variety of thistles, ragwort, scabious, and other flowering weeds, very charming to a botanist in July, but extremely disheartening to the hungry cattle who are doomed to wander amongst them seeking for grass.

"Since the days of Jethro Tull, there have been two recognised methods of keeping up the fertility of land, viz., either manuring at short intervals, or thorough disintegration produced by frequent stirrings of the soil. It cannot be too strongly urged that as grass land is necessarily deprived of the advantage received by arable land from frequent exposure to the atmosphere, * it ought to be furnished in some way with the minerals required to produce good crops of nutritive herbage. The use of artificial manures has given the grass-land farmer complete command over the supply of nitrogen, but a perfect restoration of the mineral ingredients removed by grazing, and still more by mowing, cannot be effected without an occasional application of farm-yard manure, or of compost in which farm-yard manure holds an important part; so that it would really be better practice, so far as farm-yard dung is concerned, to let the grass starve the arable land than the arable land starve the grass, since the arable land can receive its mineral supply from other sources, viz., deep cultivation and thorough aération. The slovenly management of grass land which a few years ago was general, and is still too common, would never have been seen if the quality of grass could be appraised as easily and certainly as that of corn. But it is notorious that even the most experienced farmers and graziers can only distinguish between good, moderate, and bad; no man living can distinguish by the eye the subtle difference in the quality of the herbage which makes one very good field worth £1 an acre more rent than another very good field, or one bad field worth less than another equally bad-looking field. So long as a grass field grows about the usual quantity of grass, and the cattle eat it, the occupier is too apt to rest content with the good or bad reputation earned by particular fields, without any attempt to alter it for the better, or even to ascertain whether it is not gradually getting worse.

"In early life I learnt a lesson on this point which I have never forgotten. A neighbouring

* It is to be hoped that a steam implement will before long be devised that will produce a thorough disturbance of the sub-soil without material injury to the grass-sward above. We think such an implement would do great good to many pastures. [Ed.]
gentleman mowed about fifty acres of his park annually, and, not being a farmer, he believed that grass was grass, and made equally good hay whether he went to the expense of manuring it or not. He was also remarkably indifferent on the subject of quantity, saying that he kept a fixed number of horses and cows, and if in a good season he had a large crop, they ate it all, and in a bad season they made it do; so that he stuck to his system as long as he lived, and the land got no manure but what the horses and cows made. I was thoroughly acquainted with this land, and much interested in watching the result. The produce grew gradually less—not year by year, or the owner would have taken the alarm; but each droughty year that came produced a worse crop than the preceding dry season, until I have seen the produce of fifty acres carried home in nineteen cart-loads! The quality, too, had fallen off quite as much as the quantity. In one part of the park where the land was light, one kind of grass (*Arenaria flava*) had taken almost exclusive possession of the land, and neither cattle nor sheep would graze on this portion, except in the most desultory way; a mouthful here and another five yards further on, picked up on the move, showed what they thought of the system; and even the hay was sorted over rather than eaten by the cows, a large portion being deliberately rejected and trodden under foot. This is an instructive instance, showing that the produce of grass land restored to it annually, less the value abstracted from it by the animals fed on it, will not, when continued for a length of time, prevent ordinary grass land from gradual but steady deterioration. It also shows how much more rapidly light land deteriorates than that which is stronger. The park in question, after being mown for many years, was certainly not worth more to let than 20s. per acre on the lighter, and 30s. on the stronger land; but after ten years' continuous pasturing, with occasional manurings and top-dressings, it became worth 50s. per acre all round.

"Having endeavoured to lay it down as an established fact that no grass land will maintain itself unimpaired without the farmer's aid, I will venture to prescribe a mode of treatment which aims higher than mere maintenance:—

"On first-rate grass land there is comparatively little to be done. Deep alluvial soils contain such store of the elements of plant growth, and are for the most part so easily penetrated by the roots of the grasses, that many years' successive pasturing seems to produce but little change in the quality of the herbage. But even here there are gradations of goodness. If the occupier carefully scrutinises his fields in early spring, he will find backward patches, and in early autumn places that turn brown before the rest. These evidently want helping up; and in midsummer he will generally meet with places more or less avoided by the cattle when making their regular grazing rounds. In all these cases a slight dressing of the mixture hereafter mentioned may be put on at any time, being perfectly harmless to the cattle if taken up with their food. No dressing, however, should ever be applied in droughty weather. Where a piece has grown coarse from not being eaten, it should be switched over with the seythe, in order that the tillage may quickly reach the roots of the grass. In this way the land may be kept up to its full producing power.

"There is in the country a large quantity of grass land which is not considered feeding land, but yet will fatten young heifers or small Irish beasts if the occupier is not in a hurry, and does not put them too thick on the ground. This kind of land is the most inviting to the improver; and if the occupier cannot screw up his courage to face the whole at once, he should till ten acres well rather than twenty in a half-and-half way. Let him give a sufficient dressing to change the character of the herbage at once, so that he may have one field at least on which he can finish off his forward beasts. Mr. Lawes, on his experimental grass-plots at Rothamstead, first taught the world that on a piece of old pasture, neither very good nor very bad, different kinds of tillage, repeated on the same ground for a few successive years, will produce as many different kinds of crop as there are kinds of tillage used, the character of the plants in the different plots varying as much as the quantity and quality of the produce. It is quite safe to assert that any occupier may, if he pleases, convert his grass into feeding land; and though it will not always pay to do so, there are very many thousand acres on which it will pay well at the present price of meat. If any one wishes to satisfy himself whether what he has done in the way of improvement is in the right direction, and whether
he has carried it far enough, let him watch his cattle when they are grazing. If they take the grass as it comes, heartily and contentedly, merely rejecting piled portions, so that they are quickly satisfied and lie down to rest, the occupier may be sure he is on the right tack, and may leave well alone; but if they pick one bit and leave another, take the top off one kind of plant and nibble a few leaves off another, he may be equally sure that the pasture is unpalatable to the cattle, and that without change they will not give a satisfactory account of themselves at the end of the season.

"The three worst kinds of pastures are generally supposed to be those on light sands, on strong clays, and on black peaty soils. The light sands I give up to the plough, unless in parks or ornamental grounds, where it is important to preserve the turf; ammoniacal dressings will produce a sudden appearance of improvement on light sandy land, but the effect is not lasting, and the dry benti grasses soon re-assume their sway. A mixed top-dressing will, for a time, increase the clovers, but a heavy dressing of compost, containing root-scrapings or any other tolerably strong soil, is the most permanently useful. Improving pasture on really light sand is, however, one of the most thankless and ceaseless of agricultural operations, and ought to be the next task for Sisyphus, if ever his rolling stone should wear out.

"The strong clays are much more promising. Most clay contains an abundant supply of the minerals which make a soil fertile, but they are in a crude state, and require air to make them fit for plant-food. The cracks caused by drought and worm-holes partially effect this, but the mineral supply from clay land that has long been in pasture is not sufficient to support heavy crops, and it should be a fundamental maxim with all clay-land farmers that their grass should never remain long without a dressing of farm-yard manure. Even the poorest, worst made manure, which is little better than straw, is of great value, as it furnishes the requisite minerals, and, though deficient in ammonia, that can be supplied in soot, nitrate of soda, guano, &c. The grass grown on clay is wholesome and nutritious, unless the drainage is defective or the land has been robbed; and with a little extra tillage clay pastures may be made to get moderate-sized beasts fit for market, especially if helped with cake or corn in the latter end of summer. All tillage should be applied to strong land pastures early in winter. Many weeks are required to wash in the various mineral salts, and, from the retentive character of the soil, there is no fear of their washing out again. All operations on clay land require more time than on lighter soil; soluble matters make their way more slowly down, and plants extend their roots with greater difficulty. It is, therefore, a great object to put on farm-yard manure, compost, and even mineral applications, soon after the grass is eaten bare in autumn, so as to have the full benefit of the winter rains. The roots of grass are always growing when the thermometer is above freezing-point; and if by means of tillage applied in early winter the roots of the grass strengthen and extend themselves before the growing season arrives, a good foundation is laid for the increased development above ground which is sure to follow. If, on the other hand, the application of tillage be delayed till March or April, and a droughty spring follow, the application loses great part of its effect for that season.

"Where grass on clay is very unproductive, it sometimes becomes a question whether it would be better to plough it out and relay it. In such a case, much ought to depend on whether the form of the land can be much improved by taking it out, whether high ridges require levelling, awkward water-courses filling up, old banks removing, &c. This is landlord's work, and requires both time and money to do it well. Those who set about it deliberately, knowing the difficulty of restoring the fertility of the old ridges after..."
ploughing down, and prepared to go on paying until the object is accomplished, will ultimately reap their reward; but tenant-farmers or landlords who do not mean to do it thoroughly would be wise to confine themselves to making the best of the old turf. If properly drained, it will yield an immediate return for all tillage bestowed upon it; and, on the whole, I incline to the opinion that grass on clay, being let low, will generally pay an improving farmer better than any other kind of pasture land.

"The third kind of inferior pasture mentioned above is that on black peaty soils. Where the depth of peat is considerable, or where it lies on white or yellow sand, it is very unpromising; but even in these cases I have seen instances where nitrate of soda or soot had a striking effect, and made the cattle eat the rough herbage greedily. The varieties of peaty soils are so numerous, and the results of applying tillage differ so widely, that it is generally advisable to try it experimentally in the first instance, putting a heavy dressing of the tillage intended to be used on a small portion of land. Where the peat lies upon clay it can always be made good land if the situation is such as to admit of efficient drainage. Should the thickness of peat be inconsiderable, so that the roots of the grass can reach the clay, a dressing of the tillage already mentioned will almost always succeed in making black land very useful for rearing young stock, with which it seems to agree remarkably well. Should a few acres be contiguous to a feeding pasture on higher land, I have found it answer well to let even fattening cattle have the run of the whole. They highly relish the variety of herbage thus afforded them, and in dry seasons the black land pasture will often keep its colour and freshness when the other burns. Should there be three or more feet of peat upon the clay, it answers best to break it up, and give the land a substantial dressing of clay before laying it down again, either by throwing it over the land from trenches, as practised in some of the Eastern counties, or, if too deep for spade-work, then by carting it from pits. When this expense has been incurred, it will probably become doubtful whether to lay it down again to grass or to keep it under the plough, for which, after claying, it is extremely well suited.

"Frequent mention has been made of a mixed top-dressing which has been found to be a valuable application to grass land. It has been gradually arrived at, after many trials and modifications, and consists of nitrogen, phosphoric acid, and potash. These substances may be supplied in the form in which they can be most readily and cheaply obtained at the time and place required. The nitrogen may be furnished in guano, soot, nitrate of soda, or in the more specific form of muriate or sulphate of ammonia. The phosphoric acid may be obtained from bones, mineral superphosphate, or some of the poorer guanos. The potash similarly may be applied in the form of kainite, sulphate of potash, &c. The particular substances I am employing this season (1872) are nitrate of soda, mineral superphosphate, and kainite, in the following proportions:—1 ewt. of nitrate of soda, 2 cwt. of mineral superphosphate, and 3 cwt. of kainite per acre for pasture. At present prices this costs about 42s. per acre. For mowing land, where no manure is used, I should add to the above quantities ½ cwt. of nitrate of soda, making the whole outlay about 50s. per acre. Where land is annually mown, a dressing of this manorial value is required every year to prevent deterioration, except in exceptional cases, such as deep alluvial land, water-side meadows subject to flooding, &c. The best practice is, no doubt, to manure mowing land regularly with good farm-yard manure; but in the numerous instances in which this cannot be done, the meadow may be maintained in full productiveness by a good manuring once in three or four years, and a dressing of the above mixture in the intermediate seasons. For pastures it cannot be contended that a dressing of this character is required year by year, but after laying down a field to permanent grass, it is absolutely necessary to till hard for three or four years, in order to keep it steadily progressive; and when grass land has been long neglected, and is thoroughly out of condition, one dressing will not suffice. It requires following up for two or three successive years before the traces of long neglect will be completely obliterated."

The foregoing is written mainly from a grazier's point of view as to the manner of treating grass land, but it applies equally to dairy-farming. The land, in fact, which is well adapted to fattening cattle is, as a rule, equally suitable to the production of milk. Dairy-cows will, of course, milk fairly well on land that will
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hardly fatten stock, and such land is commonly used for dairy purposes; but it is none the less true, on that account, that the better the land, the greater will be the production of milk. Still, it must be admitted that of two kinds of pasture land, equally strong, sound, healthy, and excellent, the one is, for some reason or other not at present well understood, peculiarly well adapted for fattening, whilst the other's speciality is the production of a maximum quantity of milk. This singular difference between them is, however, seldom a very marked one, though there can be no doubt that it really exists in some cases. But this cannot be interpreted into an argument against the policy of improving all grass land that needs improvement—rather the contrary; for most dairy-farmers fatten a few cattle, and it is a simple matter to fatten on those fields which, rightly or wrongly, are supposed to be better for that purpose than for any other, and to devote the remainder to dairying. Both these sorts of land will commonly be found on the same farm, often in adjoining fields; and the practical issue of the matter is that such land is interchangeable as to either of these uses—that is, the land which is found excellent for fattening will be found equally so for dairying, and the better condition the land is in, the better adapted it is for either purpose.

"Nothing is so cheap as land" is an argument used by some farmers against going to the expense of improving pastures either for grazing or dairying. Whether or not this is true as to some kinds of land, or as to land which is held at a low rent, the argument does not interfere with the soundness of our position as to the improvement of grass land. The root of the argument lies in the fact that many farmers are afraid to improve their land lest they be called on by the landlord, after a time, to pay an increase of rent commensurate with those improvements. This has often been done, and it has made tenant-farmers very cautious how they improve their farms. But where a man can repose confidence in his landlord—and the majority of landlords merit this confidence—where he feels conscious that he is secure against being raised in rent on the basis of his own improvements, there can be no doubt that money judiciously laid out in the improvement of grass land will pay the farmer well. Let us admit that nothing is so cheap as land, and it follows that, as land is limited in quantity, the thing next in cheapness is to improve that land. When a man can feel sure of reaping the reward of his improvements, he is more than merely justified in making them; for by those very improvements he practically extends the area of his farm, he increases its stock-carrying capacity, he improves the quality as well as increases the quantity of his productions, and he benefits not himself only, but also the nation at large.

FARM-YARD MANURE.

Farm-yard manure, strictly speaking, is the residue of various kinds of vegetable productions, either as forage or as corn, which are used as food and litter by the animals in the farm-yard. The animal system uses up a portion of these, and the remainder is ejected in the form of liquid and solid excreta. The quantity and quality of the manure will vary in obedience to the kinds of food consumed, and the method of consuming it. If much forage be used as food, and litter as bedding, along with a large proportion of roots or other green food, and with little or no corn or cake, the quantity of manure produced will be large, but it will be poor in quality, and its actual worth will not as a rule exceed 5s. per ton. But if a large quantity of corn or cake, especially decocted cotton-cake, be consumed along with the forage, instead of roots and other green food, the manure will be less in quantity, but very much better in quality; the more concentrated the food, the richer the manure and the less of it. Again, the conditions under which the food and litter are used will materially influence the quality of the manure; thus, if they are given to the cattle in open yards or courts, a large quantity of rain-water falls on the manure, and if this rain-water be not absorbed by an adequate quantity of dry litter it must pass through and away from it, and in passing it dissolves and carries away a large portion of the soluble and more valuable elements of the manure, thus reducing the quality of it; and the bulk of this liquid is only too commonly allowed to run away to waste. It is, however, in some cases collected in tanks, to be afterwards carted out on the land in barrels or liquid-manure cars; but it is commonly so much diluted with water that it is scarcely worth the expense of carting out; the cheapest and simplest way of dealing with it is to allow it to run over the land by the aid of
sluices cut in the surface and so arranged as to distribute it equally. The best system is to have covered yards to protect the manure as well as the cattle from rain and snow. Where the cattle are kept in boxes or stalls, they of course are protected, but if the manure is taken out from them and put in heaps in an open yard, and there exposed to the inclemencies of the weather, all the evils incident to open yards are present, so far as the manure is concerned; and under this system it would always pay the farmer to have his manure-heaps shedded over.

In box-feeding, the manure commonly remains where it is made until it is wanted for use on the land; but in box-feeding there is a great waste of space, and a large quantity of litter, of which a better use ought to be made, is trodden under foot by the cattle. The most modern method is that practised by Mr. Mechi, of Tiptree; all his animals are fed under cover, on sparred floors, and the excreta fall down between the spars into chambers or cellars beneath, from which they are removed whenever expedient. A similar system is followed by American farmers, who place dry earth, sawdust, leaves of trees, dried weeds, refuse litter, or anything else that will answer the purpose, on the floors of the cellars to absorb the liquid portion of the excreta, and to augment the quantity of solid manure. Yet on either of these systems, the simplest plan is to conduct the liquid manure over the surface of some contiguous field of meadow land; and the manure cellars need to be so arranged that ready access to them can be obtained by the carts which will convey the manure away. To this end the buildings, wherever it is possible, are best built on sloping land, in which case it is a simple matter to cut out a runway to the manure cellars. But if no sloping land is available, incline planes are constructed, and up these not only do the cattle go to their stalls on the first floor, but at harvest-time the cart-loads of hay go up also and enter the building by the large door seen in Fig. 45. This figure represents the exterior view of a dairy-barn belonging to Mr. Merriam, of Cherry Brook Farm, Weston, Massachusetts; and the diagrams given in Figs. 46, 47, and 48 represent respectively the basement and first and second floors of the building.

The engravings mentioned represent what is considered a favourable specimen of an improved American dairy-barn. These American barns are usually built of wood, with stone basements, and, from personal inspection of barns similar to that in the accompanying engraving, we can speak to the comfort and convenience secured in this arrangement. Another and still more modern American barn is illustrated and described in the section on Dairy Homesteads, page 57.

A knowledge of chemistry and physiology is not needed to enable us to comprehend that the quality and quantity of dung voided by any description of fattening stock or milk-cows is the balance between the food consumed and that portion of it which is retained in their bodies as flesh, fat, &c., or withdrawn in the form of milk, perspiration, respiration, &c. The dung is therefore inferior to the food, from a fertilising point of view, just in proportion to the substances extracted from the food by the animal economy; but it is improved in form as food for plants by having been consumed by animals—they prepare it for the plants, which in turn again prepare it for the animals. A four-year-old beast extracts from the food given him only those substances which go to increase the soft portions of his body, and to maintain the various processes of which his life is made up; but a young beast not only does both these, but also extracts what is required for developing the bone; hence the dung of a mature animal is more valuable than that of a young one, just in proportion to the amount of matter which the young one keeps to build up the bony and muscular structure of his frame. It follows, consequently, that the quantity of manure produced on a farm will depend on the quantity of food grown and consumed on it, and on the quantity of feeding-stuffs purchased to supplement and improve the food produced on the farm itself; and that the quality of the manure will in like manner depend on the kind of stock kept, and on the kind of food purchased in addition to that produced.

The management of farm-yard manure may be said to be, next to the management of stock, one of the most important departments of farm practice, and it is unfortunately one in which there is a disastrous amount of waste on the great majority of farms. Science has striven for a long time to impress this important fact on the agricultural mind, but still the waste is permitted to go on in too many places. It is, however,
true that of late years a great improvement has taken place in the construction of farm-buildings, the preservation of manure in these cases having had the attention devoted to it that it merits, but in most of the older farmsteads there is still a deplorable want of such accommodation. The bare fact that about 30 in. of rain fall annually over Great Britain and Ireland ought long ago to have suggested the necessity of protecting the manure-heap from such deluges. The first want of the present day, then, where they are not already provided, we may take to be covered yards. About this there is not the slightest room to doubt, for a loss of manure is equivalent to a diminished produce. The great reason why we water, or it runs away to waste, unless there happens to be a field adjacent on which it can be made to run at will. Covered yards remove to a great extent the difficulties connected with farm-yard manure, and the liquid portion of it becomes a less difficult problem, because it is almost wholly soaked up by the solid, and is not, as in the case of open yards, increased in quantity and equally decreased in quality by the addition of unlimited rain-water. Covered yards, however, on most dairy-farms can only be made available for young stock—dairy-cows, unless barren, will be out of place in them, because they settle each other, and so bring on abortion.

Farm-yard manure, owing to its complex nature, to the variety and quantity of valuable ingredients it contains, all necessary to plant-life, and because its mechanical effects are valuable along with its manural properties, is justly taken as the type of a perfect general manure, and as such no reasonable care and trouble should be spared in its production first and in its management afterwards. The farmer cannot always be held responsible for the good or inferior quality of the actual manure, as produced, since this is influenced so much by the nature and age of the stock that produces it and the kind of food they have to eat, and by the nature of the buildings he has at command; but he can and should take care that the straw and dung get properly mixed, as well as the manure of different kinds of stock, so as to secure a uniform description of manure. If he stall-feeds, and uses a

![Fig. 45.—American Dairy Barn (Exterior View).](image-url)
quantity of litter as bedding, he should take care that the litter from behind his cattle, and the manure which is very imperfectly mixed with it at the time, should be well trodden down and thoroughly amalgamated in the yard to which they are taken. When there are only open yards or sheds, he should prevent all the water he can from pouring down on the manure, washing out its goodness only to waste it, and to this end the roofs of the sheds should be properly spouted. No straw should be spread in the yards beyond what is required to keep the beasts moderately dry, and the black liquid which oozes from the manure should be thrown over it that it may be re-absorbed. The manure from the stables should not be thrown in a place by itself, but scattered over the other, for it differs in such a way in its nature, from that produced by the cattle, as to materially affect the crops to which it is applied. The manure-heap must not be allowed to get too dry, especially if a large part of it consists of horse-manure, or a white mould will be found in parts of it when it comes to be forked over; this should be prevented by timely moistening with liquid manure.

Due regard must be paid to the time when the manure will be required for use; if it is carted into a heap in the corner of a field, and intended to remain there some months, precautions must be taken to exclude the air and prevent fermentation. In this case dig out a bed in the soil, some 12 or 18 inches deep, at the bottom of which put some kind of refuse which, by soaking up any waste liquid, will in time become valuable; here build up the heap in an oblong shape to the height of 5 feet or so—carting while you can each successive new load over those previously deposited, so as to compress the mass. When up to the height, round the top slightly so as to allow rain-water to run off, trim the sides of long straws, and spread the soil previously dug out for the bed over the top of the heap in a layer of a few inches. This will prevent the escape of volatile gases. Gypsum so applied will also arrest these gases either on the heap or scattered on the stable floors, and will yield them up to the land afterwards. A month before the heap will be required it should be once, or perhaps twice, turned over, which will cause, by admission of air, fermentation and decay, so that it will cut with a spade. When manure-heaps are required for almost immediate use, they should not be so compressed, but only well forked about and mixed,
has been in most cases so diluted with rain and other water as to be rendered powerless for good. The drains from all buildings should run into one tank, which should be completely protected from surface water, and from thence the liquid manure can be carted, or conducted by pipes or other means, on to the pastures or wherever it is required.

The custom of making large heaps of manure out in the fields is going out of fashion. Many farmers have covered sheds for it, where it commonly remains until it is wanted, and it is afterwards generally spread on arable land in the autumn and ploughed under at once; on clover-root, which is about to be broken up for wheat, it is spread in August, and on grass land it is spread at almost any period except summer; on most kinds of meadow land it is generally, and with truth, supposed that there is a better crop of hay if the manure is applied in the previous autumn rather than in the spring of the year in which the crop is grown. Except on a very light and open soil, it is always a good plan, providing the weather is suitable, to get out the manure on meadow land as soon as the hay-crop is gathered in; on very light, open soils this is not to be recommended, but the heavier soils possess the faculty of absorbing the manure, and in their case the roots of the plants can make use of it at any time that will best promote their fertility. But where it is still the custom to keep manure-heaps out in the fields or in open yards, it should be remembered that there will be a serious loss of the volatile elements of the manure, unless something is done to prevent their escape. Gypsum and oil of vitriol (sulphuric acid), having a strong affinity for fugitive alkalies, are very useful chemico-agricultural detectives, and they may with great advantage be used to arrest any such fugitives as are trying to escape. Ammonia, or, rather, carbonate of ammonia—the form in which ammonia escapes from a manure-heap—has the property of decomposing sulphate of lime (gypsum) in a considerable degree. The chemical action which takes place results in the formation of carbonate of lime and sulphate of ammonia, the ammonia being thus converted into a fixed, whereas it was previously a volatile salt, extremely liable to evaporation. But the chemical action which takes place is very weak, and there is a limit to the absorption of ammonia by sulphate of lime; and if all the ammonia is to be absorbed, a considerable quantity of sulphate of lime must be used on the manure-heap. A more effective plan is to sprinkle the manure-heap occasionally with diluted oil of vitriol; this will effectually fix the ammonia, converting it into sulphate of ammonia. As most sulphates, nitrates, and phosphates are freely soluble in water, it is necessary to be sparing rather than profuse in using the diluted acid; it is expedient not to saturate the heap, but simply to moisten the surface occasionally, and it is equally necessary to keep, if possible, the heap from being saturated with rain-water. It is not difficult to ascertain when the heap wants a fresh moistening—when the fumes of ammonia are again escaping, that is. If a small piece of red litmus paper, moistened, be held close to the heap, it will almost immediately turn blue if any ammoniacal vapours are being evolved; but as long as the surface of the heap is kept in an acid state, by sprinkling diluted acid over it, no volatile ammonia can possibly be given off and escape in the form of vapour. It must, however, be remembered that the very elements which you have been trying to arrest at the top will escape at the bottom, if the heap is exposed to deluges of rain-water.

It is always true policy on a farmer's part as well to augment the quantity as to conserve the quality of the manure produced on his farm. Leaves of trees, coarse grass, unripe thistles, nettles, charlock, the roots of couch-grass, peat-soil, burnt clay, and any products of the farm, all serve to increase the bulk of the manure-heap, and if they are well dried to start with they will absorb the volatile and liquid portions of it; indeed, he cannot easily attach too much importance to this part of the farm economy. It must ever be borne in mind that farm-yard manure and lime should never be applied together on land, for the lime has a destructive influence over the valuable elements of the manure; thus, it drives off all the ammonia, which is one of the most precious constituents. If it is desired to apply both lime and farm-yard manure to the growth of any one crop, an interval of two or three months should be allowed to occur between the dressings.

It has been, and still is in some places, the custom to make large compost-heaps of the scourings of ponds and ditches, of road-scrapings, of the
surplus soil which is left over in draining land, and in levelling old banks and fences—of any kind of refuse, in fact, that was capable of being improved by mixing with lime or dung. These are turned over one or more times at intervals of a month or two, and are sometimes carted considerable distances to the meadows, where they are spread, chain harrowed, and the stones picked carefully in order that they may not interfere with the knives of the mowing-machine. It is, however, now beginning to be thought that these composts are not worth the labour expended on them, that it is more economical to apply a small dressing of good artificial manures, and that any coarse soil that has to be removed is better applied with as little labour as possible upon the nearest pasture land that it would be likely to do any good to. But it cannot be denied that a good large compost-heap, consisting of lime and soil well amalgamated together, is a very useful piece of supplementary manure, and a good dressing of it has an excellent effect on meadow land that has been long accustomed to no other than farm-yard manure, or to pasture land that has received no dressings of manure at all; it is a change of system which gives a fillip to the land, and the effect of it is commonly seen for years in the greatly improved quality of the herbage. The question of expense with regard to it is a matter which must always be left to the farmer's own judgment, and in this he will be governed by the price of labour in the district.

Unlike farm-yard manure, compost is injured by being put under cover. It has everything to gain and little or nothing to lose by contact with air and rain. Under cover it deteriorates; exposed to the atmosphere it improves. The more exposure it receives, the better it is, for two reasons: in the first place, the stuff of which compost is usually made has generally been excluded for a long time from the air, and, partly in consequence of this, it has great facilities for absorbing from the air those valuable properties of which it stands so much in need. And in order that it may the more freely absorb these, it is expedient that it be frequently turned over with a shovel, so that all of it may in turn be well exposed to the air.

At the same time, it must be remembered that even farm-yard manure may be injured by being too long under cover, unless it is kept moist enough. Manure that contains much litter is of course the most liable to become too dry under cover; and it needs to be well moistened now and again with liquid manure, if any of it is at hand, and with water if it is not, but only moistened—not saturated through and through.

Anyway, compost-heaps are very useful; whether or not they pay is another matter; but in any case it is unwise to reject, on grounds which are merely conjectural, the use of anything which may be available as a manure.
CHAPTER XII.

FORAGE PLANTS AND WEEDS.


We shall consider the various forage plants under the heads of the natural orders to which they respectively belong, as we believe this method will be found advantageous to the reader acquainted with the outlines of classification, while it will in no way complicate the subject for the non-botanical reader. A natural order is simply an assemblage of plants grouped together on account of the many botanical characters they possess in common, and the general characters of the natural order pertain in most cases to all the plants included in it. The botanical name of a plant consists of two words; the first is the generic name, and refers to the sub-group, or genus of the order to which the plant belongs; the second is the specific name, and indicates, when there are more plants than one in the genus, which particular plant or species is referred to. Thus, the primrose, Primula vulgaris, and the cowslip, Primula veris, are both species of the genus Primula, and Primula itself is one of a number of genera which constitute the order Primulaceae. An order then is made up of genera, and a genus of species. Occasionally a species is divided into several varieties, and sometimes a genus only contains a single species.

Passing under view a list of natural orders systematically arranged, the first to attract our attention, as being of agricultural importance, is the one named Crucifere. The fruit of this order may be either long, as in the mustard, cabbage, and gillyflower (Fig. 49), or short, as in the common weed, shepherd's purse. In either case a thin membrane will be exposed to view when the two valves of the fruit open, and it is to the margins of this membrane that the seeds on each side are attached. The arrangement of the leaves in plants of this order is alternate, first one on one side of the stem, then another at a different level on the other side. There are no stipules and no bracts. Stipules are small leaves at or near the base of the leaf-stalk, or petiole, as seen in the rose-leaf (Fig. 50, a); bracts are similar small leaves on the flower-stalk.

The plants of this order are distinguished by their pungent, stimulating, and sometimes acrid properties, but none of them are poisonous. They are anti-scorbutic, hence the desire of people, such as sailors, who have for a long period subsisted on salt meat, and rendered themselves liable to scurvy, to obtain vegetables yielded by this order. The Crucifere contain notable quantities of sulphur and nitrogen, and these, in union with other elements present, form, amongst other products, a peculiar volatile acrid oil, to which the stimulating properties of the order are due. The disgusting odour which arises from decaying heaps of cabbages and turnips is due, in great part, to the formation of sulphuretted hydrogen and ammonia.
1. **Trifolium pratense** (Common Red or Broad-leaved Clover).
2. **Trifolium arvense** (Dutch Clover).
3. **Trifolium incarnatum** (Crimson Clover).
4. **Trifolium hybridum** (Alsike Clover).
5. **Oxytropis sativa** (Sainfoin).
6. **Medicago lupulina** (Black Medick).
7. **Leucaena leucocephala** (Lupin, blue variety).
8. **Vicia sativa** (Vetch).
Among crucifers, the cabbage, *Brassica oleracea*, is used as a cattle-food, especially in autumn and winter. Analysis No. 8 refers to this plant. The inner and younger leaves contain much more water than the older outside leaves, and on the whole this vegetable may be considered more nutritious than the turnip. Savoys, Brussels sprouts, Scotch kale, and red cabbage are all varieties of the common cabbage; so are the cauliflower and broccoli, in both of which a large number of very imperfect flowers are crowded together to form the white heads so much relished at our tables. The kohl-rabi is a variety in which the stem is enlarged into a fleshy turnip-like knob above ground.

The turnip, *Brassica rapa*, is a widely cultivated crucifer, and is a food much relished by cattle and sheep. The peculiar flavour of the root, which is especially noticeable in a "strong" turnip, is due to the presence of a pungent essential oil. As will be seen from the analysis (No. 1), the root is very watery, and contains but little nourishment, so that if an animal tried to get fat on turnips alone, it would have to pass a large quantity of unnecessary water through its stomach. The Swedish turnip, or sweed, is specifically distinct from the turnip, and is believed to have sprung from *Brassica campestris*; it is rather more nutritious, and contains less water than the common turnip (Anal. No. 2). The rape, *Brassica napus*, is valuable both as green fodder and for ploughing in as a green manure; its seeds (rape and colza) are crushed for oil, and the residue, consisting chiefly of the seed-coats, is made up into cake, and used as cattle-food, and as a fertiliser. An analysis (No. 52) of rape-cake is given.

White mustard, *Sinapis alba*, the leaves of which are used as a salad; black mustard, *Sinapis nigra*, the ground seeds of which form a condiment; and the troublesome weed called charlock, *Sinapis arvensis*, are closely allied to the foregoing plants of the genus *Brassica*. White mustard is eaten off as a green crop, and ploughed in as a green manure.

The radish, horse-radish, sea-kale, cress, water-cress, Jack-by-the-hedge, shepherd's purse, wallflower, and stock are all familiar crucifers.

The natural order *Leguminosae* is the one to which the pulses (peas, beans, &c.) and the clovers belong. Its botanical characters are very definite, so that it is easy to determine whether or not a given plant belongs to this order. Thus, the corolla consists of five petals, which are of three different sizes; their arrangement will be understood by reference to the corolla of the pea, as represented in Figs. 51 and 52. At the top is seen the largest petal, called the standard; below and enclosed by the standard are two side petals both alike, termed the wings; these latter partly overlap the two smallest petals, which are joined together to form the keel. Every British leguminous plant has its corolla built up on this type. After fertilisation, the pistil develops into the fruit, which is a pod, or *legume*. In Fig. 53 is shown the legume of the pea, with the flower-stalk and calyx still remaining. The pod of the leguminous plants resembles that of the crucifers in opening by a pair of valves, but the two differ in that the cruciferous pod has a thin partition down the middle, while the leguminous pod has not. The foliage leaves are furnished with stipules, and are alter-
nate. The leaves, again, instead of being simple, are usually compound; that is, each leaf consists of several distinct pieces called leaflets, as is seen in the ternate leaf of the clover, and the pinnate leaf of the pea and laburnum. Frequently the leaves are converted into tendrils, which enable weak climbing stems to obtain support from more substantial structures. In the representation of the pea, Fig. 54, we see a pinnate leaf with the upper leaflets transformed into tendrils, at the base of the leaf-stalks are two large stipules which meet round the stem, and the peduncle bears a flower and a fruit.

The Leguminose yield more substances of general use than, perhaps, any other order. The farinaeuous seeds are highly nutritious, and the herbage affords a superior fodder.

The clovers, or trefoils, belong to the genus Trifolium, which includes some eighteen or twenty species, and derives its name from the fact that each leaf is divided into three leaflets. The part commonly called the blossom will be seen, on examination, to consist really of a large number of small flowers crowded together into one head on the receptacle. The fruit is a short, unjointed, nearly straight pod containing from one to four seeds. Not more than six or seven species are under cultivation as forage plants.

White, Dutch, or Honeysuckle Clover, Trifolium repens (Plate 1, Fig. 2). The large globose head of white, rarely pinkish flowers at once distinguishes this plant from its allies; the lower flowers of the head are often to be seen brown and withered, while the upper ones are still in their prime. The longish pod contains four to six small seeds. The green leaflets have usually a horse-shoe mark near the base, and the creeping stem sends down fibrous roots at the joints. The plant should find a place in all pastures, as it bears grazing well, and quickly springs up again. Too much of it, however, is said to have a scouring effect on cattle. Two analyses are given, one of white clover in blossom (No. 9), the other of hay made from white clover (No. 28).

Common Red, Purple, or Broad-leaved Clover, Trifolium pratense (Plate 1, Fig. 1), is one of the most valuable clovers. Its hard, somewhat woody root supports a stem growing from 12 to 18 inches high, and the oval leaflets have a horse-shoe mark in the middle. The pod contains one seed, purple in colour, and rather large for a clover seed. This plant is chiefly used for alternate husbandry. There are many varieties of it peculiar to different countries, the plant appearing to vary according to soil and climate. Two analyses of the green plant are given, and one of the hay (Nos. 10, 11, 20). A variety called True Cow Grass Clover, or Perennial Red Clover, Trifolium pratense perenne, is much in favour just now; it only differs from the common red clover in being, according to some growers, more lasting, and therefore preferable in seeds for several years’ lay, and for permanent pasture.

Hybrid or Alsike Clover, Trifolium hybridum (Plate 1, Fig. 4), is a smooth perennial plant with hollow stems and fibrous roots. The flowers are partly white and partly pinkish, and are arranged in loose heads on long stalks, so that the plant has an appearance intermediate between that of white clover and common red clover. The pod is short, and contains a couple of dark little seeds. Alsike
PLATE 2. LEGUMINOUS PLANTS AND WEEDS.

1. Trifolium pratense (Meadow Clover, or Clover, Trefoil).
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X.—Trifoliim (Bove, or clover, Trefoil).
2. Trifolium pratense (Hops Trefoil).
3. 
4. Lotus corniculatus (Sub-chestnut Trefoil).
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X.—Trifolium (Bove, or clover, Trefoil).
2. Trifolium pratense (Hops Trefoil).
3. 
4. Lotus corniculatus (Sub-chestnut Trefoil).
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X.—Trifolium (Bove, or clover, Trefoil).
2. Trifolium pratense (Hops Trefoil).
3. 
4. Lotus corniculatus (Sub-chestnut Trefoil).
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X.—Trifolium (Bove, or clover, Trefoil).
possesses the useful property of yielding abundant crops on "clover sick" soils. Two analyses of the green plant and one of the hay are given (Nos. 12, 13, 30).

Crimson, Scarlet, Carnation, or Italian Clover, *Trifolium incarnatum* (Plate 1, Fig. 3), is readily known by its elongated, velvety-like, crimson head of flowers. As it is particularly addicted to limestone soils, it can be grown to far greater advantage on such than on any other kind. Sown in autumn, it is ready for cutting or eating down in the following May. It may be either grown alone or with Italian rye-grass. As a green fodder, cattle and sheep eat it eagerly. (Analyses Nos. 14, 31.)

Other clovers occasionally grown are the Zigzag Trefoil, or Meadow Clover, *Trifolium medium* (Plate 2, Fig. 1), with rather rigid leaflets, and heads of flowers of a rose-purple colour; and the Lesser Yellow Trefoil, or Yellow Suckling Clover, *Trifolium minus*, which much resembles *Medicago lupulina* (Plate 1, Fig. 6), differing from the latter, however, in that its leaflets are heart-shaped with the narrow parts joined to the leaf-stalk, and in having the florets less densely crowded on the receptacle. The Hop Clover, or Hop Trefoil, *Trifolium procumbens* (Plate 2, Fig. 2), is sometimes included in mixtures. Its flower-head is rather larger than that of *M. lupulina*, and its colour is a pale yellow. As the largest petal of each floret is bent back at its free extremity, the whole head has a hop-like appearance.

From a botanical point of view, only those plants which belong to the genus *Trifolium* are properly termed clovers, or trefoils. There are, however, many other useful leguminous plants which the farmer includes under the general name of clover. The chief of these we proceed to notice:

The genus *Medicago* resembles *Trifolium* in that each of its leaves consists of three leaflets. But the little flowers are arranged in short racemes, that is, a number of short-stalked florets is given off from each side of a common flower-stalk, the resulting structure appearing not unlike a small clover-head. Again, the unjointed pod of *Medicago* is spiral, while the pod of *Trifolium* is nearly straight. Two important plants, black medick and lucerne, belong to this genus.

Black Medick, or Nonsuch, *Medicago lupulina* (Plate 1, Fig. 6), is a pretty little plant, considered by some writers to be identical with the shamrock of Ireland. As a wild British plant it is common in fields and waste places. The root is tapering and fibrous, the stem much branched. Black medick is so called from the black colour of the seed-vessel, or pod, which is coiled into a kidney-shaped spiral, and has a net-work on its outer surface. The pod contains only one seed. As the plant is an annual or biennial, it is not suited to permanent pasture, and is always best grown in connection with rye-grass or sainfoin. Analyses of the hay and of the green plant are quoted (Nos. 15, 32).

Lucerne, or Purple Medick, *Medicago sativa* (Plate 2, Fig. 3), has an erect stem, bluish-purple flowers arranged in open racemes, and the pods twisted two or three times. It is rather later than most of the so-called clovers, as it does not flower till June or July; it is a plant of vigorous growth, and attains a height of 2 feet or more. If not eaten down, it may be cut several times during the season for green food. The analyses (Nos. 16, 17, 33) indicate that it may be used to better advantage as a green food than in the form of hay, the amount of indigestible fibre in the latter being one-third of the entire weight. This plant deserves more attention than it has hitherto received from growers, for, in addition to the qualities already mentioned, it is of long duration, and, being very deep-rooted, is eminently suited to withstand long droughts. Partly on account of this last-named property it is extensively cultivated in India.

Sainfoin, *Onobrychis sativa* (Plate 1, Fig. 5), has pinnate leaves, each leaf consisting of an odd number of leaflets, there being a solitary leaflet at the end. There are no tendrils. The beautiful pink flowers are arranged in elegant racemes, and the solitary seeds are contained in flat, wrinkled, one-jointed pods. Sainfoin is a perennial, it has an upright stem about 2 feet high, and a rather woody root penetrating deeply into the ground. It grows on all good soils, and has the additional merit of producing excellent crops on dry limestone soils, a property it owes to its long roots. (Analyses 18 and 34.)

In connection with sainfoin, mention may be made of the Burnet, *Sanguisorba officinalis* (Poterium officinale), (Plate 2, Fig. 6), which is a plant belonging to the rose-family, differing, however,
from most plants in that order by possessing no petals. Its height varies from 6 to 18 inches, and it was formerly recommended for growth with sainfoin and lucerne, but as it has proved to be a coarse and somewhat useless plant, the practice is discontinued, and care should be taken that neither its seeds nor those of its ally, the Salad Burnet, \textit{Poterium sanguisorba}, are introduced with clover-seed.

The Vetch, or Tare, \textit{Vicia sativa} (Plate 1, Fig. 8), has pinnate leaves, which differ from those of sainfoin in consisting of an even number of leaflets, and in having the upper leaflets transformed into tendrils. The plant is an annual, it has pale purple flowers which produce straight unjointed hairy pods containing four to ten seeds, the pods being not unlike those of the sweet pea, but rather smaller. It has a stout trailing or climbing stem. Vetches have long constituted a favourite crop, and an American writer states that "there is no green food of any variety so well relished by horses as vetches, and none which has such a purifying effect, lucerne being no exception." Analyses of the green plant and of the hay are quoted below (Nos. 19 and 33). There are ten or twelve species of wild vetch, one of the most beautiful being \textit{Vicia Cracca}, which bears fine racemes of blue flowers.

The Kidney Vetch, or Ladies' Fingers, \textit{Anthyllis vulneraria} (Plate 2, Fig. 5), has pinnate leaves with unequal leaflets, a terminal leaflet being present. Notwithstanding that it is much relished by sheep and cattle, and that it succeeds well on limestone soils, it is very rarely cultivated.

In the genus \textit{Lotus} the yellow flowers are arranged in an umbel, that is, several short-stalked flowers all spring from one point, as in the cowslip. Each leaf consists of three leaflets, as in \textit{Trifolium} and \textit{Medicago}, and has large leaf-like stipules at the base of the leaf-stalk. The pod is nearly straight, and is many-seeded. The two following species are perennials.

The Common Bird's-foot Trefoil, \textit{Lotus corniculatus} (Plate 2, Fig. 4), is an elegant little plant, in which the yellow flowers are crimson before expanding. It may be seen in flower almost any time between May and September on grassy banks and in dry pastures. The smooth stem lies on the ground, and the height of the plant is from 6 to 12 inches. It is very nutritious, is well liked by cattle, and admirably suited for growing on elevated soils of too poor a character to suit the ordinary clovers.

The Greater Bird's-foot Trefoil, \textit{Lotus major}, is very like the foregoing, differing from it chiefly in its larger more numerous flowers of duller hue, and in its erect stem. It thrives best on somewhat peaty soils.

The Melilot, \textit{Melilotus officinalis}, is rarely grown as a forage crop; it is odoriferous when dry, and sweetens hay.

The Lupins, belonging to the genus \textit{Lupinus} (Plate 1, Fig. 7), include several varieties with differently coloured flowers. They are not much cultivated in England, but the yellow lupin is extensively grown on the Continent, where it is used both as a forage plant and as a green manure. (Analysis No. 20.) It must be stated with regard to the lupin that, quite recently at Namslan, and various other places in Germany, hundreds of sheep have been poisoned by eating the plant. The cause of these fatal effects has not yet been fully determined, but two suspicious facts are known: first, that the lupin contains an active bitter poisonous principle closely allied to the poisonous alkaloid of the water-hemlock; and, secondly, that the plant is extremely liable to the attacks of a fungus which produces a hard dark-coloured structure somewhat like that which accompanies ergot of rye, and which, like this latter, may have injurious effects on animals partaking of it.

The Furze, Whin, or Gorse, \textit{Ulex Europaeus}, is a prickly shrub with deep yellow blossoms, and it grows where little else will. It can be raised from the seed on any waste land available, but transplanting may prove fatal to the plant. Furze is recommended on account of its yielding a nutritious green food for horses and cattle in the winter, forming at that season an agreeable change in diet from hay, and from such roots as turnips and carrots. On account of the prickles it is, of course, necessary to bruise furze before supplying it to cattle, and this may be done either in a furze-breaking machine, or by hand with a mallet. (Analysis No. 21.)

Besides those leguminous plants which are used either as green fodder or hay, there are others which are grown chiefly for their valuable seeds. The pea, \textit{Pisum sativum}, affords in its green unripe seeds a fresh vegetable for the table, while from the ripe seeds are obtained pea-meal and the
split peas used in soups and as cattle-food; it is sometimes grown as a fodder crop, the pea-straw, of which the composition is shown in analysis No. 36, serving as a nutritious adjunct in chaff. The lentil, which is the seed of *Lens culinaris*, is imported into Britain from southern Europe and Egypt, and is used by millers in the composition of meals for cattle-food. "Revalenta," "Ervalenta," and other widely advertised preparations contain lentil meal, generally mixed with the flour of barley or some other grain; they are sold at many times their real value. A glance at the analyses (Nos. 53, 54, 55) of these leguminous seeds will show their high value as nutrients.

The seeds of the laburnum-tree, an ornamental leguminous plant, are poisonous.

The natural order *Umbelliferae* is characterised by producing its flowers in umbels (Fig. 55), and by the leaves being usually much divided; the leaf-stalk at its base sheaths the stem, which is hollow. Harmless weeds belonging to the order are the hedge-parsley, and cow-parsnip; more objectionable are such poisonous plants as the hemlock, fool's parsley, and the water-dropwort. The hemlock, *Conium maculatum*, is at once known by its polished stem, covered with brownish-red spots, and by the unpleasant odour of mice emitted by the stem when bruised. It usually grows in hedges and waste places, attaining a height of from 2 to 4 feet. The fool's parsley, *Anthriscus sylvestris*, is another denizen of waste places, and grows from 1 to 2 feet high. It is very poisonous, and is known by its three narrow bracts which grow towards one side at the base of each little umbel and point downwards. The water-dropwort, *Eranthe crocata*, contains a dangerous poison; it grows in marshes and on the banks of rivers and ditches, its height varying from 2 to 5 feet. Its flowers are white, as are those of the hemlock and fool's parsley. The well-known herb parsley, *Petroselinum sativum*, is sometimes sparingly introduced into pastures, as it is believed to produce a beneficial medicinal effect on sheep. It is a biennial, and produces umbels of light yellow flowers in July. Parsley is distinguished by its pleasant odour, and by the extreme tips of its leaf-segments being white. The most interesting umbellifers to the farmer, however, are undoubtedly the carrot and parsnip, both of which are cultivated for the sake of their succulent tap-roots, which yield an acceptable supply of juicy food in the winter. The wild carrot, *Daucus carota*, has a pungent odour and disagreeable taste, but it has been much improved by cultivation. Carrots, unlike parsnips, contain no starch; analyses of two varieties are given (Nos. 3, 4). The parsnip is a cultivated form of the wild parsnip, *Pastinaca sativa*; its root contains a good deal of starch and some sugar. The composition of the parsnip is shown in analysis No. 5. The carrot has a white blossom, the parsnip a yellow one.

The *Compositae*, although it is the largest natural order, including a greater number of plants than any other, is yet of far less service to man than such orders as *Gramineae*, *Leguminosae*, and *Cruciferae*. The order is distinguished by the extraordinary character of its inflorescence, which is easily examined in the daisy, where the so-called flower will be seen to be made up of a large number of very small florets. The order includes many well-known plants, such as the lettuce, dandelion, tansy, sowthistle, hawkweed, nipplewort, thistle, corn blue-bottle, groundsel, chamomile, and

Fig. 55.—*Compound Umbel of the Chervil.*
everlastings. Two only require notice here, the milfoil and the chicory.

Milfoil, or Yarrow, Achillea Millefolium (Plate 2, Fig. 7), is a plant which occurs in most pastures and on roadsides, especially on poor soils. It has very much divided leaves, and the flowers, though usually white, vary from that colour to pink and red; this frequently occurs on one and the same plant. It possesses astringent properties, and is eaten in moderate quantity by sheep, rather perhaps as a condiment than for any direct nutritive value it may possess. Milfoil is usually recommended to be sown on light sandy soils, railway cuttings and embankments, because of the creeping fibrous character of its roots, which serve admirably to bind loose soils together. The plant is perennial, and grows to the height of about 1 foot.

Wild Chicory, or Sweetsor, Cichorium intybus (Fig. 56), has blue flowers, the heads being given off from the stem in pairs. It is a deep-rooted perennial, flowering from June to August. Chicory is used on the Continent both as a forage plant and as a salad, but it has found little favour in Britain. Cattle are fond of the foliage, but it is said to give an unpleasant flavour to their milk. The root, dried and ground, forms the chicory which is frequently mixed with coffee.

The natural order Boraginaceae requires a passing note, as it includes the prickly comfrey, Symphytum asperatum. Common wild plants belonging to the order are the borage, forget-me-not, hound’s tongue, lungwort, and gromwell. There are two native British species of comfrey, the common comfrey, Symphytum officinale (Fig. 57), and the tuberous-rooted comfrey, S. tuberosum. The common comfrey grows by river-sides, and its leaves were formerly boiled for food by the poorer people. The prickly comfrey, which attains a height of 5 feet, is rather larger than the common comfrey; it has much rougher leaves, and its flowers are more variable in colour—dull white, reddish, or blue; their form is apparent from Fig. 58. A native of the Caucasus, it was introduced into Britain at the beginning of the present century as an ornamental plant, and has only been grown as a forage plant within recent years. It is raised from the roots in this country, as the seeds do not appear to arrive at perfection. The plant is of such rapid growth that it may be cut for green fodder at least four times in the season. It has about the same feeding value as green mustard, or mangold, or turnip-tops, and is recommended to dairy-farmers as a change of food for their cattle. Being a very deep-rooted plant, it is far less liable than plants of more superficial growth to be affected by drought, and it is therefore being cultivated in India. Another point in its favour is its enormous yield, which in the green state is said to be upwards of 80 tons per acre, or from two to...
three times the yield of lucerne. It comes in earlier than other crops, and lasts longer, and its cultivation requires but little care after the root-cuttings are once planted, as it is a perennial. Cattle, sheep, and especially horses, although they prefer other food, soon acquire a taste for it in the green state; when dried it makes an excellent substitute for hay to mix with straw for chaff-cutting. Prickly comfrey is at present cultivated in parts of England, Ireland, France, and India, and its introduction into California for the poultry yards has been suggested, as fowls are very fond of it. The analysis No. 22 refers to a freshly-gathered plant.

Common Plantain, or Rib-grass, *Plantago lanceolata* (Plate 2, Fig. 8), belongs to the natural order Plantagineae, and is not a true grass. It has narrow leaves tapering at both ends, and with prominent parallel veins. The flowers are small, and without stamens, and are closely arranged on an elongated axis. The fruit is a nutlet containing a seed, and the long clusters of these nutlets, forming the "bobtails" of which canaries and other birds are so fond, constitute familiar objects in summer in meadows and cultivated fields. The leaves are produced early in the season, and are then eaten by horses and cattle; but it is rather for the binding action which this plant, like the milfoil, exerts on loose soils, than as a forage plant, that it is introduced into seed mixtures. Owing to the low-lying and spreading habit of its leaves, however, the plant often takes up much more room than it is worth; this property manifests itself especially on lawns, where the rib-grass is nothing but a nuisance. The Greater Plantain, *Plantago major*, has broader leaves than the rib-grass, and its long spikes of nutlets are much sought after by birds.

The Mangold, or Mangel Wurzel, *Beta vulgaris*, belongs to the Goose-foot order, Chenopodiaceae, which includes the beet, spinach, good King Henry, and various common weeds to which the name of goose-foot is applied. The root of the mangold, of which an analysis (No. 6) is given, affords a supply of winter food; it will be seen from its composition that it contains less water than the turnip. The garden-beet used in salads, and the sugar-beet which is cultivated, especially in France, for sugar-manufacture, are simply other varieties of *Beta vulgaris*, the mangold itself being the field-beet. The beet-root (analysis No. 7) and mangold owe their sweet taste to the large amount of sugar they contain.

The order Polygonaceae, known by its membranous sheathing stipules and three-cornered fruits (Fig. 60), includes, in addition to the common weeds called docks (Fig. 59) and sorrels, the rhubarb plant, of which the leaf-stalks are eaten at the table, and the buckwheat, *Polygonum Fagopyrum* (Fig. 61), which is an annual of quick growth and easy cultivation. It is grown for green fodder, and its starchy seeds (analysis No. 56), which resemble those of the cereals in composition, are used for feeding poultry and for making meal.

The flowers of Chenopodiaceae and Polygonaceae have no corolla, and therefore easily escape notice.

The natural order Gramineae is of much greater importance to man than any other family of plants. All our cereals—wheat, barley, oats, rye, maize, rice, millet, dali, and canary-seed—are
true pasture grasses; the succulent sugar-cane and the lofty bamboo alike belong to this order. Rice alone furnishes more food to the human race than any other one species, and probably ninetenths of the plants in an ordinary natural pasture are true grasses.

Before giving a brief account of the most important pasture grasses it will be necessary to say a few words on the structure of the grass-plant and its flower, and to indicate the means of distinguishing between the true grasses and certain far less valuable plants which bear a close resemblance to them.

All grasses have fibrous roots, which are frequently given off from creeping underground stems. The parts above ground consist of ascending axes, or stems, called culms, and these produce the leaves and flowers. The leaves are always entire and usually strap-shaped, tapering, however, towards the upper end. If the base of the leaf be examined, it will be seen to form a sheath around the culm, the sheath being not entire but split down lengthwise in front. At the place where the leaf springs from the stem, the latter will be seen to be swollen, and this swollen part is called a joint. By cutting across the stem it will be found to be hollow, excepting at the joint, where it is solid. Most of these details will be best understood by examining a living specimen, nevertheless they are represented in Fig. 62, which illustrates the culms of the rye-plant. If the leaf be bent back from the culm, there will be seen at the top of the leaf-sheath, and between the leaf and the culm, a small membranous projection, which is apparently a continuation of the lining of the sheath. This structure is called a ligule, and attention is drawn to it because, as it varies in size and shape in different grasses, it will in some cases be found of use in discriminating between grasses which closely resemble each other. In Fig. 63, l is the ligule of the millet-grass.

It is, however, in the indorcescence that the most striking peculiarities of grasses are apparent, and they may be illustrated by reference to the accompanying woodcut (Fig. 64). An examination of a wheat-ear in flower will show it to consist of a number of distinct structures arranged in rows lengthwise on the upper part of the stem or axis (Fig. 65). The entire ear is called a spike; let the spike be broken through at the middle, and let one of the structures already referred to be taken from the bottom of the upper part. This structure is a single spikelet, and it will be noticed that it is attached broadside to the axis, as is the case in most grasses—rye-grass, however, forming an exception. This spikelet should be carefully taken to pieces, proceeding regularly from the outer and lowest parts inwards. Two dry, scaly leaves nearly opposite to each other are first removed; these are the outer glumes. Inside
Plate 3.—

1. Rough Cock's-foot. (Rumex acetosella)
2. Annual Meadow-grass. (Poa annua)
3. Darnel. (Tragopogon pratensis)
4. Fescue. (Festuca pratensis)
5. Dog's-tail. (Cynosurus cristatus)
6. Italian Kye-grass. (Briza minor)
are three to five little florets alternately arranged on opposite sides of the axis of the spikelet. Let one of these florets be taken from about the middle and dissected just as the spikelet has been. The outermost and lowest scaly leaf which appears to envelope the inner parts is called the flowering glume opposite to this, but at a little higher level, is another scaly leaf called the pale; notice that the edges of the flowering glume overlap the pale to some extent. The flowering glume in many grasses bears a bristle, or awn, which springs from its back or summit. By laying apart the flowering glume and pale, the contents of the space between them are exposed to view. At the very bottom of the cavity, and lying one against the flowering glume and the other against the pale, are two very small scales, or lodicules, representing perhaps the calyx and corolla of ordinary flowers. Next are seen the lower ends of the filaments of three stamens; and lastly, nestling snugly in the very middle of the cavity is the ovary, surmounted by two short styles with feathery stigmas. This is shown in Fig. 64, which, it must be understood, is not a dissection of the entire spikelet, but represents below the outer glumes of the spikelet, and shows above the details of only one of the several florets which the outer glumes enclose. After fertilisation the little ovary develops into the grain of wheat, which is the true fruit of the plant, termed by botanists a caryopsis. In some cases, as in barley, the grain when ripe remains firmly enclosed by the scale-leaves; this is not the case in wheat. In some grasses, between the outer glumes and the flowering glume of the lowest floret, one or more scale-leaves, called empty glumes, considered to represent barren florets, are inserted. Such empty glumes may also occur above the uppermost perfect floret. An example of the former case is afforded by sweet vernal grass (Fig. 66), in which the entire spikelet consists of, first, two outer glumes, then two awned empty glumes representing two barren florets, and lastly a perfect floret with its flowering glume and pale, but with no lodicules, only two stamens, and the pistil surmounted by two feathery stigmas.

The foregoing descriptions of the spikelets of wheat and vernal grass will give the reader a general idea of the structure of the flowers of grasses. The actual dissection of spikelets of various grasses by the aid of a penknife, a mounted needle, and a magnifying glass, is strongly recommended, when the minor characters which enable botanists to classify grasses will be brought into view.

The manner in which the anthers are attached to the filaments will also be seen from the woodcuts. As the anthers can swing freely about their point of attachment they are said to be versatile. The anthers and feathery stigmas are usually to be seen protruding from the spikelets at the time of flowering. Most grasses have three
stamens, but the rice-plant has six, and sweet vernal grass, as we have remarked, only two. The flowering glume and pale are nearly always present, but in fox-tail grass there is no pale. Lodicules again, of which the number is usually two, are absent in sweet vernal, fox-tail, and mat grass, while the feather-grass has three.

The inflorescence of grasses may be described either as spicate, when the spikelets are arranged close against the axis in the form of a spike, as in fox-tail (Plate 3, Fig. 2), or it is a panicle, in which case the spikelets spread out on little branches, as in the smooth meadow-grass (Plate 3, Fig. 7). There are various intermediate forms, as sweet vernal grass (Plate 3, Fig. 3).

There are two groups of plants which may be, and not unfrequently are, mistaken for grasses; these are the rushes and sedges. The rushes belong to the order Juncaceae, and grow in moist meadows and by the sides of streams and ponds; in them the stem is solid and tapers to a point, and the flowers are produced in heads on the side of the stem, and are quite different in their structure from those of grasses. The reader is, of course, familiar with a tulip flower; its protective envelope consists of three outer leaves and three inner leaves all like petals, while inside are six stamens and the pistil. Imagine such a flower to be greatly reduced in size, so as to be not much larger than a pin's head, and at the same time suppose the six petal-like leaves of the protective envelope to become brown and membranous; a good idea will then be obtained of the kind of flower met with in rushes, and it will be evident that it is quite unlike a grass flower.

The sedges (Fig. 67) belong to the order Cyperaceae, and are generally found accompanying rushes. They apparently have a close resemblance to grasses, but are easily distinguished from them by the characters contrasted in the table below.* The sedges, then, may be distinguished by their angular solid stems, entire leaf-sheaths, and the absence of ligules. Both rushes and sedges are worthless from a nutritive point of view; indeed, cattle seldom touch them on account of their brittle character, which is due to the presence of an unusually large amount of silica. If these plants make their appearance in a meadow, a defective state of drainage is probably the cause.

The term "grasses," as used by the farmer, includes not only gramineous but also leguminous plants, so that clovers, vetches, saffoin, lucerne, and even other green crops may be embraced by the term in an agricultural sense, when reference is made to the artificial grasses. In a botanical sense, the true grasses belong exclusively to the order Gramineae.

* | Cyperaceae | Gramineae |
--- | --- | --- |
Stem | Angular | Round |
Leaf-sheath | Entire | Split |
Anther | Entire at the ends | Notched at the ends |
Ligule | Absent | Present |
TIMOTHY GRASS AND FOX-TAIL.

In the following account of the true grasses, the object in view has been to give a brief notice of all those which are usually cultivated. In addition to this, the reader's attention has been directed to some of the more commonly occurring "weed-grasses," grasses, that is, which, from an agricultural point of view, must be looked upon as worthless, and which the cultivator, when he is able to recognise them, would find it advantageous to exterminate, and replace by more valuable species. No attempt at a botanical classification of the grasses has been made, but those mentioned are given in the order in which they occur in Sir J. D. Hooker's "Flora of the British Islands." Some grasses are unfortunately burdened with a superfluity of common names, so that much confusion results. We therefore recommend the reader to familiarise himself with the botanical names, as these more usually have a definite and unvarying application, which is the same in all countries. Where not otherwise stated, it is to be understood that the undermentioned grasses are perennials.

Cat's-tail or Timothy Grass, Phleum pratense (Plate 3, Fig. 1). Root fibrous, slightly creeping. Stem 18 inches to 3 feet high in Britain, but frequently 4 feet in America. Flowers from June to August. The spikelets are one-flowered, and arranged in a spicate manner. This grass, although well known to the British grower, is far more extensively cultivated in the United States, where it was introduced from Britain, nearly a century ago, by Mr. Timothy Hanson, and for this reason it is called Timothy grass. It thrives most luxuriantly on clay lands, peaty soils, improved moors, alluvial flats, and estuarine warp lands, but is not suited either to very stiff clays or to chalk soils. If grown on light dry soils its roots have a tendency to become bulbous. As cat's-tail is a late species yielding comparatively little aftermath, it is better adapted for grazing or pasture land than for the meadow. If intended for hay, however, it may be fed on till late in spring without prejudice to the crop. Analyses (Nos. 23, 37) are quoted of the grass and the hay, in both of which forms it is eagerly eaten by all kinds of stock.

Meadow Fox-tail Grass, Alopecurus pratensis (Plate 3, Fig. 2). Root fibrous; height of stem, 1 to 3 feet. Flowers from April to June, ripening its seeds from June to August. The one-flowered spikelets are arranged in cylindrical spike-like panicles tapering at each end. The leaves springing from the lower part of the stem are long, broad, soft, and of full green colour. Fox-tail is one of our earliest grasses, and forms a principal part of the herbage in many rich pastures, yielding an abundant aftermath. It labours, however, under the disadvantage of not attaining its full productive power till the third or fourth year after sowing, and it is, therefore, not suitable for alternate husbandry. It flourishes best on stiff soils, its produce on a clayey loam being nearly double that on a sandy soil. No. 38 is an analysis of the hay of fox-tail.

Fox-tail and cat's-tail are frequently confused the one with the other. They differ botanically thus:—Fox-tail has an awn projecting from the middle or base of the flowering glume, but the floret contains no pale; cat's-tail has no awn from the flowering glume, but a pale is present. But, setting aside botanical characters, it must be remembered that these two grasses flower at different periods; fox-tail has nearly done flowering when the first inflorescences of cat's-tail appear. The most useful distinction, however, for the general observer is afforded by the appearance of the cylindrical spike-like flower-heads. That of fox-tail is slender, soft, and silky, whereas in cat's-tail it is usually longer, stouter, and bristly. We have the two grasses lying before us as we write, and feel sure that if the silky inflorescence of fox-tail be once contrasted with the bristly one of cat's-tail, the distinction will not be forgotten.

Two other grasses in the genus Alopecurus are Floating Fox-tail, A. geniculatus, and Slender or Field Fox-tail, A. agrestis, both of which are bad grasses shunned by the farmer. Floating fox-tail grows from 6 to 12 inches high, and its stem is bent at the joints, so that it is easily distinguished from meadow fox-tail. Animals dislike it, and fortunately its yield is small. It grows chiefly in the vicinity of ponds and streams on clay soils, and may sometimes be seen floating on the surface of a pond; on dry soils it becomes stunted in growth. It flowers in June and July. Slender fox-tail, or, as it is also called, black-bent, is distinguished by having a more slender inflorescence than meadow fox-tail; in black-bent, again, the ligule is long, whereas it is short and obtuse in meadow fox-tail. Black-bent is an inferior grass growing naturally on poor soils; in wheat
fields it is a troublesome weed difficult to eradicate, and is known in some localities as ‘‘hunger-weed.” Partridges and pheasants are said to be fond of the seed, which ripens in August. Floating fox-tail and black-bent are best got rid of by drainage and liberal application of manure.

Sweet-scented Vernal Grass, *Agrostis alba* (Plate 3, Fig. 3). Root fibrous but not creeping, stem 12 to 15 inches high. Panicle oblong, consisting of a series of minor panicles each with four or five spikelets. Florets three in a spikelet, the two lower ones being barren. Flowers in May, and ripens its seeds in June. Each floret contains only two stamens, instead of three as in other grasses. This is the grass which imparts the pleasant fragrance to a new-mown hay-field, the odour being due to the presence of benzoic acid. Hence it is always recommended in mixtures for parks and pleasure-grounds, as the fragrance is very noticeable during the time the seeds are ripening; it is hardly adapted for close-cut lawns, as its leaves are somewhat broad and spreading, and therefore unsightly. If the lower end of the culm of this grass be drawn through the closed teeth, a lavender-like flavour identical with the odour of the grass will at once be noticed. Cattle do not appear to be particularly fond of sweet vernal, but its seeds are introduced into all mixtures, if only with the object of producing fragrant grass and sweet-smelling hay. Nevertheless, it grows extensively in the sheep-grazing districts of the South Downs, and as it is said to improve the flavour of mutton, it is considered an essential ingredient in sheep-pastures. Sweet vernal is less productive than cock’s-foot, fox-tail, and other useful grasses, but it is ready for grazing very early, and the after-math, though sparse, contains more nourishment than the flowering crop. The leaves of this grass are of a light green colour, and somewhat hairy on both sides, and the leaf-sheath is roughish when felt from below upwards. Sweet vernal will grow on most soils, but thrives best on deep moist land. Analysis No. 39 shows the composition of the hay.

Common or Creeping-rooted Bent-grass, Purple Bent, Quick-grass, Fine Bent-grass, *Agrostis vulgaris* (Plate 3, Fig. 4), has rather a tufted growth, and grows everywhere, preferring dry soils. Cattle and sheep will eat it, but it can only be looked upon as a weed-grass.

Marsh Bent-grass, or Creeping Fiorin, *Agrostis alba*, variety *stolonifera*, has fibrous creeping roots, and attains a height of about 2 feet. The flowers appear in July, and the panicle is then spreading, but afterwards compact. The florets are awnless, and the leaves rough. The nutritious qualities of this grass are inferior, and it is only recommended for permanent pastures because its herbage appears early in spring and lasts far into autumn. It is best grown on peaty soils or irrigated meadows; on light dry soils its small wiry underground stems make it as troublesome as couch-grass, and it is then called “squitch.” It is similar in appearance to the foregoing grass, but in *Agrostis vulgaris* the leaf-sheaths are smooth, the ligules short and obtuse, whereas *A. alba* has rough sheaths and long acute ligules.

Tufted Hair-grass, *Aira caryophylica* (Plate 4, Fig. 1), is a not uncommon weed-grass, with strong, fibrous, deeply penetrating roots, long flat leaves, and stems often 4 feet high. It flowers in July and August. It usually occurs in large tufts or hasses on damp and marshy soils. Being coarse and wiry it is seldom eaten; it affords cover for game. Grey Hair-grass, *Aira caespitosa*, has a denser panicle than *A. caryophylica*, and is only about 6 or 8 inches high. Silver Hair-grass, *Aira caespitosa*, has an elegant shining spreading panicle with its branches dividing into threes. It has very scanty herbage, and grows on sandy fields and hill-sides, flowers in June, and soon after withers up. The Hair-grasses are useless to the farmer.

Yellow or Golden Oat-grass, *Avena flavescens* (Plate 4, Fig. 2), has fibrous slightly creeping roots, smooth stems 1 to 2 feet high, with spreading, erect, much-branched panicles composed of spikelets containing each two or three florets, the individual florets being smaller than those of any other oat-grass. It is a late species, flowering in July and ripening its seed in August. The yellow colour of the stem and the bright golden cluster of flowers seem to distinguish it. Yellow oat-grass, though it is a weak plant, is recommended in mixtures for dry limestone soils, and good light soils generally, on which it yields a quantity of fine herbage, of which cattle are fond. No. 40 is an analysis of the hay.

Hairy or Downy Oat-grass, *Avena pubescens*, has somewhat creeping roots, stems 1 to 2 feet
1. Leptochloa chinensis (Hair-grass).
2. Avena strigosa (Yellow Oat-grass).
3. Arrhenatherum elatius (False Oat-grass).
5. Briza media (Quaking-grass).
7. Bromus erectus (Tall Brome-grass).
8. Bromus sterilis (Barren Brome-grass).
9. Cuscuta europaea (Dodder).

PLATE 4.—WEED GRASSES AND PARASITES.
SOFT GRASS AND COCK’S-FOOT.

high, erect nearly simple panicles, and flowers in June. This is a sweet barley grass only employed on shallow limestone soils unsuited to the superior kinds. It grows in solitary culms with a scanty hairy herbage. On rich soils the hairs practically disappear. To distinguish between this and the foregoing—in _A. pubescens_ the ligule is long and acute, in _A. flaveescens_ very short and obtuse.

The Wild Oat, _Avena fatua_, is a common weed in corn-fields, and attains a height of 2 to 3 feet. It is said to be the wild form of the cultivated oat, which it much resembles. The spikelets are three-flowered with very long awns, and the awned fruits so closely resemble artificial flies as to be successfully used by anglers as substitutes.

False Oat-grass, or Common Oat-like Grass, _Arrhenatherum arenaeaceum_ (Avena elatior), (Plate 4, Fig. 3), is a fibrous rooted weed-grass, common in hedges, and on roadsides and dry soils, attaining sometimes a height of 3 feet, and flowering from May to July. It produces a quantity of bitter-tasted herbage, not liked by cattle, and containing only a small proportion of nutritive matter. Its composition is shown in analysis No. 41. Another species, _Arrhenatherum bulbosum_, is distinguished by its tuberous roots, and the paler colour of its foliage; it is really a mere variety.

Soft-grass, also called Meadow Soft-grass, Woolly Soft-grass, or Yorkshire Fog, _Holcus lanatus_ (Plate 4, Fig. 4), is a plant with fibrous roots and downy leaves, and grows from 1 to 3 feet high, flowering from May to July. It grows naturally on poor light soils, and thrives on peaty soils; it is very productive and easy to cultivate, but almost worthless, whether as hay or pasture; indeed, it has been recommended to sprinkle the hay with salt to make it palatable.

Creeping or Bearded Soft-grass, _Holcus mollis_, has fewer culms, broader leaves, looser panicles, and longer awns, and is much less frequent than _H. lanatus_, preferring hedges and copses. It flowers in July. On account of its strong creeping roots, it is useful on railway embankments and sandy slopes. These soft grasses, especially _H. lanatus_, sometimes occur to an alarming extent in meadows and pastures; when this is the case, no pains should be spared to exterminate them so as to make room for better ones.

Rough Cock’s-foot Grass, _Dactylis glomerata_ (Plate 3, Fig. 5). Fibrous, somewhat spreading roots, rough stems growing 2 to 3 feet high. Flowers from June to August. A glance at the coloured sketch will at once enable the reader to recognise this grass whenever he sees it, as there is no other grass so similar to it in general appearance as to be likely to be mistaken for it. As it thrives well under the shade and droppings of trees, it has in America received the name of “Orchard grass.” It will grow on all kinds of soil, a damp soil with dry subsoil, allowing free growth to its roots, appearing to suit it best. Cock’s-foot is really a most excellent grass, as will be seen from the analysis (No 42) of its hay, the only precaution required being not to let it grow too old before cutting, as it then becomes wiry and tough. It is of rapid growth, forming unsightly tufts, and should enter into all mixtures of seeds for permanent pasture, where the regular cropping of sheep and cattle will ensure its being constantly consumed while young and juicy. The Secretary of the Massachusetts Board of Agriculture writes:—“This is one of the most valuable and widely known of all the pasture grasses. It is common to every country in Europe, to the north of Africa, and to Asia, as well as America. Its culture was introduced into England from Virginia in 1764. It forms one of the most common grasses of English natural pastures on rich, deep, moist soils. It became, soon after its introduction into England, an object of special agricultural interest among cattle-feeders, having been found to be exceedingly palatable to stock of all kinds. Its rapidity of growth, the luxuriance of its after-math, and its power of enduring the cropping of cattle, commend it highly to the farmer’s care, especially as a pasture grass. As it blossoms earlier than timothy and about the time of red clover, it makes an admirable mixture with that plant to cut in the blossom and cure for hay. As a pasture grass it should be fed close, both to prevent its forming thick tufts and to prevent its running to seed, when it loses a large proportion of its nutritious matter and becomes hard and wiry. All kinds of stock eat it greedily when green.” Cock’s-foot grows wild on most roadsides, and if the young stem is drawn between the closed teeth, its sweet juicy character will be perceived.

The genus _Poa_ includes the so-called meadow-grasses, always noticeable in a hay-field at the time of flowering by their elegant panicles.
Their general habit will be apparent on referring to the sketches of the three species represented in Plate 3. We shall briefly notice the more important meadow-grasses, and then point out how to distinguish between them.

Annual Meadow-grass, *Poa annua* (Plate 3, Fig. 6). This little grass only attains a height of 6 to 10 inches. It grows almost everywhere, and may be seen in flower any time between April and September. It is about the only flowering plant which grows naturally in the squalid courts and lanes of crowded cities, springing up from the earth between paving stones. Being an annual, it is, of course, unsuited to permanent pasture, and even for one year’s hay it is never intentionally included in seed mixtures, on account of its meagre produce. Nevertheless, as the plant will spring up, produce its flower, and ripen its seeds within a period of six or eight weeks, the annual meadow-grass is naturally widely disseminated, and may be found in all pastures. An analysis of its hay is given (No. 43).

Smooth-stalked Meadow-grass, *Poa pratensis* (Plate 3, Fig. 7). Root creeping, and forming numerous horizontal offshoots; stem smooth, round, 1 to 2 feet high; leaves broad, upper leaf shorter than its sheath; spikelets oblong, with four or five florets in each. Flowers from end of May to July. This grass occurs plentifully in all dry meadows, and is of a bright green colour in early spring. As a pasture grass it is considered of medium quality, but as its patch-like mode of growth enables it to overcome other grasses, it is not in high favour with the farmer. It is noted for early yield, and should be cut while in flower if intended for hay, as if left till the seeds are ripe, a considerable loss in feeding value results. This grass is rather liable to attacks of rust. No. 44 is an analysis of the hay. In the United States of America, *Poa pratensis* is called “Kentucky blue grass.”

Flat-stalked Meadow-grass, *Poa compressa*, also has a creeping root, but its stem is somewhat flattened, and the upper leaf is as long as its sheath. It is called “June grass” in America, and is of little importance.

Rough-stalked Meadow-grass, *Poa trivialis* (Plate 3, Fig. 8). Fibrous root; rough stem, 18 inches to 2 feet high. Flowers in June, and ripens its seeds during second half of July. The ovate spikelets contain three florets. It thrives best in low damp situations, such as heavy clays, and the moist fertile loams of irrigated meadows, and constitutes a considerable part of river-side grass. It prefers sheltered situations, as it cannot withstand the sun’s heat, and dies off dry exposed soils in four or five years. It therefore grows best in mixtures of upright grasses, as fescues and rye-grasses. As it contains most nutrient matter when ripened grasses, as fescues and rye-grasses. It should not be cut till then; a loss of about one-quarter is sustained by cutting in flower. Cattle, horses, and sheep are very partial to it, and it yields a fair aftermath. It is quite unsuited to upland pastures. Analysis No. 45 shows the composition of the hay.

Wood Meadow-grass, *Poa nemoralis*, has fibrous, somewhat creeping roots, and smooth stems 18 inches to 3 feet high. Leaves long and narrow. The panicle is loose and rather one-sided, and the spikelets contain usually three or four florets. It flowers in June and July, the seeds being ripe early in August. This is a common grass in woods; it lies thicker on the ground than *P. trivialis* or *P. pratensis*, and forms a good close sward under trees, and is therefore suitable for lawns. The leaves, which are of a light green colour, are somewhat intertwined below, thus producing a dense growth which enables this grass to displace weeds of one or two years’ duration. Rough meadow-grass shows a preference for limestone soils, and is susceptible to rust. It produces a fine succulent nutritious herbage, and may be relied upon for early spring growth.

As *P. pratensis*, *P. trivialis*, and *P. nemoralis* are all of common occurrence, it is very useful to be able to distinguish each from the other two. The reader will already have gleaned certain general distinctive characters; in addition to these, however, some very practical distinctions are based on the form of the ligule: in *P. pratensis* the ligule is obtuse but prominent, in *P. trivialis* it is long and pointed, and in *P. nemoralis* so very short as to be practically absent. As the application of these tests only requires the bending of the leaf away from the stem so as to bring the ligule into view, they will be found far more generally useful than the truly botanical distinctions founded on minute differences in the structure of the florets.

Floating Sweet-grass, *Water-grass, Mamagrass, Glyceria fluitans*. Root-stock stout, widely creeping. Stems about 3 feet high, leaves
narrow. Distinguished by its slender slightly spreading panicle, and long linear spikelets containing from six to twelve florets. Flowers from June to August. This is essentially a water-grass, and is readily eaten by cattle and sheep. As it grows naturally by the water-side, it is well adapted for irrigated grounds and moist situations, as in the Fen country, for example. Its herbage is succulent and abundant. Floating sweet-grass is cultivated in Germany for its seeds, which are sold under the name of mumma-seeds, and used in soups and gruels. Another botanical name for this grass is Poa fluitans.

Water Meadow-grass, or Reedy Water-grass, Glyceria aquatica, grows under similar conditions to G. fluitans, but has a very creeping root and a stem 4 to 6 feet high. It yields an immense bulk of coarse nutritious herbage, forming in marshy localities rich summer pasture, and yielding winter fodder. Also called Poa aquatica.

Quaking Grass, Briza media (Plate 4, Fig. 5), will be at once recognised from the sketch. This elegant grass is commonly met with in poor pastures, but is of no agricultural value, its herbage being extremely scanty. To get rid of it seeds of superior grasses should be sown, as in their presence the quaking grass disappears. As it frequently occurs in hay, an analysis (No. 46) is quoted. Other names for it are Maiden's hair, Lady's hair, Cow-quakes. Its height is 6 to 18 inches, and it flowers in June. The Lesser Quaking Grass, Briza minor, is a smaller variety, while Briza maxima, an annual, is a fine handsome species with very large spikelets, introduced into our flower-gardens from Southern Europe.

The Fescue Grasses, belonging to the genus Festuca, have, especially just before flowering, a habit very similar to that of grasses of the genus Poa. As a rule, the two genera may be distinguished from each other thus; in Poa the florets are not awned, whereas in Festuca the florets are awned from the summit of the flowering glume.

Sheep's Fescue, Festuca ovina (Plate 3, Fig. 9). Roots fibrous; stem smooth, round, and 1 to 2 feet high. The leaves are flat, not bristle-shaped, like those of F. ovina. The panicle is nearly upright, rather loose, and the spikelets each contain five to six florets. This is a large-growing grass, but its leaves are tender and juicy. It does not grow in tufts like F. ovina, nor does it thrive on dry soils, but luxuriates in rich well-drained clayey loams, and is therefore eminently suited for moist river-side meadows. As an early and productive grass it is recommended both for permanent pasture and alternate husbandry. It yields an abundant supply of herbage quite as early as meadow fox-tail, and is superior to the latter in nutritive properties. For hay, it should be cut in flower, as it loses much by being left till the seed is ripe.

Spiked or Darnel-leaved Fescue, Festuca loliacea, is very similar in appearance to Lolium perenne.
(Plate 3, Fig. 11), but the leaves of the former are finer or more bristly than those of the latter, and each spikelet has two outer glumes (the usual number), whereas the spikelet of L. perenne has only one outer glume, as will be mentioned when treating of that grass. *F. lolacea* has no awn.

Tall Fescue, *Festuca elatior*, also has flat leaves, and it is distinguished from the other fescues mentioned by its greater size, its height varying from 2 to 5 or 6 feet.

The foregoing fescues are all useful nutritious grasses, and will usually be found in natural pastures on soils suitable to each kind.

The genus *Bromus* includes a number of species which are quite useless from an agricultural point of view, and attention is therefore drawn to them to enable the grower to identify them where they occur, and to use means for their extirpation, as the ground which they occupy may be much better filled by more profitable species. The four commonest brome-grasses are *Bromus asper*, *B. erectus*, *B. sterilis*, and *B. mollis*.

Rough Brome-grass, *Bromus asper* (Plate 4, Fig. 6), attains a height of 4 to 6 feet, and grows chiefly in woods and copses. It is an annual, and flowers from June to August. The awns are short. Upright Brome-grass, *Bromus erectus* (Plate 4, Fig. 7), grows to a height of 2 to 3 feet, and occurs in sandy fields and waste places on dry soils. It is a perennial, flowering at the same time as *B. asper*, which it resembles in having short awns, but its spikelets are usually of a darker colour. Barren Brome-grass, *Bromus sterilis* (Plate 4, Fig. 8), unfortunately bears its name, for it is productive of a large number of seeds which get scattered and serve to reproduce this undesirable grass. It is from 1 to 2 feet high, and is a common weed-grass in fields. Like *B. asper*, it is an annual, flowering from June to August. In outward appearance, also, it is like *B. asper*, but differs from it in its very long awns. Soft Brome-grass, *Bromus mollis* (Plate 4, Fig. 9), is perhaps the commonest of the brome-grasses. Its height varies from 6 inches to 2 feet, and it is abundant on roadsides and margins of fields. It is an annual or biennial, and flowers from May to June or July. The spikelets are shaped like a lance-head, and the awns project a little beyond them. Smooth Rye Brome-grass, *Bromus secalinus*, is an annual, and closely resembles *B. mollis*, but differs in that the florets are rather more spreading in the spikelet. *B. secalinus*, again, is of larger growth than *B. mollis*, and in the former the awns are shorter than the florets, whereas in the latter they are as long as the florets. The rye brome-grass is a troublesome weed in wheat and rye fields, and it should be destroyed early in the season, when it is easily distinguished by the different appearance of its foliage from that of the young corn. This plant is the so-called "cheat" of the United States corn-fields. Its seeds, when they get mixed with wheat or rye, make the bread produced from them very unpalatable.

Crested Dog's-tail Grass, *Cynosurus cristatus* (Plate 3, Fig. 10). Root fibrous. Smooth upright stem, bearing usually five leaves with smooth sheaths. The leaves are short, rather narrow, and tapering. It grows to a height of 1 or 2 feet, and flowers in June and July. The interrupted spike-like panicle, as represented in the sketch, suffices for the detection of this grass. It grows naturally on dry pastures, but will thrive well in damp tenacious soils or in irrigated meadows. As its foliage is not coarse, and as it does not grow in tufts, it is useful for lawns and other swarms kept under by the scythe. Dog's-tail is juicy and soft at the time of flowering, and for hay (analysis No. 48) should be cut when it contains further more nourishment at this stage than later on. Owing to its short and somewhat fine herbage it is not a heavy crop. Cattle, sheep, and deer are very fond of it, but they will not eat the culms, and these, brown and withered, may often be seen standing erect late in the autumn, and forming "the bents so brown?" they afford useful material in the manufacture of straw-plait.

To the genus *Triticum* belongs the troublesome weed called couch or twitch grass, but this is more than compensated for by its including that most useful grass, the wheat-plant. A closely allied genus is *Lolium*, to which the rye-grasses belong. *Triticum* differs from *Lolium* in the following particulars: in *Triticum*, as in most genera of grasses, there are two outer glumes to the spikelet, whereas in *Lolium* there is only one, and that one occurs on the side away from the axis, as may be seen by examining the spikelets of any rye-grass. Furthermore, the spikelets in *Triticum* are fixed broadside to the axis, as may be seen in a wheat ear; in *Lolium*, on the other
hand, the spikelets are fixed edgewise to the axis.

Couch-grass, *Triticum repens* (Plate 4, Fig. 10), is a very variable plant, with stems growing from 1 to 4 feet high, and flowering from June to August. This grass, owing to its creeping habit, can only be looked upon as a pest, more especially in arable land, where its straggling underground stems, ramifying in every direction in the loose soil, offer serious obstacles to cultivation, and, what is worse, the fragments into which the plough or spade breaks up the prostrate stem will themselves become independent centres of growth, and thus spread the nuisance. Animals only eat the herbage when it is quite young, but they are very fond of the creeping stem, which is juicy and sweet, and contains about three times as much nutrient matter as the portions above ground. In Italy these underground stems are collected, washed, and sold as food for horses. The Sea Wheat Grass, *Triticum juncum*, and the Dog-wheat or Bearded Wheat Grass, *T. caninum*, which is awned, are much rarer species than couch-grass.

Common Rye-grass, *Lolium perenne* (Plate 3, Fig. 11), has fibrous roots, and smooth stems growing to a height of 18 inches or 2 feet. It flowers in May and June. Any one unacquainted with this grass would be able to identify it immediately by means of the coloured sketch; observe that there are no awns. Rye-grass is liable to great variation, there being as many as sixty or seventy varieties. Examples are the Devon Eaver grass, *Lolium Deveniensis*, and Pacey’s variety, *L. perenne Paceyannum*, which is an intermediate variety as regards size, and sends up a large bulk of good herbage after hay-harvest. *L. perenne sempervirens* is a very green rye-grass that keeps its colour well. Analyses of rye-grass and its hay are given (Nos. 24, 49).

Italian Rye-grass, *Lolium italicum* (Plate 3, Fig. 12), should perhaps be considered as only a variety of *L. perenne*, which it closely resembles, but is taller, has longer flower spikes, and is furnished with awns, whereas *L. perenne* is awnless. *L. italicum* is an early grass, and its yield when grown on sewage-dressed land is extremely large. As it is not always to be relied upon as a perennial, it is best adapted for alternate husbandry. Analyses Nos. 25 and 50 refer to this grass.

The two foregoing rye-grasses are excellent forage plants, and are generally grown with clover or sainfoin as spring crops. Common rye-grass on loamy soils forms a close turf, and Italian rye-grass can frequently be cut three times in a summer.

Darnel, Poison or Bearded Darnel, *Lolium temulentum* (Plate 3, Fig. 13), is a much less desirable grass than its congeners. It is very much like *L. italicum*, but differs from that and from *L. perenne* in the fact that the solitary outer glume is longer than the spikelet to which it belongs, and further from *L. perenne* in that it is awned. Darnel is a noxious weed, and poisonous properties are attributed to it; its seeds mixed with cereals cause vomiting and intoxication in animals eating them. It is found chiefly in cultivated fields, and foreign seeds, notably flax, usually contain darnel seed. Fortunately this grass is not very plentiful in Britain, and it is needless to add that where it is observed growing it should be effectually eradicated. It is, however, quite a pest in some of the Californian corn-districts, where it is termed “cheat,” the same name being given to *Bromus secalinus* on the east side of the Rocky Mountains.

The Barley-grasses, belonging to the genus *Hordeum*, and bearing a close resemblance to the cereal barley, which is also included in this genus, are rather commonly met with, especially on gravelly road-sides. They are never cultivated, and are therefore to be regarded as weed-grasses, the long brittle awns of the inflorescence piercing the skin, or irritating the intestines of animals which eat them. Grasses of the genera *Sitan* and *Calamagrostis* are objectionable for a similar reason.

Many of the foregoing details, such as height and time of flowering, can only be taken as approximately true, as they vary according to climate, soil, season, and so on. Mixtures of seeds might, perhaps, have been looked for here, but as local variations in soils are so common we could hardly have hoped to have constructed lists which would have been capable of general application. Indeed, since the time when Mr. A. C. Wheeler, the head of the Gloucester firm of seed-growers, first directed attention to the geological characters of soils as a guide to the composition of the grass-seed mixture fittest for them, seed-merchants have been bestowing more and more attention in this direction, and have, as the result of accumulated experience, not only been able to construct
general tables, but are able, when furnished with full particulars, to "prescribe" mixtures for exceptional soils.

Here we may conveniently introduce a

**List of Cultivated Grasses.**

- Agrostis stolonifera — Creeping Bent-grass
- Alopecurus pratensis — Meadow Fox-tail,
- Anthoxanthum odoratum — Sweet Vernal,
- Arrhenatherum elatius — Yellow Oat-grass,
- Arrhenatherum geniculatum — Hairy Oat-grass,
- Cynosurus cristatus — Crested Dog-tail,
- Dactylis glomerata — Rough Cock s-foot,
- Festuca duriuscula — Hard Fescue,
- Festuca elatior — Tall Fescue,
- Festuca heterophylla — Various-leaved Fescue,
- Festuca lanata — Darnel-leaved Fescue,
- Festuca ovina — Sheep’s Fescue,
- Festuca pratensis — Meadow Fescue,
- Festuca rubra — Red Fescue,
- Festuca tenuifolia — Fine-leaved Fescue,
- Glyceria aquatica — Water Meadow-grass,
- Glyceria fluitans — Floating Sweet grass,
- Lolium perenne — Devon Evergrass.
- Lolium multiflorum — Italian Rye-grass.
- Lolium Fesciform — Pacey’s Rye-grass.
- Lolium perenne — Common Rye-grass,
- Lolium multiflorum — Evergreen Rye-grass.
- Piptatherum pratense — Timothy, or Cat’s-tail
- Poa nemoralis — Wood Meadow-grass.
- Poa pratensis — Smooth-stalked Meadow-grass.
- Poa trivialis — Rough-stalked Meadow-grass.

It will be noticed that the fescues, rye-grasses, and meadow-grasses furnish more than half the whole number. Other genera, again, are totally unrepresented—*Aira, Holcus, Briza, Bromus, Triticeum, Hordeum.*

How often have we seen a farmer strolling contentedly through his meadows just before hay-harvest, and gazing complacently at the big crop he would shortly gather in! A big crop, truly, and yet we have felt sorry when a walk through the meadows has convinced us that more than half of it would consist of quaking, brome, and soft grasses, with others equally undesirable. And as we have looked at the great quantity, and thought of the poor quality, we have at the same time thought how much it would be to the advantage of the farmer to make himself acquainted with the grasses, so that he might be able to repress the bad species in favour of the good.

Before leaving the Gramineae we desire to call attention to a few other analyses of products yielded by this very useful order. No. 51 is an analysis of ordinary meadow-hay of average quality. No. 27 shows the composition of green rye (the cereal, *Secale cereale,* a plant distinct from rye-grass), and No. 26 that of green maize (Indian corn, *Zea Mays*), which will not perfect itself in so cold a climate as that of Britain, but is largely cultivated in the United States of America; they both afford green fodder. Analyses are also quoted of the following cereals, which are all more or less used by millers in the preparation of various kinds of meal for stock-feeding: wheat, barley, rye, maize, millet, duri, rice, and the nutritious oatmeal (Nos. 57 to 64).

Unfortunately, the grasses and cereals are subject to serious diseases, which arise from the plants becoming infested with the spores or germes of certain parasitic fungi. These spores germinate in the plant and send out in all directions fine branches or tubes called *hyphae,* which break through the walls of the cells constituting the tissue of the plant, and derive their nourishment from the material which the plant had obtained for its own use. As a consequence the plant sickens and the parts attacked become rotten, the fungus meanwhile luxuriating in the destruction and decay which it has effected, and producing fresh crops of spores which by various agencies are transmitted to neighbouring healthy plants, and these in their
DISEASES OF PLANTS.

173

turn become also the prey of disease. These fungal diseases are known by such names as smut, bunt, rust, mildew, and ergot. Some attack one part of a plant, others another.

Smut attacks the young seed, and sometimes it destroys the glumes as well. It is indicated by masses of dark-coloured dust (the spores) emerging from the inflorescence, and perhaps from that portion of the stem immediately beneath. Barley, rye, wheat, and especially oats are attacked by smut, wild grasses being less liable. In warmer countries, maize and millet suffer, swellings as large as a turnip being sometimes produced in the former (Figs. 68 and 69).

The bunt, brand, or pepper-brand infests all kinds of wheat, spelt being less liable to attack than other sorts, and winter wheat less than spring wheat. This fungus, like smut, attacks the young seed, which it destroys and replaces by a black greasy substance of disagreeable odour. Figs. 70 and 71.

Rust and mildew attack chiefly the leaves and stems, and not often the seeds, so that the injury rests chiefly in the very bad quality of the straw; nevertheless, the grains suffer to some extent. Rust is first indicated by blotches of brown rust-coloured dust breaking out on the surface of the plant. Certain spores are then produced which get transferred to the barberry plant, on the leaves of which another stage in the life-history of the fungus is completed, resulting in the production of a new set of spores which can only germinate on wheat or some similar plant. This disease usually attacks wheat, barley, and oats; it is less frequent in rye and pasture-grasses. Mildew forms a delicate web-like covering on the green leaves of clovers, turnips, mangolds, &c.

Ergot, or ergot of rye, as it is frequently called, is a disease more to be dreaded than those already mentioned, for not only does it involve practically the destruction of the grass it infests, but it also produces a substance which is in itself highly dangerous, and which, if taken internally, is capable of producing abortion in cows and mares. A case is on record of a Shropshire cattle-breeder having lost £1,200 in three years from this cause. This disease attacks the young ovary, or seed-vessel, which becomes at first enclosed by a soft mass of hyphae-tissue. This is accompanied by a honey-like secretion, and followed by the conversion of the entire ovary into a hard blackish mass, similar in shape to the rye-grain but much lengthened. It is to this hard bluish-black substance that the name of "ergot" is popularly given, and the representation of an ergotised grass at this stage is seen in Plate 4, Fig. 11. Where rye-bread is used, the ergot sometimes gets ground up with the rye-grains in the preparation of the flour, and very disastrous, sometimes fatal, results have ensued to the people who have eaten it, gangrenous diseases being the usual consequence. Ergot attacks a great many grasses and cereals, rye being notably subject to its ravages. The cultivated grasses which most frequently become ergotised are timothy grass (Phleum pratense), fox-tail (Alopecurus pratensis), tall fescue (Festuca elatior), floating sweet-grass (Glyceria fluitans), rye-grass (Lolium perenne). Of weed-grasses, those most liable to attacks of ergot are soft brome-grass (Bromus mollis), meadow brome (B. pratensis), couch-grass (Triticum repens), and wall barley-grass (Hordeum murinum).*

We may here refer to certain flowering-plants which are more or less parasitic on forage crops, and the rise or spread of which the cultivator should do his best to check. Those we have selected are the dodder, broom-rape, yellow-rattle, and eye-bright.

Clover Dodder, Convolvulus minor (Plate 4, Fig. 13), is a plant belonging to the order Convolvulaceae, which includes the well-known bindweed, or field convolvulus Convolvulus arvensis.

The dodder may become a serious pest in clover-fields, where it usually obtains a footing through its small seeds having been sown with those of the clover. The dodder-seed germinates in the ground and the young shoot trailing over a clover stem develops small sucking rootlets which penetrate into the tissue of the host, and enable the parasite to abstract nutriment from the clover to assist in its own growth. Like all truly parasitic plants, dodder contains no green colouring matter, its colour being pale yellow to whitish, except towards the tips of the stems, where it is pinkish. It can easily be discerned from a distance in a clover-field by the light-coloured patches it produces. The stem of the dodder will encircle that of the clover many times, and is not easy to detach. Usually the interlacing stems of the parasite are seen at the surface, the heads of flowers being underneath; the whole plant has a faint aromatic odour. If a mass of dodder be stripped away by hand from the ground, the hands will become sticky, owing to a moist adhesive matter on the surface of the dodder, and the ground which is thus exposed will be seen to have every trace of clover on it destroyed. Other species of dodder attack the flax-plant and the stinging-nettle.

Broom-rape, Orobanche minor (Plate 4, Fig. 12), is a yellowish-brown plant parasitic on the roots of clover. It is stated that the seeds of this plant remain dormant in the soil until they come in contact with the roots of the plant on which the parasite preys, when they at once germinate. The minute irregularly-shaped seeds get introduced in imperfectly-cleaned clover-seed. The height of the broom-rape plant varies from 6 inches to 2 feet. Other species are parasitic on the roots of broom, furze, and milfoil.

Yellow-rattle, Rhinanthus Crispa-galli (Plate 2, Fig. 9), and Eye-bright, Euphrasia officinalis (Plate 2, Fig. 10), both belong to the order Scrophulariaceae, which includes such wild plants and weeds as toad-flax, snap-dragon, figwort, foxglove, speedwell, brooklime, bartsia, and cow-wheat, most of which are characterised by the irregular form of the corolla, as in the snap-dragon. Both yellow-rattle and eye-bright have the reputation of being parasitic on the roots of grasses; they are not, however, completely parasitic, as they contain green colouring matter, and therefore differ from dodder and broom-rape. They generally occur in poor pastures, and their presence is a sure indication of bad soil. To get rid of them the land should be well cleaned and manured. The yellow-rattle is called horse-penny in some districts. The house-wort and cow-wheat are similar partial parasites belonging to the same natural order.

Of non-flowering plants, two may be mentioned as being used for cattle-food—Iceland moss and Irish moss. They are unfortunately named, as neither of them is really a moss. The true mosses, indeed, are quite valueless to the stock-feeder, and when they occur in a pasture a wholesome application of the brush-harrow, followed by a course of good manure, will be found useful for effecting their eradication.

Iceland moss, Cladaria islandica, is really a lichen, one of that class of curious, many-coloured vegetable growths seen on rocks, old walls, tree-trunks, &c. It grows plentifully in cold regions, upon otherwise barren rocks, and occurs in the mountainous districts of Britain. The reindeer subsists largely on Iceland moss, the bitter taste of which disappears after soaking in a weak solution of carbonate of soda. Its percentage composition is:

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<td><strong>Total</strong></td>
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Irish moss, Chondrus crispus, is a sea-weed occurring plentifully on our rocky coasts. It is used both as human food and as cattle-food, and consists chiefly of a gummy substance which forms a stiff paste with boiling water. Its composition, as sold, is:

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The important subject of seeds, with their adulterations, deserves more than the passing note we are able to give it. The old practice of saving seeds from his own crop is now seldom adopted by the farmer, as he finds it more to his advantage to
## COMPOSITION OF FEEDING-STUFFS.

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purchase from seed-merchants, and there are many reasons why this should be so. Thus, it would scarcely pay the farmer to set up the various mechanical contrivances by which seeds are cleaned, nor would he, as a rule, be able easily to command the services of a person well acquainted with the various impurities which different samples of seeds usually contain. Further, as the seed-merchant works on a large scale, the expenses are less than they otherwise would be, and the seeds proportionately cheaper. Adulteration of seeds is either accidental, intentional, or both. Of the two, the accidental adulteration is usually the more injurious; it occurs in imperfectly cleaned samples, so that what is sold as a sample of the seed required contains, in addition to the seeds themselves, small sticks and stones, and seeds of other plants, usually of ordinary weeds, or perhaps, what is far worse, the seeds of such plants as dodder, broom-rape, yellow-rattle, darnel, and even ergot of rye, which from its appearance is often mistaken for mice-dung. Intentional adulteration is punishable by law, and is usually effected by introducing into the sample for the sake of the extra weight other valueless seeds which may or may not have been "killed" by heating them. Of course, if the added seed has first been killed, far less harm is done to the crop than would otherwise have been the ease; it would suffer in quantity rather than in quality. The best protection which the grower has is to obtain his seed from a thoroughly trustworthy firm, and at the same time not to be too close-fisted, for bad seed is dear at any price.

Explanation of the Analyses.

All plants contain water, more especially in the green state; after being air-dried they are found to have lost the greater portion of this water. Albuminoids are bodies rich in nitrogen, and when they occur in food-stuffs they are the only materials which play the part of flesh-formers. Albumen (or white of egg), casein (the nitrogenous compound in milk and cheese), and gluten (the sticky elastic substance contained in wheat) may be taken as examples of albuminoids. Carbohydrates contain carbon, hydrogen, and oxygen, the two latter being present in the proportion in which they occur in water; in food-stuffs carbohydrates primarily perform the function of heat-givers, and they are usually present in the form of some modification of starch or sugar. Thus, in a grain of wheat, or in a potato, the chief carbohydrate is starch, in beet-root it is sugar. Fat, also, is a compound of carbon, hydrogen, and oxygen, but the oxygen is present in a smaller proportion than that in which it occurs in the carbohydrates. Like these latter, fat assumes the function of a heat-giver in the animal body. In the analyses given on the preceding page, small quantities of wax and green colouring matter are included under the head of fat. Crude fibre is chiefly composed of a carbohydrate called cellulose, and the fibre being indigestible has no direct value as a food-stuff. The ash, or mineral residue, is that which is left behind after the plant is burnt in the air; it consists of inorganic compounds such as potash, lime, magnesia, and silica, which the plant derived from the soil. The value of a plant as a food-stuff must be estimated from the amount of albuminoids, or flesh-formers, and of carbohydrates, or heat-givers, present; fat, also, when it occurs, should be taken into consideration. As an illustration of the manner in which the analyses should be read, let us take, say, No. 37, the hay of timothy grass. We learn from it that, on an average, 100 lbs. of this hay would contain $14\frac{1}{8}$ lbs. of water, $9\frac{7}{8}$ lbs. of albuminoids, $45\frac{3}{5}$ lbs. of carbohydrate, $3$ lbs. of fat, $22\frac{1}{5}$ lbs. of indigestible fibre, and $4\frac{1}{8}$ lbs. of ash. It may be mentioned here that recent investigations show that the percentage of albuminoids given in the analyses of the roots (Nos. 1 to 7) are somewhat above the truth. For about one-half of the foregoing analyses we have to thank Professor A. H. Church; most of the others are quoted after Professor Emil Wolff, of Hohenheim, and some of them appear in an English form for the first time.

W. F.
CHAPTER XIII.

Hay-making.


The dairy-farmer it is always a matter of great importance that the hay-crop be well secured, free from rain and well made; and the hay-harvest in a fickle climate like that of England is a period of considerable anxiety and activity. Most dairy-farmers depend to a large extent on the hay-crop for the wintering of stock, and some depend wholly on it; hence it is very desirable that the crop be harvested in good condition. Hay that is well-harvested, cut at the proper time, and neither under nor over dried, is very nearly as valuable as its equivalent quantity of green and succulent grass; while badly-harvested hay, cut much too young or too old, sunburnt with too much exposure, or badly weathered by showers of rain, is so much reduced in value as to be no better, and sometimes worse, than so much straw. And in wintering stock on hay of this kind, it is necessary to use a quantity of corn to make up for the nutritive properties of which the hay was deprived by improper or unlucky harvesting. This corn is so much dead loss to the farmer, for with good hay he would have done just as well without it. There is some ground, therefore, for the anxiety and energy that are brought into play on a dairy-farm at the time of hay-harvest. There is plenty of excuse for the laying aside, for the time being, of all other farm operations that can possibly afford to wait, and for directing all the available force toward saving the all-important hay-crop in the best possible condition. When this is done, the farmer always feels as if a weight had been removed from his mind. There is some difference of opinion as to whether or not well-made hay is equal to the grass from which it was made in nutritious properties and in general usefulness to stock. The grass must, as a matter of course, be preserved in some way for use in winter; it cannot in this climate be left on the land and consumed in situ through the whole of the year. If it were so left, it would not only become faded and weather-beaten, the nutritive properties having mostly gone back to the roots; but the cattle could not safely remain out of doors to eat it. Green grass is, of course, the most nearly perfect food for dairy-cows, and it becomes a matter of importance that winter forage should differ from it as little as may be, that it should not suffer in feeding value, and that it should be very nearly as palatable as the grass was at the time of cutting it. When the summer's sun is hot enough and not too hot, when the grass is cut at the right stage of growth, when the hay is carefully and intelligently made, and when there is no rain about, all the valuable properties of the grass are secured in the hay, and water only is given off in the drying. Even the colour, the sweet taste, and the pleasant smell are retained, the two latter improved and the former not much reduced; and the solid constituents remain in much the same state of combination as they were in the grass.

Time of Cutting.—The time to cut meadow-grass is when the complexion of the field begins to wear a brownish tinge. At this stage the bulk of the grasses are flowering, and some
of the earliest ones have gone to seed. Very heavy crops should be cut earlier than this, particularly sewage grass, or they will become laid and rotten in the bottom. Clover should be cut when the majority of the heads are in blossom, for if it stands till it has done flowering the wooly fibre increases and the nutritive qualities decrease in proportion. All grass and clover should, in fact, be cut a little under rather than over ripe, as at this stage they contain a considerable quantity of sugar, gum, mucilage, albuminous and other soluble compounds, which are all liable to be washed out by repeated or long-continued showers of rain, and particularly so after the hay is partly made. While the grass is still newly cut and fresh, a coating of waxy or oily matter is found on the epidermis, giving it a waterproof covering and protecting it from injury by rain; this protection remains so long as the grass is fresh and unbruised, but when it has been turned and knocked about repeatedly, the fibres are more or less bruised or broken, the cell-walls are lacerated, and the juices containing the soluble constituents begin to ooze out and escape, unless the drying proceeds pretty rapidly, sealing them up in the stems and leaves. If rain falls at this period the drying is checked, the escape of the compounds is promoted, and fermentation sets in, during which the two most valuable properties of the hay are destroyed, viz., albumen and sugar. So in showery weather it is advisable to leave the grass or half-made hay quite alone; for stirring them during rain, and when there is no certainty of getting them dried and made up into cocks in good condition, does much more harm than good. To make up into cocks hay that is wet with rain-water is the surest way to spoil the hay, and until the rain ceases and the wet can be got out of it, it is best to leave it quite alone. The stirring bruises the hay all the more—a result that is easily attained when it is full of rain-water—and cocking it up wet only promotes fermentation, so that no good whatever, but great harm, comes of messing about among it in wet weather.

The following analyses by Dr. Voelcker illustrate the mischief which is done to hay by rain and improper making:

**Average Composition of Good Clover-hay.**

<table>
<thead>
<tr>
<th></th>
<th>Moisture</th>
<th>*Nitrogenous substances</th>
<th>Non-nitrogenous substances</th>
<th>Mineral matter (ash)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>16:60</td>
<td>15:81</td>
<td>60:00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7:39</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>100:00</td>
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</tr>
</tbody>
</table>

**Clover-hay injured by Rain, and badly made.**

<table>
<thead>
<tr>
<th></th>
<th>Moisture</th>
<th>†Nitrogenous organic matter</th>
<th>Non-nitrogenous substances</th>
<th>Mineral matter (ash)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>8:50</td>
<td>61:27</td>
<td>6:78</td>
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<tr>
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<tr>
<td></td>
<td>100:00</td>
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</tr>
</tbody>
</table>

There is no good whatever in stirring hay about when even the atmosphere is such that no drying will take place. It is not enough that it is not raining and that the hay has no rain-water in it, for if the atmosphere be damp no moisture will evaporate from the hay, consequently no drying is going on, and the hay is far better left alone without the bruising it gets in stirring and knocking about. It is sun, or wind, or dry air, or all these together that do the drying; and, however valuable it may be with them, stirring is absolutely worthless without them.

**Mowing Machines.** — The invention of the mowing-machine, and its general adoption throughout the country, have completely changed the features of hay-making. In Fig. 72 we give an illustration of a two-horse grass-mower, by means of which 8 or 10 acres of grass may be con-

* Contains nitrogen 2:52
† Contains nitrogen 1:36
veniently mown in one day, one man and two horses only being employed; if more is wanted of, and the harvest is over in a very short time; or, if the weather is unsettled, the grass can be left standing till there is better promise, and then be quickly mown. It is difficult to say whether a mower is of most striking value in a settled or in an unsettled time of weather; in the latter case a few fine days can be made the best use of, and in the former the harvest is quickly over. Anyway, no farmer who cuts 10 acres of grass ought to be without a mower, unless he can always depend on having the mowing done by a neighbour at a moderate cost; and for small farms a one-horse will be found preferable to a two-horse machine.

*Hay-makers.*—Grass that is cut by machine lies in good form for drying, and it may be left so until next day if there is other work to do; and, indeed, as a rule it is as well left until next day, unless the weather is unusually hot, and there is a danger of its being sunburnt. It is difficult to shake out machine swathes by hand or with a fork, when they want tedding, simply because they are so much spread over the land; and to do the work well a tedding-machine, or hay-maker (Fig. 74), is required. However valuable a mower may be, a tedder is hardly less so; and, indeed, the latter is almost a necessary sequel to the former. The forward motion for tedding, and the backward for turning, are each useful time after time in the hay, and the hay-maker is a most valuable machine; it will do all that is required in settled weather to make the hay dry enough for stacking, and it is a good plan to keep it going all day, repeatedly stirring the hay about, now shaking it out and now turning it, mixing it well.
up together, leaving it so light on the ground that sun and wind can get freely into it, and making it better and quicker than can be done by hand. In very hot weather the hay-maker is particularly valuable; the hay requires to be constantly kept stirring, so that the sun may not sear a portion of it while the rest is still under-made. Sunburnt hay is deprived of no small portion of its nutritive properties, and it does not contain enough moisture; the only way to prevent this is to stir it about as often as possible, and for this purpose the tedder is uncommonly useful.

_Horse-rakes._—In good weather the hay will not require touching at all by hand. The mower cuts it; the tedder stirs it about, leaving it light on the field; the sun and wind dry it, and it is ready for stacking. At this stage a horse-rake (Fig. 75) will be found a most useful implement, doing the work of six or eight men, who are thus set at liberty for carting and stacking. A horse-rake with four-feet-six wheels will collect the hay into rows that are quite thick enough to cart from, leaving the ground much cleaner than would be done by hand, and in long hay leaving it so clean that it will require no raking afterwards; in short hay it will generally be found necessary to rake the ground after the "putting-in" is done, but this the horse-rake will do, crossing the direction taken before and raking perfectly clean. A boy riding and a light horse will do a large amount of work in a very short time with one of these self-acting horse-rakes, and a farmer with 20 acres of hay will always be repaid in a short time the capital laid out in buying one of them.

_Hay-loaders._—For large farms the hay-loader (Fig. 76) is a very valuable implement. In construction it is not unlike a hay-maker: a revolving frame with curved teeth places the hay on an endless web, which conveys it to the top of the load; the horses are kept going, and the wheels of both
Fig. 77—Hay-loader at Work.

These four machines—the mower, the tedder, the raker, and the loader—costing no more than two middling horses, are an excellent investment for a farmer who cuts 50 or 60 acres of meadow-grass; and even on small farms, a one-horse mower, with a small tedder and horse-rake, will pay excellent interest on the outlay, enabling the farmer to do more work in less time and with fewer hands than could be done under the old-fashioned system of hay-making.

Hay-barns.—One of the most useful of modern farm equipments is the hay-barn, which is simply a permanent shed for the storage of hay or of corn. In a climate whose fickleness is proverbial, and in which good seasons for sowing crops are the exception and bad ones the rule, it is a great advantage to be able to avoid rick-making. Where there is a hay-barn the hay can be scoured load after load as it gets ready, but where stacks are made it must either be made up into "tramp-cocks," where it can remain until there is sufficient to begin and finish a rick, or a rick-cloth must be put up, as in Fig. 78, with the poles stuck in cart-wheels or in the ground; and if neither of these precautions is adopted there is danger of the rick being deluged while it is still at the width, in which case there is great trouble to get it dry again. But a rick-cloth does not remove the necessity of afterwards roofing and thatching the rick, and the former of these is a tedious, the latter an expensive operation; it is at best a protection against rain whilst the rick is being made, and can in no sense be regarded as more than temporary, whereas a hay-barn provides all the advantages of the rick-cloth, with various additional ones, and it is to all intents and purposes a permanent protection against bad weather. Where there is a good hay-barn, several cart-loads can be hastily drawn in under it, if the weather is

waggon and loader are astride the row of hay; the machine is easily and quickly attached to and disengaged from any kind of harvesting cart or waggon, and it takes up the hay as cleanly as a fork; it will raise a ton of hay from the wind-row in five minutes, and it requires no extra men or horses to work it; it will work satisfactorily on all fairly level and even land, and it can be used to gather loose grain-crops with equal facility. These are the advantages claimed for it. Fig. 77 shows the loader at work.
threatening and there is hay dry in the field, and they can be unloaded at leisure when the rain is falling. A hay-barn admits of the hay being got a little softer, because it can be stored away a load or two at a time, and so settle quietly down, cooling as it settles; but if hay is got too soft, and put into a rick which is begun and completed in a couple of days or so, the excess of moisture causes far more "sweating" than is good for the hay. In many cases the ricks have had to be hastily cut to prevent firing, and it is no uncommon thing for hay-ricks to be destroyed by spontaneous combustion, which comes of the heating and sweating. Hay-barns, too, are very useful for a variety of purposes when there is spare room in them; for the storage of carts and implements, and in spring-time they are particularly useful as lambing-sheds, for by that time the bulk of the hay is generally eaten.

Hay-barns are constructed in many different ways and of a great variety of materials. They may be run up at a very moderate cost on poles stuck in the ground, surmounted by a light framework which is covered over with asphalted cloth; and a structure of this kind will answer every purpose required of a hay-barn, while it will last a long period if it is smeared over with boiled gas-

![Fig. 78.—Hay-stack and Rick-cloth.](image)

![Fig. 79.—Iron Hay-barn.](image)

tar every second year, to preserve it against the damp. They are also commonly built in a substantial manner on brick or stone or iron pillars, and roofed with tile or slate, and in many cases the bleak side of the barn will be entirely built in with wall, the front only being open and standing on pillars. The most recent, and, on the whole, the most approved and satisfactory kind are built wholly of iron, as seen in Fig. 79, or the barn may be a single rather than a double one; the pillars are of cast-iron, standing on and strongly bolted to large slabs of stone that stand a foot or two out of the ground and dip a foot or two into it, and the roof is of corrugated and galvanised sheet-iron, well braced and bolted, and firmly attached to the pillars. Such a barn as this, erected at a moderate cost, will hold an enormous quantity of hay or corn, and it will be noticed that the carts or waggons may be drawn in and unloaded under cover, part of the barn being filled up at a time. The hay-barn in the cut has a raised floor, whose object is to keep the hay off the damp ground. The best kind of floor is stone or asphalt, well laid down.

If the hay is got hurriedly on account of the weather, and rather soft, it is a simple matter to leave a sort of chimney here and there in it to allow the heat and steam to escape; this is simply done by filling a sack with hay, setting it upright on the ground, building the hay round it, and drawing it up as the hay-mow rises; or it may be done by nailing strips of wood on three poles that are placed in a triangular form, reaching from the bottom to the top, and remaining in
the mow. Either of these methods is very simple and very effectual.

**Horse-forks.**—Another valuable, and time as well as labour saving equipment of modern days, at three grabs and in about five minutes, saving the toilsome labour of pitching by hand, and doing the work with fewer hands and in much less time.

Another kind of horse-fork is made to run on one spar only, which is not rigid, but merely suspended from the ridge-tree. In this case the four small wheels which carry the fork run on the one spar instead of two, clasping it, so to speak, turned inwards instead of outwards on the frame to which they and the fork are attached, and leaving a space between each pair, so as to clear the iron bolts by which the spar is suspended. This principle will answer instead of the foregoing one inside a barn, while it admits of being arranged to serve for stacking outside, as seen in Fig. 82; and the framework that carries the fork-equipment will answer well to sustain a rick-cloth in showery weather.

Yet another kind, made by Mr. Wright, of Cardiff, used for stacking only, and not applicable to the inside of a barn, is attached to a pole and suspended from a boom, as seen in Fig. 83. The boom works freely either to the right or left, dropping its load in almost any desired place on a moderately big stack. The fork is adapted for hay, straw, chaff, or even corn in sheaf, and it will unload a two-horse waggon, elevating the load to a height of 30 feet or so, in from five to

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Fig. 80.—**Horse-fork.**

is the horse-fork, or elevator. Of these implements there is an endless variety, but one principle is common to all of them, viz., the employment of horse-power by means of ropes and pulleys. In Fig. 80 is shown one of the most effective of these tools, and also the method by which it is employed inside a building. Two parallel and stout spars of wood, some 6 or 8 inches apart, and leaving a clear space between them all along, are suspended from and well braced to the ridge-tree of the barn. The fork is suspended from a carriage which runs on four wheels, A; one end of the rope is fast, and the other runs over pulleys, B, passing down to the ground, where it runs under a third pulley and is attached to the horse. The fork with its load is easily sent along the whole length of the building, and the load is dropped wherever it is wanted by pulling the rope c, which forces the forks asunder. The general arrangement of this simple but effective machinery inside a hay-barn is seen in Fig. 81. By means of it a cart-load of hay can be unloaded

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Fig. 81.—**Horse-fork at Work.**

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Fig. 82.—**Horse-fork on Framework.**

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Fig. 83.—**Horse-fork on Pole.**

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HORSE-FORKS.
ten minutes. One or other of these implements, according to requirement and taste, will be found of great service to the dairy-farmer in the busy time of harvest.

Artificial Hay-making.—The artificial drying of hay in a treacherous climate like that of Britain is a question full of importance to farmers. It not uncommonly happens that the crop is made almost completely worthless, and it is frequently greatly injured, by continuous wet weather in harvest-time. In such cases the farmer is utterly helpless, and all he can do is to stand by and see the mischief done, being powerless to prevent it. But the problem of saving the hay-crop in a wet season by means of artificial heat appears to have been solved by Mr. Gibbs, of Gilwell Park, Essex, after many years’ patient study and experiment. In Fig. 84 we give a woodcut of the harvester, and the following description of it is by Mr. R. S. Burn:

"When examining Mr. Gibbs’ latest form of machine for hay-drying, I was struck with the way in which it opens up the grass so as to present every part of every fibre thoroughly to the dry air. This is done by a combination of movements, capable of adjustment as to speed and angle. The first movement is effected by tines placed upon a horizontal cranked shaft, very much after the fashion of the three-throw pump. The tines are placed at intervals on the shaft. The second motion is the ‘reciprocating,’ applied to the table on which the grass rests, and along which it moves while being subjected to the dry air; while, therefore, the grass is tedded by the tines, it is at the same time moved alternately, first in one direction, then in another, the combination of the two movements being such that it causes the grass to pass along from the end at which it is fed to that at which it is delivered in a dry condition. The third movement is very novel and curious in its action. The tines are not fixed on the shaft, but the ‘boss’ which carries them, and which is connected to the shaft, has a certain amount of play given to it; hence, when the tines are lifted by the revolutions of the cranks, they finish off with a diagonal action, which gives a movement in the direction of the delivery end of the machine, and this causes the grass to move along the table towards that end.

"The result of these three actions is that grass fed in at one end in the most tangled and matted condition, or wet, half-made hay, comes out at the delivery end quite loose and opened up. The action of the tines is peculiarly delicate and yet foreible, and the extreme simplicity of the mechanical movements and fittings is the best feature of the apparatus. There is nothing of importance to go wrong; any labourer can work it, adjust its parts, and repair them instantly."

During the tossing about the hay is exposed to a current of heated air, produced from coke, which quickly drives off the moisture, and the effect of this artificial drying is to restore quality to hay which has been partly spoilt by the rain. The colour of good hay is preserved and the odour maintained when freshly-cut grass is used; and these qualities are brought back in some measure when they have been lost by overmuch exposure to wet. The fan of the furnace and
the machinery of the dryer are driven by an engine; the rest of the arrangement is clearly enough seen in the illustration. The quantity of hay that this machine will make in a day depends on the degree of wetness in the hay; it is, as a rule, better to let the hay be partly made in the field and to finish it off in the machine, if this can be done in the wet weather, during which the machine is valuable; and of this half-made hay the machine will get through a load an hour, while freshly-cut grass would take a longer time. The machine is not designed to supersede the ordinary method of hay-making in good weather, but to continue the work when the weather is such that it is impossible to save the hay in the usual way. The inventor has received many testimonials as to the efficiency of his machine from practical agriculturists in this and other countries. We have seen Mr. Gibbs put green grass, and afterwards badly-weathered and thoroughly-wetted hay, into his machine; the former came out sweet-smelling, well-made green hay, and the latter a tolerable article, very much improved in the process, which lasted some four or five minutes. The invention is clearly one of great value and merit.

**Ensilage.**—The following very curious system of storing green fodder is of Hungarian origin, and was introduced to the notice of British farmers by Professor Wrightson, in an article contributed to the *Journal* of the Royal Agricultural Society in the year 1874. The system consists in cramming the green food, of whatever description, tightly down into deep and wide trenches that have been dug in the ground, and the wetter the fodder is the better its packing and preservation; when cut out in winter it is found to be a rich brown colour, very palatable to stock, and it is known under the unattractive name of "sour hay." In this way various kinds of green forage may be preserved for winter use.

In France the system has been somewhat extensively practised for several years. It is there known by the term "ensilage," which means, literally, in a pit or trench; but the word is now understood to mean also green fodder that has been preserved in a pit or trench. Green maize is put through a chaff-cutter and cut into half-inch lengths, in which form it is found to pack better and closer; the air is excluded more satisfactorily, and the preservation of the fodder thereby secured. Pits are dug in the ground, the perpendicular sides walled and the inside cemented to exclude the air, while rain and the water in the soil are kept out of it, the one by a roof and the other by drains. In some cases a building is put up purposely for ensilage, with the walls well cemented. The main requirement is the exclusion of air, the next the exclusion of extraneous water; yet the forage cannot contain too much moisture of its own. As the preservation of the fodder is generally more or less defective round the outsides, it is probable that a circular trench or building would be the most suitable form, presenting the least area of outside; and it should be as large as may be consistent with convenience and economy in practice. In using the ensilage a portion is taken out of the pit each day for the next day’s use; and, however cold it may be when taken out, it becomes in twelve or fifteen hours’ time quite warm with active fermentation. After twenty-four hours’ exposure to the air it will have passed the proper limit of fermentation, and will then rapidly spoil. While in the pit the fermentation is very slow; exposure to the air stimulates it.
CHAPTER XIV.

Milk.


dairy-farming one prominent fact must always be borne in mind: that some breeds of cows are specially adapted to butter, and others to cheese production. And this holds good not only in reference to different breeds, but also to different animals of the same breed. Every one who has paid attention to cheese and butter making is aware that certain cows in a herd are much better “butter-cows” than the rest; and this is seen not only in the quantity of butter their milk will yield, but also in the readiness with which the cream is churned. Some breeds, indeed—the Ayrshires, for example, and, in a somewhat less pronounced degree, the Short-horns—are well adapted to the production of either cheese or butter, as may be desired; and yet in these breeds there will be a difference, as between one animal and another, with regard to special adaptation to the one purpose or to the other, as the case may be. Speaking in general terms, both the quantity of milk given and its special features will bear a given relation to the type of the breed.

Left in a state of nature, or when not bred and trained for the production of milk, we find that cows are unable to do much more, so far as milk is concerned, than support their own calves; and wherever we find a breed of cows celebrated either for quantity or for quality of milk, we may conclude justly that its reputation in this respect is chiefly owing to the skill which man has brought to bear, one generation after another, with a view to secure the sort of animal most useful to him. In a greater or lesser degree, and with varying success, all dairy-farmers seek to do this. Locality and soil, no doubt, have a great influence on the result, but the art of man has a greater, though he cannot entirely overrule those influences that are not his own. In speaking of a breed of cows, as adapted to dairy uses, it is unfair to take exceptional individuals of that breed and hold them up as an illustration of the type; this may only be done when we wish to show the highest capability of a specimen animal produced by the breed, or when we give an illustration of the end we wish to attain. Such an animal, indeed, is, at the present time especially, a practical expression of the average opinions of the best breeders as to the qualities they consider are best fitted to the end they have in view; but as yet there are few, if any, breeds whose special characteristics do not fluctuate more or less in different individuals of the breed.

In respect of some breeds of cattle, as, for instance, the Scotch Polled or the Herefords, the object of several generations of breeders appears to have been less the production of milk than of beef, and perhaps more the quality of the beef than the highest form of symmetry in the animal. In other cases, of which the Ayrshires are the best example we have in the British Islands, the object has been to produce a breed of cows whose reputation rests chiefly on the large quantity of milk they give, the production of beef having been an extrinsic consideration. And yet again, other breeds, of which the Alderneys may be taken as the highest type in this or any other country, have been bred with a view to quality of milk rather than quantity, and beef has been at most a secondary consideration. Once more, the Short-
horus present to us an embodiment of the best results yet attained in combining symmetry, size, beef, and milk in one breed; and yet the Shorthorns are apt to swerve too much in the direction of one or two of these qualifications, leaving the others more or less in the background, if the breeding is not carefully watched and undue tendencies immediately checked.

For her size, the Ayrshire cow is commonly considered, in districts where she is well known, to be the highest embodiment of great milking powers; and though, on account of the smaller average size of the cream-globules in it (Fig. 85), her milk is not so well adapted as that of the Alderney to butter-making, it is not because it is really poor in fats, but because the cream-globules, being as a rule smaller, separate less readily from the milk. For this reason the milk of the Ayrshire cow is especially adapted to cheese-making, because the butter is the more perfectly enclosed in the curd; the milk of the Alderney, on the contrary, is especially adapted to butter-making, because the cream-globules, being larger, rise the more readily to the surface of the milk, and the cream is the more easily churned into butter (Fig. 86). And the Ayrshire cow presents the wedge-like form which is by many considered to be the most conducive to milk-production—that is, her hind-quarters are spacious, deep, and well developed, while her fore-end is lighter, finer, thinner, and narrower. Her udder and teats, too, present us with another peculiarity, which may or may not be indicative of deep milking properties: the udder is attached to a larger portion of the surface of the abdomen—that is, it spreads further forward and backward, is held up flatter and closer to the body, and is less of a pendent form than in most other breeds; the teats have a close affinity to the udder in form, being rather short and stump; and set wide apart—less pronounced, in fact, and more as if they were an after-thought than those of other kinds of cows. It is not to be desired either that the udder-glands should stretch along the belly too far, or that the teats should be very flat and short, for in the latter case it is very difficult to milk them by hand; but spreading rather than pendent teats and udders are peculiarities of true-bred Ayrshires, and, within bounds, it is better they should be as they are in general form.

If we take the Alderneys as a type differing in these respects from the Ayrshires, we find their teats and udders preserving the same affinity to each other in form and structure, but they are both much more elongated and pendent, and when full of milk are more prominent and obvious for the size of the cattle. The udder-glands are elongated rather than flattened, pointing downwards rather than spreading forwards, and the teats are cone-shaped rather than short and flat. These characters are, in fact, common to many—to most—breeds; while in some, the Shorthorns, for example, the form and shape of the udder and teats, and the relative size of the latter, may be regarded as intermediate between the types we have mentioned. The elongation of both teats and udder, and the size of the former, will generally be found to increase the longer the cow is in milk, so that short teats, which at first are difficult to milk, will improve in this respect.

J. P. S.

Anatomy of the Mammal Gland.

The female animal of the bovine species secretes in the mammal glands, which we call "udder," the milk intended for the nourishment of its young.

The udder of the cow consists of two longitudinal glands, which lie alongside each other, separated by a fibrous partition. Each of these glands has two outlets, but sometimes also three, in which case the third and hindmost is small, and rarely of any milk-producing capacity. The usual
division of the udder into four quarters* is not strictly correct, though the four teats are independent of each other, forming as it were four divisions of the udder, for ducts and blood-vessels run from the foremost part of the udder to the other extremity, and vice versa. The outer skin of the animal covers also the udder, only that it is thinner and softer there, and especially at the base of the teats it is very fine and peculiarly elastic.

The degree of fineness of the skin on the udder is in direct relation to the structure of the other skin and to the individuality of the animal. Also, the hair on the udder gives us a clue as to the condition of the animal. Cows with thick, coarse skin have also stiff, coarse, and long hair on the udder; while with fine skin the hair is scarce, soft, and lustrous. The teats are hairless.

The udder is not merely covered with the general skin of the body, but underlyin...
udder of a cow after the skin is taken off it. The vessels are shown very carefully injected, and exposed so as to show each material portion of the udder in situ.

The large milk-duets which open in the cistern get smaller the further they are from the latter; they also branch off in all directions, and every branch gets narrower until it can only be distinguished by a microscope. The organisation of the gland which contains these ducts will be found the following, when looked at through a microscope:—Light-coloured strips surround pieces of reddish-grey gland and send smaller threads into the mass to surround smaller particles of it. The latter are the small flaps, the former the large flaps, and the stripes consist of bundles of connective tissue, vessels, and fat. In animals that are nourished very highly there is much fat in this place, which exercises sometimes a pressure on the gland, and either hinders or stops the secretion of milk. We know such udders by their, at first sight, promising size, but they feel hard and give little milk; they are called "flesh udders."

The arteries and veins of the udder are very large. The arterial blood comes into the udder from the arteria pudenda externa, which descends from the sexual parts with the vena pudenda externa. This artery passes along the upper part, and sends a small branch to the back part of the glands. An inch farther forward there are two large branches, the arter-mammae posticae, which supply the after part of the glands, and in the middle we find another large branch, the art-mammae interna, which spreads on the inner side of the gland. A smaller artery gives blood to the middle part of the gland, and in the fore part of the gland the art-mammae anterior does the same. The principal artery now leaves the udder and goes towards the navel, but it has become very small by this time.

The principal veins which bring the blood again out of the udder are the vena pudenda externa and the vena subcutanea abdominis. Their branches correspond with the above-mentioned arteries, and are called vena mammae posticae, vena mammae interna, and vena mammae anteriores. The first and last send branches to and form a network around the fore and hind teats. The exterior of this network lies immediately under the skin, the interior on the membrane of the canal leading out of the milk-cistern. The lymphatics accompany the veins in their branchings, and during the periods of lactation are filled with lymph. Each gland is provided with a nerve coming from the loins, which corresponds in its branchings, generally speaking, with the veins and arteries.

The development of the mammal gland begins already in the fifth week of the foetus, when the latter is not quite 2 inches long. We may see at this period four small rounded protuberances, which are separated by a hardly discernible cavity. Later on we find in these little warts the traces of a fine duct, and the warts develop themselves into teats. At the time of birth the udder consists of a larger or smaller quantity of fatty tissue, which contains already a few ducts surrounded by a little gland substance.

The development of the gland begins from the canal in the teats. The new milk-duets, or canals, are formed by new branches sprouting in all directions from those already existing. The ends of these canals divide at last into many small cells, and this process is repeated until the udder has stopped growing.

The secretion of milk is generally possible when the animal is two years old; but when the udder is irritated sooner the animal may give milk soon after the first year of its life. Such cases are, of course, exceptional, but they have been repeatedly observed. Fürstenberg has often tried successfully having heifers milked by the hand or sucked by a calf, when they would not conceive because they were too fat and highly fed. After some time milk appeared, and through its secretion the fat of the animal decreased and conception followed.

Also male and castrated animals can give, under certain conditions, milk not differing in composition from the milk of the female animal. Especially he-goats and oxen give a little milk when the teats are irritated regularly by the hand or by sucking.

**Physiology of Milk Secretion.**

It is not yet ascertained how milk is formed. Two hypotheses of this physiological process are very far apart as yet, and neither of them
show us more than the way in which it might be produced. One of these hypotheses is called the theory of transudation, the other the theory of metamorphosis. The first assumes a simple filtering of the constituents of milk from the blood through the gland, and a turning into milk by this process; the second that milk is formed in the gland by the decomposition of the cells of that organ. It will be necessary to state in short the reasons which both parties bring forward.

The theory of metamorphosis assumes that all feeding experiments of milk-cows have resulted in the observation that with the food we can influence the composition of milk only to a very small degree, while it is just the opposite with blood, therefore no transudation is possible. The colostrum-cells, which appear before and after the birth and in some diseases, are gland-cells, which are in an incipient state of decomposition, and are secreted in such cases without having advanced so far in it as to be simple milk-globules. Therefore one might conclude that the formation of milk is in its usual and normal state a decomposition of gland-cells. In the blood the salts of sodium prevail, in the gland those of potassium, therefore milk is formed by liquefaction of the latter. Also, one may say that the life and health of the sucking-calf would be continually endangered if milk was formed direct out of blood, as the composition of blood is subject to great changes. Casein is explained to be a modification of ordinary cell albumen, which is decomposed. Butter is said to be partly formed by direct transudation of fat out of the blood, partly by a fatty metamorphosis of albumen in the gland. Milk-sugar may be partly derived from the sugar in the blood or by the decomposition of fats and albumen.

The opposite theory, that of transudation, is little studied as yet; the origin of casein it explains as being the serum albumen of the blood, changed by a ferment which exists in the gland.

It may be said that both these hypotheses are impossibilities if considered to their full extent; their combination alone affords explanations which are at all satisfying to the present state of science. Milk is not formed by transudation nor by metamorphosis exclusively; both processes must be certainly called in requisition, but to assign to each of them the part which it has to perform is as yet impossible.

**Physical Properties of Milk.**

The boiling-point of milk is only a small fraction of a degree higher than that of water; the freezing-point as much lower. Its capacity of heat is a little smaller than that of water; about like 0:817 to 1. Of course the capacity changes according to the composition. Milk contracts until it reaches its freezing-point, and expands strongly in the moment of congelation. Its power of expansion is no constant quantity; it varies according to the amount of solids in the milk.

Below 50° the consistence of milk gets more viscous, and the more so the lower the temperature is. At the same time, its powers of cohesion and adhesion are augmented in the same degree.

The specific gravity of milk at 59° varies between 1:027 and 1:035, but in general, exceptional cases excluded, only between 1:028 and 1:034. Milk which is out of the first mentioned limits may be taken as either adulterated or diseased. An experiment made with 233 cows of different breeds, in different countries, had the following result:

| Over 1:034 | ... | ... | 2 per cent. |
| Between 1:034 and 1:033 | ... | 10 | " |
| " 1:033 " | 1:032 | ... | 19 | " |
| " 1:032 " | 1:031 | ... | 24 | " |
| " 1:031 " | 1:030 | ... | 28 | " |
| " 1:030 " | 1:029 | ... | 10 | " |
| " 1:029 " | 1:028 | ... | 5 | " |
| Under 1:028 | ... | ... | 2 | " |

Under normal conditions the average specific gravity of milk obtained from a number of cows will be 1:030 to 1:031.

**The Composition of Milk.**

The milk of cows, as well as of all other mammals, consists of water, butter, casein, albumen, milk-sugar, and mineral substances.

The average percentage is the following:

| Water | ... | 87.25 per cent. |
| Butter | ... | 3.50 |
| Casein | ... | 3.50 |
| Albumen | ... | 0.40 |
| Milk-sugar | ... | 4.68 |
| Mineral substances | ... | 0.75 |
| **100** | | **100** |
The limits of variation in the composition of pure milk are considerable, as will be seen in the following table:

<p>| | | | |</p>
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<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>...</td>
<td>83-65 to 90-00 per cent.</td>
<td></td>
</tr>
<tr>
<td>Butter</td>
<td>...</td>
<td>1-50</td>
<td>5-20</td>
</tr>
<tr>
<td>Casein</td>
<td>...</td>
<td>3-00</td>
<td>5-00</td>
</tr>
<tr>
<td>Albumen</td>
<td>...</td>
<td>0-30</td>
<td>0-55</td>
</tr>
<tr>
<td>Milk-sugar</td>
<td>...</td>
<td>3-00</td>
<td>5-50</td>
</tr>
<tr>
<td>Mineral substances</td>
<td>...</td>
<td>0-70</td>
<td>0-80</td>
</tr>
</tbody>
</table>

Casein is a member of the group albumen, about which so little is yet known. Voelcker found its composition to be the following:

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>...</td>
<td>53-57</td>
<td></td>
</tr>
<tr>
<td>Hydrogen</td>
<td>...</td>
<td>7-14</td>
<td></td>
</tr>
<tr>
<td>Nitrogen</td>
<td>...</td>
<td>15-41</td>
<td></td>
</tr>
<tr>
<td>Oxygen</td>
<td>...</td>
<td>22-03</td>
<td></td>
</tr>
<tr>
<td>Sulphur</td>
<td>...</td>
<td>1-11</td>
<td></td>
</tr>
<tr>
<td>Phosphorus</td>
<td>...</td>
<td>0-74</td>
<td></td>
</tr>
</tbody>
</table>

100-00

Casein is not in solution in the milk, but is swelled up by its absorption of water into a kind of very thin jelly. This may be proved by putting milk in a dialysator, when the casein does not pass the membrane, as it would do if it were dissolved.

Casein, not soluble in water and highly-diluted salt solution, is soluble in diluted hydrochloric acid and carbonate of soda. Acetic acid precipitates casein, but dissolves it again when more of it is added. Casein is not precipitated on boiling, but this is the case when rennet is added at a certain temperature.

The coagulation of casein is observed in three modifications:

(a) The natural coagulation by acidity of the milk and by the influence of rennet;
(b) The precipitation with acids; and
(c) Mechanical precipitation.

The first form may be observed when milk stands until it gets sour, when the milk-sugar (lactine) is changed slowly to lactic acid, which changes the neutral phosphate in the milk into acid phosphates, and forms alkaline salts at the same time. As soon as a certain quantity of acid phosphates has formed, which is in direct relation to the quantity of neutral phosphate, the casein is coagulated, because the acid phosphate influences the alkali of the casein. This also proves that the casein is an alkali-albuminate.

The formation of lactic acid out of milk-sugar is explained by the following formula:

\[ \text{C}_{14}\text{H}_{22}\text{O}_{11} \text{(Milk-sugar)} + \text{H}_2\text{O} \text{(Water)} = \text{C}_3\text{H}_4\text{O}_3 \text{(lactic acid)} \]

For some time before the coagulation of the casein begins by natural acidity the milk cannot bear the slightest addition of any acid, nor boiling, without coagulating immediately. In a higher temperature less lactic acid is necessary to coagulate the milk, or "curdle it," as we say in practice.

The coagulation by rennet belongs also to the first modification, as before mentioned, as with both rennet and lactic acid the casein is precipitated in the milk in a jelly, which contracts very soon and emits a greenish fluid, the serum, or whey. The rennet only acts under a certain temperature; the more rennet is added and the higher the temperature the quicker it acts, but the temperature must be kept between comparatively narrow limits, as otherwise rennet does not act properly.

The second modification (b) or kind of coagulation occurs through acids, with the exception of lactic acid. Other acids—for instance, diluted hydrochloric acid and acetic acid—do not coagulate casein in a compact jelly, but in flakes, which sink to the bottom after some time. It need hardly be said that such casein is not fit to be used for making cheese.

The third modification (c) of coagulation is caused by different agents; for instance, neutral phosphate of soda, neutral carbonate of soda, and others, which precipitate milk though they dissolve casein. The addition of any of these agents forms a strong precipitation of phosphate of calcium, which makes the casein and butter fall to the bottom. In this case the casein has not been made insoluble, because water will wash it out of the precipitate.

The real coagulation of casein by rennet and acid makes the casein insoluble, or, more accurately, takes away its power to absorb a large quantity of water and to swell up like a gelatinous substance. The butter is enclosed in all cases of coagulation or precipitation of milk by the shrinking casein, and in the serum (whey) are left the soluble constituents of milk: albumen, milk-sugar, and mineral substances.
ALKHEM.

Colostrum, and also diseased milk, are generally richer in albumen than ordinary milk. The composition of albumen is the following:—

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td></td>
<td>53.5%</td>
</tr>
<tr>
<td>Hydrogen</td>
<td></td>
<td>7.0%</td>
</tr>
<tr>
<td>Nitrogen</td>
<td></td>
<td>15.5%</td>
</tr>
<tr>
<td>Oxygen</td>
<td></td>
<td>22.4%</td>
</tr>
<tr>
<td>Sulphur</td>
<td></td>
<td>1.6%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100.0%</td>
</tr>
</tbody>
</table>

The albumen of milk is taken as identic with the albumen of the blood serum; it coagulates at 161° to 163°. Carbonic, acetic, phosphoric, and tartaric acids do not precipitate albumen. It is soluble in water, diluted acids, diluted carbonate of soda, and common salt.

The existence of Lactoprotein is often been affirmed and denied. After casein and albumen are precipitated and the pure whey filtered off, we may cause another precipitation by tannic acid. This is lactoprotein, an albumen which is still little known.

Butter.

Butter, the fatty substance of milk, is not in solution in the milk, but exists in shape of tiny drops, or globules, which are suspended in the serum. In 1 lb. of milk, containing 4 per cent. of butter, about 40,000 millions of globules must be contained. After being churned, butter is a yellowish, salve-like mass of about 0.92 specific gravity, which gets crummy under 50°; over this limit pasty, at 68° soft, and about 97° it melts, while at about 73° it gets hard again if cooled. The melting and solidifying points are variable, like the composition and specific gravity. Butter consists of the triglycerides of the following fatty acids:—

- Butyric acid
- Caproic ”
- Caprylic ”
- Capric ”
- Myristic acid
- Palmitic ”
- Stearic ”
- Butyric ”
- Oleic ”
- Volatile fatty acids.
- Real fatty acids.

In their combination with glycerine they must be classified as follows:—

- Myristine
- Palmitine
- Stearine
- Butine
- As fluid fats.

- Myristine
- Caproine
- Capryline
- Caprine
- Oleine
- As solid fats.

Myristine and butine are only present in a very small percentage; under the fluid fats oleine predominates very considerably; so the butter consists principally of palmitine, stearine, and oleine.

Fresh butter contains in

<table>
<thead>
<tr>
<th>Component</th>
<th>Winter</th>
<th>Summer</th>
</tr>
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<tbody>
<tr>
<td>Solid fat</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>Fluid</td>
<td>40</td>
<td>60</td>
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</table>

Voeleker says butter contains

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
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<tbody>
<tr>
<td>Solid triglycerides</td>
<td>68 per cent.</td>
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<tr>
<td>Oleine</td>
<td>30</td>
</tr>
<tr>
<td>Triglycerides of the volatile fatty acids and of caprinic acid</td>
<td>2</td>
</tr>
</tbody>
</table>

Butter becomes changed in condition when we keep it some time; we then call it rancid. It is impossible in practice to get butter free from casein, albumen, and milk-sugar. These substances decompose sooner or later, and contaminate firstly the oleine and the triglycerides of the volatile fatty acids. The products of the decomposition of these fats can then be smelt.

The aggregate of the butter is fluid in fresh milk, as Soxhlet has proved. The globules in fresh milk and cream are rounded in form, which proves that the fat is fluid and milk is an emulsion. A still better proof is that frozen milk shows a different state of the globules. They lose their brightness, become granulated, and show under the microscope the same appearance as those which have been churned for some time. We see from this that the fat of milk gets solid by violent mechanical movement or in a temperature of about 25°. Butter globules in cold milk may be cooled down to this temperature without getting solid, though the point of solidification of butter is 73°. We have several examples in physics analogous to this, and its cause is the resistance of very small, isolated particles against freezing. Intensity of cold or agitation influences the solidification of the globules unequally, for globules of smaller size are less affected by both, so that we can explain why it is that in buttermilk we always find the smaller globules left and not turned into
butter. We stop churning when most of the fat has been solidified, as we should spoil this and beat it soft again if we continued the movement still longer.

It is still impossible to decide absolutely whether the milk-globules are covered by a kind of skin or not, though this question has been discussed and experimented on for many years. Some think the milk-globules are cells which have fallen off from the membranes of the follicles, and are consequently covered by a membrane; others believe they are covered by a layer of casein, condensed by attraction. Another view of the case is that the globules have a covering of serum, condensed by attraction. Numbers of other theories have arisen and fallen again, and only two are maintained with some amount of probability until now. We may say, either the milk-globules are cells and have a membrane, or they are drops of fat round which local attraction has formed a kind of halo of condensed serum. It would take too much space to go more into all the pros and cons here, therefore these statements may suffice, as we cannot pronounce with absolute certainty on the matter.

**Milk-sugar (lactine, lactose).**

Milk-sugar has been found in milk as far back as 1619. Its chemical formula is C_{12}H_{22}O_{11} + H_{2}O, and its composition the following:

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<tbody>
<tr>
<td>Carbon</td>
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<td>...</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Oxygen</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Water (crystallisation)</td>
<td>...</td>
<td>...</td>
<td>...</td>
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The colourless, glassy, four-sided prisms of the rhombic system are hard, not easily soluble in water and alcohol, grate like sand between the teeth, and are unaltered in dry air. At 298° to 316° they emit the crystallising water, and lactocaramel is formed. The specific gravity is 1.513 to 1.518. Milk-sugar reduces alkaline copper solutions. In milk the milk-sugar is in solution, and very apt to turn into

**Lactic Acid.**

It is not yet known what gives the impulse to its formation, but it seems to be a chemical ferment of casein. Lactic acid was detected in 1780; its chemical formula is C\(_3\)H\(_6\)O\(_3\), and consists of—

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<tbody>
<tr>
<td>Carbon</td>
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</tr>
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<td>Hydrogen</td>
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<tr>
<td>Oxygen</td>
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Lactic acid exists also as a product of sour fermentation of other kinds of sugar; for instance, in sour cucumbers, &c. It is a colourless, syrup-like, very sour, non-volatile fluid, which dissolves in water, alcohol, and ether, 1.215 specific gravity, and is decomposed at 298°. It is quite beyond doubt that the formation of lactic acid is the reason for the spontaneous coagulation of milk, as if we take the milk-sugar out of the milk in a dialysator, it coagulates only after a considerable time, when general decomposition has begun by the decomposition of the fats.

**The Mineral Substances (Ash, Salts).**

The ashes of milk are identical with those of plants, and without doubt the composition of the plant ashes is of important influence, as the analyses of milk ashes show considerable difference. Experiments have proved that food rich in potash augmented the percentage of potash in the ashes of milk.

An average of many analyses shows the composition of milk ashes to be the following:

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<tbody>
<tr>
<td>Phosphoric acid</td>
<td>...</td>
<td>...</td>
<td>28.31 per cent.</td>
</tr>
<tr>
<td>Chlorine</td>
<td>...</td>
<td>...</td>
<td>16.34</td>
</tr>
<tr>
<td>Oxide of calcium</td>
<td>...</td>
<td>...</td>
<td>27.00</td>
</tr>
<tr>
<td>Oxide of potassium</td>
<td>...</td>
<td>...</td>
<td>17.34</td>
</tr>
<tr>
<td>Oxide of sodium</td>
<td>...</td>
<td>...</td>
<td>10.00</td>
</tr>
<tr>
<td>Oxide of magnesium</td>
<td>...</td>
<td>...</td>
<td>4.07</td>
</tr>
<tr>
<td>Oxide of iron...</td>
<td>...</td>
<td>...</td>
<td>0.62</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Oxygen deducted</td>
<td>...</td>
<td>...</td>
<td>3.68</td>
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This table shows that the ashes consist principally of phosphoric salts.

**Gases.**

If milk just from the cow is filled in a bottle and tightly corked, so that no air is left in it, a little gas will soon collect at the surface and make the bottle look as if it had not been perfectly filled.
These gases are composed as follows:—

Oxygen ... ... 0·99 to 0·1 per cent.
Carbonic acid ... ... 7·4 " 7·6 "
Nitrogen ... ... 0·7 " 0·3 "

Urea.

There can be no doubt as to urea being a regular part of milk, but to a very small extent—about 0·007 per cent. Diseased milk contains considerably more of it, especially when the gland has been affected by inflammation, when the milk, even for years afterwards, contains urea in abnormal quantities.

Creatine, creatinine, leucine, and tyrosine have been found in milk, but they must not be regarded as among its constituents. Their presence is only sporadic, and caused by premature decomposition of the proteids of milk.

Iodide has been found in milk, but proved to come from food containing that element. In the same way other substances which are absorbed by the blood can pass into the milk.

Colouring stuffs and etheric oils are also to be found in milk. Green food visibly affects the colour of milk and butter, and aromatic food gives also an aromatic smell or taste to both.

Influences Bearing on Milk Secretion.

Individuality.—The individuality of the animal has a most important influence on the quantity and quality of milk. This will be easily understood when we think of the formation of milk as an action of secreting organs. An animal whose organs of circulation and vesicular system are well developed, so that circulation and assimilation are not hindered, must show a higher secreting action, under similar conditions, than an animal who is deficient in these organs; and a mammary gland which is perfectly developed in all its parts must secrete more milk than one which is smaller or stunted in growth. On the other side, an animal whose constitution shows a strong propensity for the production of fat and flesh must give less milk, and practice proves that in such cases we may not reckon on a large yield of milk. Further, the general state of health and the pathological condition of the udder are in direct relation to the secretion of milk, and we may remind the reader of the decrease in milk which accompanies every disease, and also of the morbid augmentation of milk-secretion—the hyperplasia of the mammal gland.

Of course, it is not the quantity alone which must be valued in the dairy; the quality is of great importance, as with a great quantity of very watery milk we are not always better off.

The digestive assimilation of the animal is in intimate connection with this question. Let us take, for instance, two cows, of which one requires proportionally more food to supply material for the physiological functions of the body; we must prefer the other, even if she gives no more milk than the first, as she wants less food. But this question frequently appears in practice with a much wider margin between the two animals in question, and heavy eaters, who want much food for their large bodies, are very often poor milkers.

On the Continent we expect a good cow to give four to five times her live weight in milk per year, or, on the average, 5 to 7 litres daily.

Breed.—It has often been both denied and affirmed that breed and milk-production stand in constant relation to each other. Practice, however, affirms that this relation exists so far, at all events, as quality of milk is concerned. We have two prominent examples furnishing proofs of this that cannot be overthrown, however ingeniously a contrary theory may be built up. The Dutch breed, or, as they are wrongly called in America, Holstein cattle, give us a permanent example of milk deficient in fats, and the Jerseys give us an also permanent example of very rich milk. These instances show clearly enough that breed is in direct relation to milk-production; but it must not be overlooked that this relation consists only in the handing down from the parents of a disposition, and that this disposition can be influenced, or even annulled, by breeding, feeding, rearing, state of health, development of the organs, as well as by other causes. If we speak of the influence of breed on milk-production we must acknowledge this to be the case, but always subordinate it to the individual influences which cause the exceptions to the rule.

Period of Lactation.—We understand the period of lactation to be the time beginning directly before or after parturition, and ending...
generally some time before the following parturition. The quantity as well as quality of the milk undergoes considerable changes during this time. The largest quantity is secreted during the first month; after that the yield goes down somewhat, but remains for about two and a half months pretty stationary. It then gets less and less during the next six months, until the secretion is quite dried up. Of course, this rule applies only to the average milch-cows, and is greatly influenced by the individual properties of the animals. Many cows remain dry much longer than the desirable six or eight weeks, during which the extra nourishment required by the foetus ought not to be lessened by milk-secretion; but when cows remain dry for three or four months it is a great loss to the farmer, and considerably diminishes the value of the cows. Some animals never stop giving milk up to the day of calving, when a fresh flow of it begins.

The composition, condition, colour, taste, and smell of the milk that a cow gives for several days after calving differ greatly from that which she gives later on. It is usually of a deep yellow colour, and is peculiarly luscious and unctuous, the latter owing to an excess of albumen. Rennet does not coagulate it, but boiling does. The specific gravity is 1:016 to 1:065. Colustrum contains, besides the milk-globules, other particles, consisting, according to the researches of Fürstenberg, of pieces of membrane and clusters of cells, which he takes for milk-globules in a state of transition, i.e., not perfectly formed yet (Fig. 88). These cells contain a granulous substance and fluid in which one or more drops of fat are suspended. Fürstenberg has observed these clusters in all grades of their decay, or rather their falling into milk-globules, and has found this process further advanced the more remote the day of parturition was. Colustrum changes in composition almost from hour to hour; samples taken from six cows showed the following extremes directly after the birth:

- **Dry matter** \( \ldots \) \( 15:9 \) to \( 38:4 \) per cent.

Amongst this:

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<tr>
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<tbody>
<tr>
<td>Butter</td>
<td>Milk-sugar</td>
<td>Albumen</td>
<td>Casein</td>
<td>Ashes</td>
</tr>
<tr>
<td>27 to 85</td>
<td>6:0 to 2:9</td>
<td>4:1 to 15:5</td>
<td>7:3 to 11:2</td>
<td>2:5 to 3:3</td>
</tr>
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</table>

In the creamometer colustrum shows up to 50 per cent. of a creamy matter, which consists, however, only to a very small extent of fatty matter. In general we may say that the changes in colustrum proceed in the following manner:

- The solids, which are very considerable in the first hours, become normal in quantity during the next five to eight days. The proportion of fat, which usually appears only a little higher or lower a few hours after calving, is quickly reduced to its normal position. Milk-sugar is found at first in only very small quantities, but has reached its normal height in three to five hours. Albumen is sometimes found up to 15 per cent. in the first day, and in eight to fourteen days it has fallen to the usual percentage. On the average the colustrum of the first day contains:

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<tbody>
<tr>
<td>Water</td>
<td>78:7 per cent.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butter</td>
<td>4:0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk-sugar</td>
<td>1:5</td>
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<tr>
<td>Casein</td>
<td>7:3</td>
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<tr>
<td>Albumen</td>
<td>7:5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ashes</td>
<td>1:0</td>
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\[ \text{Total: 100} \]

- Solids 21:3
- Water 78:7

\[ \text{Total: 100} \]

Colustrum has a purgative influence on the intestines of the calf, and this has been for a long time the reason of its being thought unhealthy; but it is not only the best medium for clearing the intestines of the excrements collected there during foetal life, but for the newly-born calf it is also a nourishment of the highest physiological importance. If colustrum is an excellent nourishment for the calf, it is, on the other hand, very dangerous in the dairy, as it promotes all kinds of irregularities, particularly in the process of curing or ripening of cheese. Milk should never be used for cheese-making until the fifth day after calving, and even then it is not always safe.

H. L. de K.
CHAPTER XV.

Cheese-making.


It seems, with regard to many things, to be a principle in the human mind to praise the past at the expense of the present. We are never tired of referring to the "good old times," and of wishing that they were with us again or that they had never left us. We assume that times are worse now than they were in the period to which we vaguely refer as "our forefathers' days;" and it is more than probable that future generations will speak much in the same strain. So it is the opinion of many people that English cheese now-a-days is not as good as it was in the olden times—say a century ago; and the opinion is in the main sound, though it does not admit of proof, for if our cheese has gone down the hill in quality within the recollection of those who are living, it is safe to assume that it is worse now than it was in the days of those who are dead. In any case we may allow that if English cheese has not actually gone worse it has relatively done so, for American cheese is certainly much better on the average now than it was twenty years ago, and it therefore follows that our own suffers more in comparison with it now than it did at that period. What is called "high-farming," whether it consists of feeding the land with artificial manures or the animals with artificial foods, has, without doubt, changed the character of the herbage on which the cows are chiefly fed in the period during which milk is most plentiful, and this, in its turn, has changed the character of the milk. What this change of character in the milk consists of is not yet made clear, but that it has taken place is a fact well known to our oldest cheese-makers. It is on account of these undetermined elements that it is difficult in many cases to produce a satisfactory cheese, and the difficulty is not by any means wholly removed, but only reduced, by skimming a portion of the cream off the milk. It is something like bleeding a patient who has a fever!

Anyway, cheese-making in these times is an art that is practised in a perfect manner by very few persons. If one in a hundred makes a perfect cheese, the ninety-and-nine make one which is more or less imperfect. And still cheese-making is not a complicated art; success in it depends less on a mastery of scientific formulæ than on watchfulness, care, industry, dexterity, cleanliness, and attention to details. There is a great difference in people. A few persons seem to acquire by intuition a mastery over technical details which science has been years in demonstrating. In the domain of cheese-making these will generally be women; they hit upon one scientific truth after another by a process of reasoning which neither they nor any one else can explain, but which is correct nevertheless, and they do the right thing at the right time, without caring to inquire into the why and wherefore of it. Experience is a valuable thing in cheese-making, but it will not make any one a first-class cheese-maker who does not possess natural or acquired habits of scrupulous cleanliness, patient industry, dexterity, and unflagging attention to details of management. Natural intelligence and acquired knowledge are equally of no avail when they are found in connection with lazy, dirty, slovenly, and careless habits. The truth must not be blinked that downright hard work cannot be wholly dispensed with in cheese-making, whether labour-
saving appliances be used or not: such equipment only lessens the amount of it, not wholly removes it. This cannot be too often impressed on the notice of those who are engaged in cheese-making, for it seems to be one of those things in which the need for tuition is perennial. Books on cheese-making will not alone make people good cheesemakers, and they cannot impart those essential qualities to which allusion has been made; they do not fill the place of practical experience, nor will they supply natural intelligence where it is lacking. But they are designed to aid those who have inquiring minds, and who are desirous of profiting by the experience of others, and they do it in this wise: by placing before them a record of results arrived at by scientific and practical men, by describing to them the systems followed in different districts and countries, by warning them against mistakes which others have fallen into, and by explaining the best and most successful methods as adapted to the ever-varying conditions of production, of soil, and of climate.

It was erstwhile the practice for dairymaids to "change place" from one farm-house to another without any misgiving as to whether they would succeed as well in the new situation as they did in the old. By taking the same amount of pains they were fairly certain of making good cheese in all places alike, making due allowance for differences in the character of the land; and their masters and mistresses were equally confident of the result. As a matter of course, all dairymaids did not make equally good cheese then any more than they do now, perhaps; but one who made good cheese at any one farm was confidently expected to make good cheese at any other farm, and she commanded a wage corresponding to her reputation as a cheese-maker. But in recent years it has been quite common for one who made a fine dairy of cheese at one place to fail in doing so at another; and it has not been at all uncommon for a dairymaid, be she mistress or servant, to succeed well one year and to entirely fail the next on the same farm. This sort of thing has been a source of much anxiety and even bewilderment to numbers of excellent people.

Land.—It may be stated as a first fact that "sound" land—that is, land which does not need artificial draining—whether improved or not by applied manures, will as a rule produce, if not a richer, at all events a sounder and a better-flavoured cheese than "unsound" land will produce under like conditions of treatment. In the first place, the sound is the healthier land for stock, however much the unsound may have been improved in that respect by draining; and the healthier cows are, the better and sounder and healthier is the milk they give. Sound land will not by any means produce in all cases more cheese per acre than unsound land will produce—this depends on the strength and richness of the land in each case—but it will usually produce more from a like quantity of herbage, because its grasses are more varied in character, more delicate, more nutritious, healthier, and altogether superior. It will generally be found that drained land has not that healthy elasticity to the tread, nor irrigated land that cheerful aspect or wealthy variety of grasses, nor recently-ploughed land that thick, warm, carpet-like sward that we find on many of the grand old pastures of the kingdom.

Herbage.—On the majority of old pastures that have not been manured for years—perhaps for generations—because they need it not, very much less skill is required in dairy operations than is found to be the case on heavily-manured land, on irrigated meadows, or on artificially-seeded land. The grasses of irrigated meadows and heavily-manured pastures are ranker and coarser, and those of newly-seeded land less matured and more succulent, than the slower-growing and more perfectly-matured herbage that is found on fine old-turf land. Milk produced from irrigated meadow-grass, or from heavily-manured land of any kind, turns sour earlier than that which comes from old pastures, and it is consequently more difficult to make cheese from it, whilst that from young and vigorous artificial grasses has a something in it that makes it less tractable than the milk produced from old pastures, the herbage of which has been permanent for generations. Generally speaking, the quality and variety of natural grasses are reduced, while the bulk is increased, by heavy dressings of manure; and irrigation produces a similar effect. If we examine the herbage of different pastures, a greater number and variety of grasses will generally be found on good old natural pastures or unmanured grass land than on land which has been farmed highly, and the scantier herbage of the former description of land will be found
to contain some of the finer grasses and leguminous plants that are looked for in vain on land which, having been heavily manured, produces a greater bulk of a coarser description of herbage.

In butter-making more particularly than in cheese-making, the flavour, aroma, and colour, not to mention quality of the product, are determined by the character of the food which the cows eat; but cheese is influenced by it in no small degree. Every dairy-farmer knows how quickly the flavour of turnips that are eaten by cows is conveyed to the milk, and through it to the butter; and it is equally plain that the peculiar excellences of grass-made butter depend, in a great measure, on the character of the herbage in the pastures. It is generally more delicate in aroma and pleasing in flavour when the cows graze on sound land, which, producing perhaps but a moderate bulk of herbage, includes among its greater variety of grasses some of the more delicate and sweet-scented ones, such as wild thyme, sweet vernal, lotus, medicago, the various clovers, and other leguminous plants, that are very "few and far between," or altogether absent from land which gives, by the agency of heavy dressings of manure or of sewage, large crops of coarse, bulky grass. As fully one-third by weight of the composition of the best qualities of cheese consists of butter, and as the quality, the flavour, and the aroma of butter are so much influenced by the kind of herbage on which the cows are pastured, it naturally follows that cheese will vary greatly, in several respects, according to the kind of land and the quality of the grass; and though the soil itself has no direct influence over milk, it has an all-powerful indirect one by means of the grasses that grow on it and the water that filters through it.

The flavour of cheese, no less than its quality, will be influenced by certain grasses, herbs, or weeds that are found in some pastures. Sometimes the flavour of milk is much injured by the cows eating rank, unhealthy, immature herbage, such as that produced by sewage-irrigation; and it will also derive a flavour, which will be communicated to the cheese and butter, if the pastures contain, or if the cattle have access to, the following plants:

Garlic mustard, Hedge mustard, Jack-by-the-Hedge, or Sainfoin-alone

<table>
<thead>
<tr>
<th>Plant</th>
<th>Order</th>
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<tbody>
<tr>
<td><em>Sisymbrium oleraceum</em></td>
<td><em>Cruciferae</em></td>
</tr>
<tr>
<td>Broad-leaved Garlic</td>
<td><em>Alliumursinum</em></td>
</tr>
<tr>
<td>Ransoms</td>
<td><em>Liliaceae</em></td>
</tr>
</tbody>
</table>

Ivy ... ...; *Hedera Helix.* Natural Order, *Araliaceae.*

Tansy ... ...; *Tanacetum vulgare.* Natural Order, *Compositae.*

Chamomile ... ...; Various species of *Aethemis.*

And other strongly-tasted composite plants.

Several of the more pungent umbellate plants.


These plants are not so commonly found in pastures as in old fences, ruins, stone- quarries, &c., to which cattle in many cases have access. The odour coming from one or other of them will sometimes be quite distinctly perceived arising from the freshly-drawn milk of such cows as have eaten them, and it will also be found in the butter and cheese, greatly to their hurt.

Water.—The influence that water has on the flavour and quality, as well as on the quantity, of milk is too commonly regarded as a matter of little or no importance. Some farmers act as if they thought their cows' systems were so many filters, that the milk is not affected no matter how impure the water is that the animals drink, and that quantity rather than quality is the thing to be aimed at in the water-supply. Yet it is not enough that dairy-cows, especially in hot weather, should have an abundant supply of water, but also that the water should be pure, if possible, and easy of access. Every dairy-farmer whose water-supply is apt to run out in hot, dry weather is aware how quickly his cows "sweat" in their milk at such times; and as water forms about 87 per cent. of ordinary milk, it is obvious that all milk-producing animals require a large supply of it. Mons. Dancel asserts that not only is the quantity of milk directly influenced by the quantity of water the cow drinks, but that if she gives more than 7 quarts of milk per day she will require to drink from 30 to 50 quarts of water in the same period, and if she habitually drinks less than 27 quarts she is actually and necessarily a poor milker. These quantities refer to hot weather, of course, and to large cows. It is true that cows will soon learn to do with less water if the supply of it is limited, but they do so at the cost of the milk; and it does not necessarily follow that the milk is richer in quality because less in quantity, under these conditions. On the contrary, the savant alluded to also declares that the results of his experiments led him to the
conclusion that by inciting cows to drink large quantities of water the quantity of milk yielded by them can be increased several quarts a day, without materially lowering its quality. Still, it is possible to push experiments of this nature so far that the milk will be reduced to a very low standard of quality. The practical application of this law is to place within easy reach of milch-cows an ample supply of the necessary liquid, and leave them to drink as much or as little as they choose to do.

But however true it may be that the quantity of water drunk will directly influence the quantity of milk produced, it is no less true that the quality of it will affect the quality of the milk. Impure water, made so by solutions of decaying animal or vegetable matter, or by filth of any kind, will inevitably produce milk that is more or less ill-flavoured and unsound. And this is not all the mischief, for such milk, beyond tainting with its own peculiar flavour the butter and cheese made from it, will always go bad earlier than milk that is produced from pure water. Swampy, stagnant ponds out in the fields, and pools in the yards into which impure drainage or surface-water flows at will, are not the places where cows should be allowed to slake their thirst. We do not notice all the mischief which comes of cows drinking impure water; and were it not that the animal system is a wonderful purifier, the mischief would be much more marked than it is. We have to thank the vis medicatrix naturae for curing much of our carelessness, and in these things we have better luck than we deserve. For winter use pure water should, if necessary, be brought from a distance; and for summer use running streams are best of all, providing they are pure. A farm well supplied with pure running streams is always more valuable than a similar one where the water has to be provided in artificial ponds and "meres," for it is next to impossible that these should long contain pure, clean water—not that rain-water, which alone supplies them, is impure, but because it carries with it, as it runs over the surface of the land, more or less of mud and other impurities, and because the cattle themselves carry much filth into it. Rain-water, in fact, where it can be collected and kept free from contamination, is perhaps as good as any kind for stock; the danger and the difficulty alike lie in the tendency of such collected water to become filthy and stale.

In many districts, however, the only water available is that provided by artificial aids, and where such is the case the best method of storing it is in "meres" that are made in this wise:—

The location of the mere is decided on, and it is generally placed in a depressed portion of the land, so that rain-water will gather into it. A circular, basin-like hollow is first scooped out, the depth of which in the centre is some 6 feet or so—according to the diameter and slope of the mere. The hollow is next lined all round and from bottom to top with a 4 or 6 inch coating of well-made concrete, which sets hard and is proof against the burrowing of worms and other inquisitive folk. On the concrete a 3 or 4 inch coating of plastic and well-tempered clay is firmly pounded—this it is that keeps the water in situ. And last of all, a compactly-arranged pavement of rather small flat stones, set edge-wise, is placed on the clay to protect it from above against injury from the feet of thirsty cattle, as the concrete protects it from below against injury from more curious but less important animals. These artificial ponds, since the dry summers of 1868 and 1870, have become very numerous in the Peak of Derbyshire, as well as in other districts, and they are found to be a very tolerable substitute for natural supplies of water where these cannot be had. Well-made at the onset, they will last for generations, but it is found necessary to clear out occasionally the mud which seldom fails to accumulate in them. It is usual to place them, if possible, where the fences separating two or more fields intersect each other, so that two or more sets of land are watered by one good-sized mere. It is not advisable to have any trees growing within at least 20 yards of them, for the roots of trees, in their wonderful quest for moisture, have often been known to penetrate through the concrete lining of a mere, tap it, and lay it dry.

But meres will seldom be made in land to which water can be conveniently brought by means of a drain, because running water is preferable to mere-water, speaking generally. Such water may commonly be brought in ordinary drain-pipes, providing it has no falling and rising land to get over and the descent is even and regular. As it is not always easy, even if it were desirable, to bring the water quite to the surface of the
land at the point where it is intended to be made use of by cattle, it becomes necessary to cut out a portion of soil so as to lay the drain bare at that point. In Fig. 89 we give a diagram representing the soil cut out and paving-stones laid down on both sides of the drain, forming a sloping path down to the water from either side. In Fig. 90 we give a diagram representing the one side only as sloped out. In this case the water is kept cleaner than in the other, because the cattle cannot easily get into it with their feet, but it has the disadvantage of offering these facilities for gorning each other that cattle are seldom slow to take advantage of, for the way into it is the way out of it. In the former instance the cattle can go in at one side and out at the other, and so escape the more easily from the spiteful attacks of their companions. They soon learn, however, to watch their opportunity for getting a drink in peace, so the question of deciding on which of the two forms of watering-place we shall adopt resolves itself mainly into a choice between keeping the water clean always and allowing it to become filthy at times. If the former, Fig. 90 will be the one adopted; if the latter, Fig. 89. The cost in each case will be so nearly the same that it need scarcely influence the choice at all. In either case the slope should be "ribbed," so as to prevent the cattle slipping as they go down to drink. In draining wet land sufficient water is commonly found to form, in the main-drain at the lower end of the field, a watering-place of the kind we are speaking of, and especially so if a spring or two be struck by the drains; but as the weakest link determines the strength of the chain, so it will not always be safe to rely in hot, dry weather on a supply of water procured in this manner.

Shelter.—The necessity of providing shelter for dairy-cattle in winter is beyond the need of argument, for all men are agreed on it; but it is not equally clear to every one that it should be provided for the other portions of the year as well. Yet in high cold districts there are many biting storms after the cows are turned out in spring and before they are tied up in autumn, and in low-lying districts they need some shelter against the summer's sun. This out-door shelter is best provided by plantations and by good white-thorn hedges, where they will grow to advantage; good, strong stone walls, in the absence of hedges and plantations, are, of course, the next best kind of shelter. Equally with that of providing good buildings, it is a landlord's duty to provide good fences on the farm, with plantations for shelter, if necessary. These are permanent improvements that the farmer ought not to be called on to make. Anyway, a well-sheltered farm is always much more productive than one which lacks shelter, and stock of all kinds will be found to do better on it. Dairy-farmers are well aware that a stormy day of any kind, be it of hail, rain, or snow, will cause dairy-cows that are out in it to suddenly fall off in quantity of milk, unless they can find shelter from the storm; and in many of the dairying districts of the British Islands these storms are common enough in early spring and late autumn. And in districts where the heat of the summer is very intense, shelter against the sun's rays is a matter of considerable importance. Forest-trees in the hedge-rows, or scattered here and there about the fields, provide this shelter, as a rule, very successfully, and cattle never fail to make use of it; but people who have no such outside shelter are in the habit of tying up their cows in the shippons or sheds for a few hours in the middle of the day, while the sun is hottest and the flies are busiest. Shelter against excessive heat on the one hand and extreme cold on the other, and against all kinds of storms, we are bound to provide, not on account of humanity only, but also on account of economy.
Faults in Cheese-making.

We have pointed out in the preceding pages the conditions necessary to the production of good milk, and we may now proceed to discuss the faults which are common in cheese-making, and which are in a great measure the cause of so much cheese being inferior in quality and condition. The treatment of the milk before the cheese is made is a matter in which many cheese-makers err greatly, and to this we will first refer. It is beyond doubt that in hot weather milk is often seriously injured before it is drawn from the cow by too much exposure to a hot sun, or by over-driving in any way. The heat of a cow’s body becomes so great that the milk in her udder is on the high road to sourness and decay before milking-time comes, and it turns sour outright in a very short time after milking, if it is not taken proper care of at once.

Decomposition.—Milk, as a fluid containing a considerable proportion of the element nitrogen, is subject to early decomposition under ordinary conditions; and all substances containing this element are much more liable to decay than those which contain carbon, hydrogen, and oxygen only, as starch, sugar, fats, &c. The active agent in the rapid decay of nitrogenous substances, whatever it may be, appears to exist in the air, for if such substances be boiled in water for a time, and afterwards kept free from the air, they will remain unchanged for a considerable time, but immediately after being re-exposed to the air they commence to decay. Milk will turn sour most readily at 98°, or blood-heat; below or above that temperature the souring is more or less retarded, for the time being, according to the extent of the variation. Above blood-heat milk is not long preserved, unless the temperature is raised to boiling-point and the milk is afterwards kept free from the atmosphere, in which event it will keep sweet a much longer period than if no such precautions were taken. The souring of milk is a fermentative process, the active principle of which consists of living organisms, most of which belong to the vegetable world. The germs or fungi from which these organisms are developed are commonly derived from atmospheric dust which is deposited on substances exposed to it; and if the substance so exposed is one that can promote their growth, these organisms vegetate and increase with wonderful rapidity, and in so doing cause the substance itself to decompose. Milk from an over-heated cow contains such organisms in one or other of their stages of development, and is in an increased degree susceptible of absorbing others from the air; hence such milk is found to decay earlier than milk produced under ordinary conditions. But the boiling of milk drives off or destroys these organisms, and if they have not already done mischief in it, the milk will afterwards keep sweet for a considerable time.

Cooling and Aeration.—Milk that is rapidly cooled down immediately after milking to a temperature of, say 55°, will keep sweet twice as long as milk that is simply allowed to slowly fall to that temperature in a room that is cold enough for the purpose, and it will remain sweet all the longer if a current of pure atmospheric air, or oxygen, is forced through it previous to cooling. The decay-germs grow only below the surface of a liquid rich in nitrogen and poor in oxygen, and the free exposure of milk to a pure air will add to its keeping properties. Again, milk in closed vessels will turn sour much sooner than in open ones, unless it is reduced to a temperature little, if any, above freezing-point; and it will also more quickly turn sour in deep than in shallow vessels, if kept at a temperature in which milk will turn sour at all. The active agent of decay requires moisture, food, and a moderate degree of warmth in order to do its work; a temperature of 212° will destroy this agent, while one of 40° to 45° checks its activity. Hence heating milk up to boiling-point and lowering it to freezing have each the effect of retarding the souring, which is the first stage in decomposition; while an exposure to pure air supplies the requisite oxygen, and admits of the escape of the gases and odours which, common to milk that is freshly drawn, are in themselves elements of decay. The simple effect of cooling it to a low temperature, of heating it up to a high one, and of passing a current of oxygen through it, is to place milk under conditions that are not favourable to the growth of the decay-germs; but restore the conditions that are favourable, and decay will at once begin again.

The practical application of these facts lies, in the first place, in providing shade of some kind, so that milch-cows shall not be over-heated by a hot summer’s sun, and in being careful that they are
not over-driven in coming from the pastures to be milked; next, in warm weather at any period of the year, in taking care to cool and aerate the evening's milk as soon as convenient after each cow is milked. For this purpose there is no implement more effective than Lawrence's refrigerator. The milk is thus cooled and aerated at one operation, and in a most effectual manner. It must not, however, be aerated in an atmosphere reeking with the odours of the cow-sheds or of the farm-yard, or of anything else that will taint the milk, and to this end the refrigerator should be set up in some place away from impure odours, and the water must be brought to it in pipes; and care must be taken not to cool the milk much, if any, below 60° for cheese-making purposes, or it is injured. If kept below that temperature, milk seems to lose certain properties that it does not afterwards regain, the curd from it is dull and spiritless, and the cheese appears to ripen after the manner of fruit in the shade. If the milk is aerated at the time of cooling, it will keep perfectly sweet until the following morning at 60° to 80°, but it is not safe at a higher temperature, unless in cold weather. The morning's milk does not, of course, require cooling, though aerating would most likely do it good.

**Cleanliness.**

Many cheese-makers do not take enough pains in keeping perfectly clean all the vessels and utensils with which the milk comes in contact. A good deal of cheese is injured through this sort of carelessness. All the vessels require to be well scalded with boiling water after every time of using, well scrubbed with a hard brush, and well rinsed in clean cold water. Care must be especially taken to clean out all impurities from the seams and joints of all the vessels, and they should always be cleaned before they have had time to become sour. If they are left several hours after using, the milk or whey dries on the surface, finds the very bottom of every crevice, crack, and seam, and is removed with increased difficulty; and if they are allowed to get sour it is not easy to get them sweet again. The vessels in which the milk is kept through the night should especially be kept perfectly sweet and clean, and so, for the matter of that, should all the others. And it is no less necessary to keep the floor and walls of the milk-rooms as fresh and clean as may be conveniently possible. In cheese-making it is impossible to avoid more or less spilling of whey on the floor or smearing the walls with spots of it; and, lying about in odd corners, decaying in the crevices between the flags of the floor or the bricks of the walls, whey is a terrible enemy to cheese-makers, many of whom do not seem to be aware of it. The same remarks apply to spilt milk that is not washed away. The walls of milk-rooms should be carefully cleaned whenever necessary, and the floors should be frequently swilled with clean water, well scrubbed to clear off all kinds of dirt, re-swilled with water, and afterwards wiped fairly dry. A capital dairy floor-wiper is seen in Fig. 91; it consists of a strip of vulcanised rubber attached to a flat piece of wood, and projecting about an inch through the piece of wood a handle is inserted, forming a cheap and handy instrument, the use of which in a dairy will be found economical of time and money, as it leaves the floor clean and nearly dry. Both whey and milk soon decay in such places, and they emit pungent, unpleasant odours during the process; accumulations of such decaying slops will soon vitiate the air of the place to such a degree that it is impossible to make either good cheese or good butter from milk kept there. Fresh paint, paraffin oil—anything, in fact, that has a powerful odour—will do harm to milk if kept in the same room; decaying vegetables or flesh-meat, onions, whey-tanks, piggeries—all are inimical to good cheese and butter. Care must be constantly observed in order to secure perfect cleanliness; the floor must be scrubbed and swilled thoroughly, and the walls carefully washed whenever necessary; all kinds of substances whose smells are offensive must be rigorously kept far enough away; everything, in fact, must be done, daily and hourly almost—and especially in warm weather, when the liability and danger are the greatest—to keep these putrefactive odours at a safe distance.

And all this care, watchfulness, cleanliness are necessary because milk is a quick absorbent of any impure odours or decay-germs that the
air may contain; because it is continually on the look-out, as it were, to seize on anything that will hasten its destruction; and because it is impossible to make very good cheese or butter from milk that has become tainted with any kind of impurity. This subtle power of absorption, which milk possesses in a higher degree than most other liquids, increases the difficulty of producing fine qualities of cheese and butter until it is understood; carelessness after that is inexusable. Thorough cleanliness of utensils, milk-rooms, atmosphere, everything, in fact, that comes into contact with milk, may justly be said to be one of the most important essentials in the dairy, and the neglect of it, in one way or another, is one of the chief causes of most of the ill-made, ill-looking, ill-flavoured, and ill-conditioned cheese and butter—especially butter—that we find everywhere in the country, that is, in every district.

After what we have said about keeping the milk away from unclean utensils or an impure atmosphere, it would almost seem superfluous to warn our readers against any other source of impurity; but there is yet one other fault that we must mention, because it is perhaps more commonly committed than most others. We refer now to carelessness at milking-time. As a rule, no notice is taken of the cows’ udders to see whether they are clean or dirty, and no pains are taken to clean them if they are dirty before milking begins. Yet it commonly happens that dust and dirt of one kind or another are sticking to the udder, only to fall into the pail as the milking goes on. In the chapter on milking we have referred at some length to the faults common at this stage. Many disasters in cheese and butter making are due to these too generally neglected details, and many a dairymaid has been baffled in her efforts by the results of the carelessness of others. Unless the milk be kept perfectly sweet and clean it is impossible to produce the finest cheese or butter from it, and the superiority of the product will generally correspond with the degree of cleanliness of the milk.

Temperature.

Another practical fault in cheese-making, very commonly committed in farm-houses, lies in “setting” the milk for coagulation at varying temperatures. Many dairymaids still go by the “rule of thumb” in deciding the temperature of the milk, and they leave the thermometer (Fig. 92), if they have one, hanging up to the wall from week’s end to week’s end, regarding it as a curious but unnecessary instrument, and trusting to their own variable hands instead. Now it is impossible to set milk at a regular heat in this manner, for the dairymaid’s hand will vary in temperature at times; still, we admit that some dairymaids are surprisingly lucky in the setting of milk by guess. But with irregular setting it is certain that the cheese will vary more or less, though regular setting will not alone secure uniformity in the cheese; but if regular setting will not secure it, other conditions being neglected, surely irregular setting will not. When we contend for a regular temperature of setting, we do not mean that it shall be unvarying throughout the whole of the year, for this would be equivalent to a certain amount of irregularity. A given temperature is not thought to be the best for all districts alike; in Derbyshire 80° is thought to be the proper heat, and in Cheshire 90°, varying, of course, with the time of the year and the state of the weather. But whatever the ideal standard of a district may be, it will be necessary to modify it as the seasons change; for instance, if 80° is the normal standard in moderate weather, it should be 82° in cold weather and 78° in hot, and if it is extremely hot or extremely cold a still greater variation would be allowed. If the temperature of the air is 80°, that of the milk may, for instance, be the same; but if the air is down at 65° the milk should be set at 82°, and if the air is at 90° the milk should be set at 78°, there or thereabouts. This is not a hard-and-fast rule, and we only give the figures to illustrate our meaning. The results of irregular setting are these: If the temperature at the time of setting the milk for coagulation is too low, the curd remains soft, a good substantial coagulum is not produced, and it is very difficult, if not impossible,
to separate enough of the whey from it afterwards; at too low a temperature, say 70° to 72°, the rennet cannot act properly, and the quantity of whey left in the cheese is at once an evidence of imperfect rennet action in the milk and the chief cause of early decay in the cheese. If, on the other hand, the temperature is too high, the coagulum produced is too firm and solid, the curd is too hard and dry, and the cheese is deficient in moisture. In making thick cheese it is necessary to coagulate at a higher temperature than in making thin, in order that the cheese may "stand," by reason of a less percentage of moisture contained in it; and this explains the reason of the high temperature at which the milk is "set" in the Cheshire system of making cheese. We assume now that no acidity is employed in the process. For thin cheese the temperature should never be under 75°, and for thick seldom under 80°, in each case varying with the weather—rising in cold, dropping again to the minimum in warm weather. These temperatures have reference to most kinds of English cheese.

**Rennet.**

The practical fault next in order is that of using badly-prepared rennet; and, as every one knows, a great deal of cheese is injured in flavour in this way. It may be that the rennet-skin has been imperfectly cured, in which event it is not the dairymaid's fault, except in this sense—she ought to reject such a skin. Or, if the skin itself be all right, it may be spoilt in a dirty vessel or in dirty water. Or, if it be right in both these respects, it may be wrong with regard to strength, in which case the milk will take a longer or shorter time, as the case may be, to coagulate. The effect of using an over-dose of rennet is to make the milk coagulate and the cheese ripen quicker than they would n with a fair quantity. It is necessary, therefore, that care should be taken, first, that the skins are good ones, to begin with; second, that they are put to soak in clean vessels and clean water; and third, that the rennet-liquid be of a uniform strength. Badly-prepared and impure rennet will give its flavour to the cheese, and a nauseous flavour it is. Nothing is better than a glazed earthenware jar to soak rennets in, and the following method will produce a perfect rennet-liquid:—Mix a brine of salt and water, one part salt to twenty parts water by weight; boil it for half an hour, after which let it stand till it is cold; to two gallons of the brine add six rennet-skins and one ounce of saltpetre. The mixture will be ready for use in a month, and will keep good for a long period if kept from the air. During the month the skins should several times be gently rubbed between the hands, and at the end of it be removed finally from the liquid, while the jar should be kept covered as much as possible, in order to exclude the air. This rennet will be of a uniform strength, and the milk will coagulate in the same time each day, if the right quantities of each are mixed together. The ordinary practice in farm-houses is to put a piece of rennet-skin in soak each day for the next day's use. By this plan the strength is not all got out of the skin, and the liquid, though fresh, is not uniform in quality. Properly-made rennet coagulates milk without turning it sour in the least degree; but it acts quicker if the milk is a little sour.

Rennet-skins from calves not yet a week old are considered to be more effective in coagulating milk than those from older calves. It is said that when a calf has begun itself to live on other kinds of food than milk, its stomach becomes less valuable for cheese-making purposes, hence the greater value of the younger skins; but the skins are all the better—contain more of the coagulating ferment—when they have been in pickle, and afterwards hung up to dry for several months, than when they are comparatively fresh, hence old "rennet-skins," or "veils," or "bag-skins," as they are variously termed, are preferred by cheese-makers. Some people hang them up to dry after they have been in pickle a month or two, and it is considered that they keep on increasing in strength as they dry; others keep them in pickle, or, at all events, in salt, until they want to put them in soak for use. It is probable that the former is, on the whole, the better plan, for the skins will sweeten as they dry, and they will thus lose the disagreeable taint that skins in pickle generally possess. The liquid in which they are pickled is not fit to use for cheese-making, and if the veils are left a long time in it, some of their strength soaks into and is thrown away with it.

**Treatment of the Curd.**

Cutting the Curd.—We come now to breaking the curd, at the stage when coagulation is far
TREATMENT OF THE CURD.

enough advanced; and here it is that practical faults of a serious kind are very commonly committed. The object of cutting the curd is, we need hardly say, to enable it to separate from the whey. In the first place we may state that numberless mistakes are made as to the particular stage of development which denotes that the curd is fit for "cutting" or "breaking." No exact time can be laid down with reference to this matter, for the period of coagulation will be influenced, first, by the temperature of the milk; second, by its condition as to sweetness; third, by the strength of the rennet; and fourth, by the quantity of rennet that is used. But coagulation should, in the making of ordinary kinds of cheese, be always perfected in forty to sixty minutes; if these limits are exceeded in either direction, the curd will be too soft in the one case and too hard in the other. If, however, the milk is always sweet, and is set at a uniform temperature, and the rennet used is uniform both in quality and quantity, the milk will vary very little as to the time required in coagulation, and the period when it will be ready for cutting may be predicted with tolerable certainty. The test of readiness is when the curd breaks cleanly over the finger when you dip into and try to raise a portion of it. The various ways of cutting the curd, and the length of time occupied in the operation, form in the process of cheese-making a period which is alike very important and very susceptible of mischief. It is not too much to say that the quality of cheese depends in no small measure on the way in which the curd is broken down—the time occupied and the instruments employed in the process. First, as to the instruments: It may be stated that curd-cutters should never have rough and ragged edges, and it is better that they should be sharp rather than blunt; but in any case the edges should be smooth, not rough, and this is a point that is too generally overlooked. The reason why the cutters should have sharp, smooth edges lies in the fact that such edges bruise the curd less than any other. At the period of cutting down the curd is very tender indeed, and an instrument that will pass through it with the greatest ease and with the least amount of friction is to be preferred to any other; but the curd-breakers in general use in this country are rough, clumsy instruments, better calculated to crush than cut the curd. The curd should be cut or split, not crushed. The old custom was to pass a wooden bowl or a skimming-dish gently through the curd, to and fro, time after time, until it was separated into moderately small particles, passing the curd, too, repeatedly between the fingers; and but for its tediousness and irregularity of action, this old method was not the worst we have seen. By breaking gently in this way, or by cutting with an instrument whose edges are clean and sharp, no harm is done to the curd; but by using a coarse, clumsy, blunt-edged breaker, the curd is bruised, and some of its butter and casein are liberated so that they pass off in the whey. The rate at which the cutting is done and the time employed in the process are matters in which hasty, careless persons should have no part or lot. Such persons, in fact, are better out of cheese-making altogether. Curd should be cut very slowly and gently, especially at first, and at least a quarter of an hour should be used in the operation. To hurry the cutting has a similar effect to crushing the curd with a rough, blunt instrument—that is, a portion of the butter is set at liberty and escapes with the whey; and where there is much whey-butter the cheese is seldom of first-rate quality. After the curd has been cut through a time or two it should be gently turned over by hand, and the cutter should again be used; as the whey goes on leaving it the curd shrinks in bulk and hardens, and as it does so the cutter may be used a little faster, so that the whole mass is cut into small pieces. The cutting is an important matter with regard, also, to the separation of the whey from the curd, and to this end it is expedient that the curd should all be cut. If a portion of it is left in lumps of varying size, the whey will not leave them so readily as it does the smaller pieces; and where scalding is not practised and acidity is not employed, it is extremely difficult to get out the excess of whey, in cases where the cutting of the curd has been improperly done; no amount of pressure afterwards will get out the whey so well as it might have been got out by careful cutting of the curd, and in this we see one of the
fruitful causes of subsequent disaster in the cheese. The whey left in sets up an excessive ferment, which causes the cheese to heave and blister, to bulge out at the sides and in the middle, and to come to an untimely end; it is also, in part, the cause of both sweetness and bitterness in the cheese, according to the kind and the extent of the ferment; and it destroys the colour where annatto is used.

Again, irregular cutting of the curd will prevent uniformity of texture in the cheese. The larger lumps of curd contract, forming a sort of shell on the outside, and enclose the whey more or less securely inside; and unless these lumps are cut through in the after-process they not only do not part with their whey under pressure, but they do not properly consolidate with the rest of the cheese, hence the texture of the cheese is irregular, and there are holes and crevices in it. And when we speak of "lumps" of curd in this sense, we do not mean large pieces, such as would be sure to be crushed in passing through the curd-mill, but lumps of any size, from a pea upwards, that contain whey which has no business there.

The first object, then, of cutting the curd is, of course, to get out the whey; it is, in fact, the first operation that can be performed for this end; and all the subsequent cuttings, and pressings, and turnings, and finally grinding, until the cheese is at length put under pressure to form it into shape, are all done with the same object. And as the efficacy of all these subsequent operations depends so greatly on the way in which the first one of cutting was performed, we see the necessity of impressing on all cheese-makers the great importance that attaches to cutting the curd at a proper time, in a proper manner, and by a proper instrument.

Getting out the Whey.—This is, of course, all-important in every sense, but it is commonly performed in a very imperfect manner, and an enormous quantity of cheese is annually ruined from this cause alone. No matter how carefully the milk has been preserved from taint and dirt, how clean all the vessels have been kept, how regular the temperature, how uniform the rennet, and how particular the cutting, no cheese can by any possible means be good unless the whey is properly got out of it. This point missed, all the rest are thrown away. In the process of making cheese, the great bulk of the milk-sugar is not retained in the curd, but passes off in the whey; so it follows that if the whey is imperfectly got out, a too large portion of the milk-sugar is also retained in the cheese, and it is this that is the cause of sweet cheese. This sugar, too, or a portion of it, enters into fermentation in the cheese, forming, amongst other products, carbonic acid gas, which, in trying to escape, causes the cheese to heave and become porous. An excess of whey causes annatto, that is used for colouring the cheese, to be unequally distributed, so that the cheese is not a uniform colour; or the lactic acid formed from the milk-sugar has a destructive effect on the colouring matter later on, causing it to fade and the cheese to become a bad colour. The presence of the whey and the fermentation begun by the milk-sugar causes the cheese to decay without ripening, in a manner that makes it a very disagreeable and unhealthy article of food.

The necessity of getting out all the moisture, over and above the quantity which the cheese may safely be allowed to retain, will now be apparent. This is effected, first, by the cutting of the curd; second, by pressure; and third, by a moderate amount of acidity, where such is employed. Acidity in cheese-making is the most effectual means of expelling the whey, but it must be employed with great caution, for though it is a capital servant, it is a bad master. This acidity may be produced at will in various ways; the best way of producing it is by heating up, by means of steam or hot water underneath the vat, the mass of curd and whey to a temperature of about 98° to 100°, and letting it rest for a time; or it may be produced by adding about two quarts of sour whey to each hundred gallons of milk at the time when the rennet is mixed with it. The quantity of sour whey to be used will depend on the temperature the milk has been at during the night, for the lower the temperature the more whey will be required to develop the acid; it will also depend on the degree of sourness that the whey has attained.

But though no heating of the curd and whey has taken place, and no sour whey has been used, acidity will arise afterwards in the curd, if it is left without salt for some time—in a few hours in warm weather, and in twenty or twenty-four in cold, a certain amount of acidity will have developed. Some of the more successful farm-house cheese-makers that we have known have
unconsciously employed the agency of acidity in expelling the whey, and they do it by not applying any salt to the cheese until the following morning. These are cases where the cheese is salted on the outside only, as in the Derbyshire system of making. In this system the whey is "dipped" whilst it is still quite free from acid, and there is no acidity in the curd when it is vatted and put in press. Now as there is no acidity, it ought to be allowed to develop a little afterwards, and this it will do if no salt is applied; but if salt is applied, even to the outside, at the time the cheese is first put in press, the curd will not turn acid at all, and in this case the whey may not be sufficiently expelled, while if the cheese is left in press until, say, the following morning without salt, a gentle acidity will have been developing slowly during the night, and as it has developed will have assisted in expelling the whey. In warm weather sufficient acidity for the purpose will develop in the course of six to ten hours, and a careful dairymaid will then apply the salt without waiting till the following morning. The application of salt checks the further development of the acid, which by the following morning would have become too acid.

Grinding the Curd.—This operation may be regarded as a necessary evil, and as such it is seldom performed with entire success. The old plan, before curd-mills were invented, was "crimming" the curd by hand, that is, working it well and repeatedly through the fingers; and this way of reducing the curd to fine pieces was better than grinding it in any mill whatever, because it did the curd less harm than any mill will do it; but the labour of crimming was very great, and this led to the introduction of curd-mills. The object of grinding curd is three-fold: first, to cause it to pack evenly in the press-vat; second, to assist the remaining whey to escape; and third, to enable the salt to be uniformly distributed throughout the entire cheese—that is, where salting the curd is practised. Previous to grinding, the curd usually becomes comparatively tough and solid, and by passing it through a curd-mill it is, of course, very much crushed and bruised, and this causes a good deal of the butter to flow out with the remaining whey when the cheese is put under pressure; the liquid that runs out of a newly-ground cheese that is put under pressure is commonly white instead of green, and the white in it is so much loss to the cheese. This is caused by the iron pegs or studs with which the mill does its work. Various things have been designed to obviate this, the latest and most successful being a mill in which there are sharp knives in place of the studs

![Fig. 93.—Curd-mill with Knives.](image)

(Salting.

The quantity of salt used to cheese varies greatly in different dairies. A great deal of cheese is injured by over-salting, a great deal also by under-salting, and this is the result of the haphazard manner which commonly prevails. A certain amount of salt is necessary to prevent the cheese from putrefying, and the quantity is governed by the amount of fat in the cheese—the richer the cheese, the less salt is required. Salt is necessary, not so much to give the cheese a salmi-like taste as to prevent excessive fermentation; but as a given amount of fermentation is necessary to the ripening of the cheese, an over-dose of salt checks the ripening by reducing the ferment too low, and the cheese never ripens properly. Salt, being powerful antiseptic, wholly prevents fermentation if a large quantity of it is used, and in this event its effect is similar in some respects to that of an over-development of lactic acid—that is, the cheese is hard and dry, and ripens improperly or not at all. On the other hand, too small a quantity of salt does not sufficiently check the fermentation, particularly in poor cheese that has too much whey left in it, and quick decay is the sequel.
Again, cheese is often injured by improper salting; the salt or the curd, or both these, are in too large lumps, so that they are not uniformly intermixed. It is of less consequence, however, that the curd be in very small pieces than that the salt should be fine and pure. If the salt is lumpy, the cheese is unequally salted, and the consequence is that some portions ferment too much and others too little; from this it follows that some parts ripen too quickly and others too slowly, while the texture and the colour alike are wanting in uniformity. The salt should be of the finest description, pure, and of good quality, and it should be mixed as evenly as possible with the recently-ground curd; the best way is to spread out the curd thinly and evenly, and then sift the salt over it by means of a fine sieve. The salt and curd should be well mixed up together by hand, and then left to cool for a time before vatting.

The right quantity of salt to use will depend on the quality of the curd—whether or not it is rich in butter, that is—on the season of the year, and on the quantity of whey still left in the curd at the time of salting. If the milk has not been skimmed at all, and all the butter is consequently left in the cheese, ¼ lb. of salt to 25 gallons of milk in summer, rising in autumn to about ½ lb. of salt to 20 gallons of milk, will, under ordinary circumstances, be found to be about the proper rate at which to salt the curd; but as milk varies greatly in the percentage of solids, according to the breed of the cows and to the district in which they are kept, it is obvious that a milk-basis is a less correct one to go upon than that of the curd itself, and the best plan is to weigh the curd just before grinding it, and apply salt at the rate of ½ lb. of salt to 25 lbs. of curd. This rate, however, will need increasing if skim-milk cheese is made or if the milk is naturally poor in fats, because the proportion of nitrogenous matter in such cheese is relatively larger than it is in cheese of good quality; the fats will take care of themselves without much aid from salt, while nitrogenous matter soon goes to decay without it. But the above rate will make due provision for the proportion of salt that is pressed out of the cheese along with the remaining whey.

The foregoing remarks apply only to methods where the salt is directly mixed with the curd. In other methods the salt is applied to the outside only of the cheese, either as dry salt or in the form of brine, and this way of salting is found to answer well where the cheese is properly made before. But while it is difficult to over-salt a rich cheese in this way, because it will not from the outside absorb more salt than it needs, it is a simple matter to over-salt a cheese that has been robbed of its cream, because nitrogenous matter absorbs salt more greedily than carbonaceous matter does; it is, in fact, easy to under-salt the one and over-salt the other, and as salt is applied _ad lib._, the result depends entirely on the absorptive desire the cheese has for salt. On other systems a portion of the salt is put in the milk before coagulation, but whether or not there is any advantage in this depends on various circumstances, and is open to argument.

Inferior salt does great harm to cheese, not only on account of its impurities, but also because it is not uniform in strength. Dryness is fairly satisfactory evidence of the purity of salt, but it ought to be crystalline and transparent, pure white in colour, and of moderately fine grain, not too fine nor yet coarse, and it should emit no odour. Many cheese-makers prefer coarse salt to fine, but it is now coming to be understood that this is a mistake. There is, of course, salt that is much too fine for cheese-making—to wit, the highly-pulverised, mealy, chalky salt—and this should be even more carefully avoided on the one hand, than very rough, coarse salt should on the other.

**Ripening.**

Much well-made cheese has been greatly injured in the ripening by one or other of the following faults:—First, damp and badly-ventilated rooms; second, newly-built or newly-plastered walls; third, a temperature that is too high (above 75°), one that is too low (below 65°), or one that is continually varying between these points or beyond them; and lastly, turning it too seldom. Mr. X. A. Willard sums up the question of temperature in the following able manner:—

"Three Points in Curing Cheese.—The Cheddar dairymen, by long-continued practice and experiment, have established three points in the curing of cheese. First, that a temperature of from 70° to 75° is the proper range for securing mellowness in texture, sweet, clean, nutty flavour, and long-keeping qualities; second, that this temperature must be maintained throughout the curing
process, and that uneven temperatures much above and then sinking below the range named are pre-judicial to fine flavour; and third, that excessive dryness of the atmosphere, like that produced from the heat of stoves, injures texture and flavour by producing a too rapid absorption of moisture. Take, for instance, the lump of curd as it comes from the press. If it has been well made from average whole milk, we have a tough, curd-like mass, consisting of—without assuming to be exact—say, 25 per cent. of butter, 40 per cent. of water, and some mineral matters. It is in this condition about as unfit for food as unbaked dough. Now, what is required of this piece of raw curd to fit it for the palate of the fastidious cheese-eater of England? Well, in the first place, the casein must be completely broken down and intimately mingled with the butter, while a portion of the water must be eliminated, and the balance so distributed through the mass as to make the whole a homogeneous substance—mellow, plastic, delicious. The moisture must be so intimately mingled through the whole that it cannot be easily separated or distinguished from the other parts, but rather giving one the impression, when a bit of cheese is pressed under the finger or tasted in the mouth, that it is rich in butter. In addition, the several parts, while undergoing this change, must have retained a clean, sweet, nutty flavour. Now we know by analysis how much moisture should be held in a properly-cured cheese. The analysis of the very best of the Cheddar cheeses when six months old shows that it contains nearly 34 per cent. of water, a little more than 33 per cent. of butter, and 25 per cent. of casein. An analysis of the best American cheese indicates about 27 per cent. of water, 35½ per cent. of butter, and 26 per cent. of casein. In other words, it has 2½ per cent. more butter and 3 per cent. less water than the English Cheddar, thus indicating that the 3 per cent. of moisture in the English Cheddar in excess of that in the American is made to take the place of butter, producing a more palatable and desirable cheese, and one that will sell for more money than the American in the English market. Mr. Reed, of Herkimer, who for some years kept an accurate record of the weight of cheese from the time it was made up to different dates, found the average shrinkage of cheese during the first thirty days after manufacture to be—in June, 10 per cent.; July, 12 per cent.; August, 6 per cent.; September, 3 per cent.; October, 3 per cent.; November, 4 per cent.; December, 3 per cent.—thus showing that as temperature decreases in the fall, the shrinkage also decreases. It is well known that our best cheese is of September make. The temperature of the weather during September and October approximates more nearly to 70° than in June or July. I think it may be safely assumed that in all well-cured cheese of desirable quality and flavour we must have at least from 30 to 33 per cent. of moisture, or else an excess of fat to more than supply the deficiency of moisture when the latter runs below 33 per cent. The defect complained of in American factory cheese when well made is a tendency to dryness. In some of our home markets—like Boston and Philadelphia, for instance—a grade of cheese made in Ohio has obtained some popularity. It is softer and more plastic than the ordinary shipping cheese of New York. Much of it has the appearance of possessing an excess of fat; it is not fat, but moisture, which is so intimately blended with the solids as to be taken for what the cheesemonger denominates 'good stock.' One of the prominent faults in curing cheese is a too rapid evaporation of moisture in the early stages of curing. The water does not have a chance to assimilate with the other parts before passing off; hence dryness and apparent lack of butter. If the evaporation had been gradual, and time given for the water to become assimilated or 'fixed,' so to speak, in the cheese, the curing process would be carried on more perfectly, and the evaporation thereafter would of necessity be more slow. I saw this exemplified in the experiment made at the McLean factory last summer, when it was attempted to cure cheese by a process of applying dry steam in the way lumber is seasoned. The cheese came out insipid and almost tasteless, so far as a development of a cheesy flavour was concerned, and although it was placed in the curing-room and kept there a long time, it did not again take on a good flavour or become mellow, like cheese properly cured. Again, when the fermentation is carried on unevenly—at one time hastened by a high temperature, and then checked by a low temperature—the cheese is apt to put on a bitter taint. I used to think this bitter taint came, for the most part, from weeds which the cows ate (and it does take taints in that way); but
I have found from experiment that a bitter taint can be developed in any cheese by alternately stimulating and checking fermentation, and this repeatedly under high and low temperatures. There are immense quantities of cheese, well made at first, that are seriously injured by this bitter taint. It is of various degrees of intensity, according to conditions in curing, but all leaving an unpleasant taste in the mouth. It is particularly objectionable to English buyers, who are generally experts in discriminating defective flavours in cheese."

Some people think cheese ripens best in darkened rooms; this, however, is a fallacy; but darkened rooms are useful in the heat of summer to discourage flies—this is the only good they can do, and they do harm where they prevent the cheese from being carefully examined from time to time. During the first month the cheese should be turned once a day, in order to prevent the moisture from settling too much toward one side of the cheese, and also to give free egress to the escaping moisture from all parts of the cheese alike in turn. When they are more than a month old they will do with turning a little seldomer, and when they are nearly ripe thrice a week is often enough to turn them. While ventilation is very necessary to the proper ripening of cheese, cold draughts must be avoided, and whatever fresh air is admitted should at all events be pure. We have known cheese very much injured by newly-plastered walls; the fresh lime in the plaster exerts a bad influence especially in the flavour of the cheese, and particularly so if the room is damp and ill-ventilated.

During the ripening the cheese is passing through a slow process of fermentation, and it is expedient that this fermentation should be regular and uniform as to rate; if the temperature fluctuates, the fermentation will proceed in a fitful manner, now going too fast, now too slow, and the ripening cannot possibly be as satisfactory as when the temperature of the room is stationary. A cheese-room should always be furnished with a thermometer, and this should be consulted each day, means being taken to prevent the irregularities of which the thermometer will not fail to give timely warning.

The best way of heating a cheese-room is by hot-water pipes laid round by the walls; by this means the warmth of the room is sustained in all parts alike, whereas if a stove is used some of the cheese will be too warm and the rest too cold. The room over a farmer's kitchen is generally a good cheese-room, and very little heat is required beyond that supplied from beneath, but in order that the cheese may derive all the benefit from the warmth, the floor should be of boards, and not lathed and plastered underneath. To apply the warmth underneath the cheese in this manner is the best possible way of applying it.

**Acid in Cheese-making.**

The question of acidity in cheese-making is a most important one; and while we admit that acid does not answer equally well in cheese made from all kinds of soil and herbage, and upon all systems or modes of manufacture, we think all kinds of cheese are, or would be, the better for a little—*just a little*—of it, however sweet, fresh, and pure may be the milk from which they are made; while some kinds, made from milk that is more or less the incorrect thing, require more than merely a little of it. The chief difficulty attending it lies in the danger there is of giving the cheese *too much of it* too early. As we have said, one of the most fruitful causes of bad cheese is found in the imperfect expulsion of the whey; and numbers of worthy persons have racked their brains sadly in trying to discover at once the cause and its remedy, little dreaming that the simplest cure imaginable was close at hand, actually waiting—almost begging—to be employed. But this "simplest cure" may easily become, except in the case of tainted milk, almost worse than the original mischief, and it consequently requires to be employed with the greatest care. While a limited development of acd is very serviceable in expelling the whey and in consolidating the curd into a compact cheese, too much of it will make the cheese harsh, hard, too dry, too solid, and poor in reality as in appearance. When too much acid has been developed in the curd, the cheese, it is true, will neither heave, nor bulge, nor crack, nor decay early; but there are other things it will not do, and the faults of these latter omissions are more marked than the merits of the former ones. For instance, it will not ripen in any reasonable time—in some cases it will not ripen at all, but goes at length to decay, without ever having come to maturity, like fruit that grows in an ungenial district, or that tries to mature too late in the autumn; it will not mellow
down in its texture, but remains hard and sad and sulky, like so much soup.

Some of this over-acidified cheese is very extraordinary; it will neither ripen nor decay, but remains passive month after month, and almost year after year, never ripening as cheese ought to ripen. There seems to be no stir, no life in it, and no chance of getting any into it; for, however carefully the temperature of the curing-room may be regulated, the cheese makes no sign of ripening, except, perhaps, that its coat becomes covered with the greenish-blue mould, called penicillium crustaceum, which is commonly found on old, ripe cheese. The cheese is dry, certainly, and there is no excess, but rather a deficiency, of moisture left in it—it is too dry, in fact; and the acid, in expelling the whey, appears to have expelled or destroyed the ripening principle of the cheese, as well as its flavouring oils. It is not that the flavour of such cheese is bad, on account of which we find fault, as that there is very little flavour in it to be either good or bad. The flavour and the quality alike are in abeyance, if they exist at all in the cheese. With respect to a good, orthodox sort of cheese, the flavour is developed in the ripening, and corresponds with it to the last, getting stronger as the cheese gets riper; but in the case of the over-acidified cheese, the flavour and the ripening alike, after having proceeded a short way, appear to remain stationary.

But this acidity, which is, of course, produced from the sugar-of-milk, cannot easily develop too far in curd which has been properly treated from the beginning, unless the curd is left unsalted for a considerable period; in several hours it can hardly, unless the weather be very warm, become too far advanced to do the good it is calculated to do, and at the same time to do no harm; this is because the whey being all or nearly all removed, very little sugar-of-milk remains in contact with the curd, and it follows that very little lactic acid is formed. But the case is wholly different where the acid is developed in the mass of curd and whey before the latter is "dipped," that is, drawn or ladled off. And this acidity is easily developed by three separate causes: first, by heating up to 98° or 100°; second, by the addition of sour whey to the milk; and third, by the milk itself being already acid, as it soon is in warm weather. But however the acid may be developed, and whatever form it may assume, there is a great deal more of it acting on the curd, and it will develop a great deal faster while the whey is still on the curd than it will in the curd alone. Hence the formation of acid while the curd is still in the whey is a matter that demands very close watching, while in the curd alone it may quite safely be treated with less reserve. But if the whey be dipped from the curd before any perceptible acidity, or, in fact, before any acidity at all, whether perceptible or not, has formed, then the curd will remain sweet for a much longer time than it would have done if the whey had remained on it, because the chief source of acidity has been removed with the whey.

There can be no doubt that lactic acid will tend to counteract, at all events for a time, the influence of any taint that the milk may possess when drawn from the cow, or that it may have afterwards absorbed from the air (the taint from such food as turnips, such drink as filthy water, or, worse still, from an impure atmospheric odour); and in these cases, as well as in certain others, a little artificially-developed acidity is an unmixed good. Indeed, to make cheese from tainted milk on the no-acid principle—that is, with no acid either developed in the whey or in the curd—is only to perpetuate in the cheese the taint which the milk had at the beginning, because such taint cannot easily be removed by other means than lactic acid, without either doing more harm than the acid would do or entailing a great deal more trouble.

In making cheese from perfectly sound and sweet milk, it is certainly better that no acid should be allowed to form whilst the whey is still on the curd, because there is nothing for it to do at this stage; but it is none the less true that the cheese from even such milk as this will be improved, in the great bulk of cases, by allowing a little acid to develop in the curd; and to this end the cheese must not be salted for some hours, whether the salt is applied in the curd or on the outside of the cheese. The whey is reluctant to leave the curd made from such milk, and such curd takes the most making into cheese in consequence. Every dairymaid knows that the cheese is longest in making when the weather is not very warm, when the air is quite fresh and light, and when there is no thunder about—that is, the whey is longer in leaving the curd at these times, do what you will with it short of employing the aid of artificially-developed acid. And a careless, hasty dairymaid, who hurries her cheese-making
at all times alike, will, paradoxical as it may appear, spoil more cheese from perfectly sweet milk in fine, clear, cool weather, than she will from milk that is slightly acid, or is on the point of becoming so, in weather whose keeping properties are not good. This is explained by the simple fact that she leaves more whey in the curd in the former case—she does not give it time to get out; and this whey afterwards sets up a wrong sort of a ferment in the cheese, decomposes there, generates gases, causes the cheese to bulge and crack, and prevents it from living to a good old age.

Here, then, is another and the greatest service that a proper amount of artificially-developed acid performs in making cheese from perfectly sweet milk—it helps to expel the whey that may have been left in by hurrying the process. Rather than hurry the process, it would be almost as well to develop the acid in the whey and curd together as to allow it to develop itself in the curd alone, providing always that too much of it be not developed, because a hasty dairymaid will not allow the necessary time for it to develop in the curd, and it is more difficult, perhaps, in the already compactly-formed cheese than in the whey to tell when enough acid is formed.

We prefer the acid to be developed in the curd while it is in the milk-vat, or soon after it is in the press-vat, providing this development can be ensured, and it may be by keeping the curd warm after the whey is removed, and not salting it; and here it is that a portion of the previous day’s curd, that has soured a little by keeping it through the night, comes in very useful—to mix with the fresh curd, and by mixing sour it. We have said there is more danger in developing the acid in the whey than in allowing it to develop itself in the curd, because it is so liable to go too far in the whey, and because the same amount of acid in the curd only does less harm to the cheese than that brought to bear on it in the whey; and when we have some of yesterday’s curd there is at once no need to acidify the whey and a certainty that the curd will produce acid enough for the purpose. But, as a rule, the best kind of acidity is that produced in the curd alone, without the intervention either of the whey or of yesterday’s curd.

In farm-house cheese-making it is seldom that thin cheese is “salted in the curd”—that is, in the systems from which acidity is carefully excluded by keeping down the temperature. The accumulated experience of generations has taught some of our dairymaids that by salting a sweet curd they entirely prevent the formation of that quantity of acidity which, in the great bulk of cases, is necessary to expel the whey up to a given point, and so they salt only on the outside of the cheese, thus unconsciously giving the acid a chance. Some, however, salt partly in the curd and partly on the outside of the cheese; others salt partly in the milk, and the remainder in the curd, or on the outside, as the case may be; whilst some salt on the outside only, and not till the following morning, thus almost ensuring, in most cases, the formation of a given amount of acidity. Whatever salting in the curd is found to answer well in farm-houses, it will generally be found that a comparatively high temperature is employed in the process of making the cheese, as in the Cheshire system; while to salt a cold-made cheese in the curd would almost certainly ensure so much whey being left in it that great mischief would ensue.

Warmth and acidity are closely allied in cheese-making, and the question of salting ought always to be considered in connection with them. If a cheese is made warm, the curd, left unsalted, will almost certainly develop a little acid before very many hours, and then is the time for salting; but if it is made cold, and the weather is cold, it is probable that no acid will form in it at all, or, at all events, not for a long time, and salt will have to be applied in the curd, irrespective of the acid. And this latter kind of cheese is very liable to be "sweet," to heave and ferment, on account of too much whey being left in it, and so its texture would be neither compact nor uniform. Lactic acid is very useful in its place in cheese-making, that is, in the whey or in the curd, but it is altogether out of place in the cheese that is already partly ripened. Whey left in the cheese until that period cannot then be expelled by the formation of lactic acid, and the ferment set up by the milk-sugar in the whey goes on to form gases, and these it is that make the cheese to swell out at the sides and in the middle, destroying alike its symmetry, texture, and compactness, while the decomposing whey inside hastens its destruction.

Too much acidity destroys, or at least greatly curtails, the action of the rennet in the cheese. The active principle in rennet is the ripening agent in
the cheese; and this being destroyed, the cheese cannot ripen—it can only decay. Cheese made from milk that is coagulated by means of acids instead of rennet does not ripen; the acids do not coagulate the casein of the milk, as rennet does, into a compact, jelly-like substance, but into flakes, and cheese made in this manner will, of course, decay in time, but it never mellows down in a way that can be called ripening. Now, if the proper ripening agent in cheese be destroyed by the action of too much lactic acid, or by any other means, the cheese is left to the decomposing influence of any acids and ferments that may form in it afterwards, but it cannot ripen like a properly-made cheese.

It is evident that the acid, while springing from the sugar-of-milk, has a destructive effect on the fats in the cheese; for a cheese which has had too great a development of acid in the making of it will be hard and dry to the end, never having that mellow, salty consistency which a properly-ripened cheese always possesses. The process of decay in an over-acidified cheese is a sort of dry-rot, rather than that unctuous, salty mellowness which we always find in a thoroughly good cheese. Many of the bastard Stiltons decay by the dry-rot method; they are too much acidified, the ripening agent is injured, and they were probably never very rich in fats.

It is also evident that the highly-prized flavour of a ripe cheese is a product of incipient decomposition—of the ripening, in fact. It did not exist in the curd or in the milk, but it was developed as the cheese ripened. Now in an over-acidified cheese this flavour is either never developed at all or only to a slight extent, proving either that the acid has in part destroyed the elements from which the flavour is produced, or that by checking and preventing the ripening of the cheese it has also checked and prevented in a corresponding degree the development of the flavour which belongs to a properly-ripened cheese.

A moderate degree of acidity, then, is serviceable in the following ways: it will greatly help to cure tainted milk, it helps to expel the whey, and it improves the compactness and the texture of the cheese. But, on the other hand, a high degree of acidity will cause the cheese to be comparatively insipid, or perhaps bitter, hard, solid, sad, dry, tough, and will prevent the ripening. And, we may add, the degree of acidity required to effect all this mischief is reached before we are aware of it, unless we watch it very closely. A high degree of acidity can never do anything but harm to cheese made from sweet, fresh milk, though a low one will do much good if properly employed; and it is only in the case of tainted milk that a high one is on any pretext admissible, and that is to prevent a worse evil. But only a very high degree of acidity will remove the taint wholly from the cheese, and a degree of it that could not be permitted in sweet milk would only suppress the taint until the conditions necessary to its resumed activity were reintroduced. Professor G. C. Caldwell, of Cornell University, with respect to tainted milk, says:*

"A particle of taint in the air or on the walls of the dairy or factory, or in the pails and vats, means a quantity of fungus germs—often a multitude of them—all ready and most willing to take possession of the milk, and to hold it too, when once in possession, with such pertinacity that no process will expel them but such as will ruin the cheese." A very high degree of acidity would expel them, but it would ruin the cheese; and the only thing that can be done with safety in such cases is to employ just that amount of acidity as will keep the fungi in abeyance without ruining the cheese.

Previous to the establishment of cheese-factories in America, the acid question was an unknown quantity in the sum of practical cheese-making, and it was in very few cases understood by the people either in that country or in this. It was, as we have said, in this country employed in many cases, but in a sense unconsciously so, unless in the Cheddar district; for the great bulk of those who refrained from salting their cheese until the following morning were not aware that by so doing they were promoting the formation of a small degree of acidity, which had the effect of causing the whey to drain out of the newly-formed cheese. The whey left the cheese all the more freely on account of no salt being used the first day—this they were conscious of, but they did not know that a slight acidity was the active cause of it. The Cheddar cheese-makers have employed acidity for scores of years—consciously and intentionally employed it—in the making of their wonderful cheese, but it was not employed in American factories previous to the year 1860. Our Cheddar system is the foundation on which American cheese has been so greatly improved in the past twenty years, and in that system acidity is the salient feature.

The carrying of milk that had not been aerated or cooled in closely-lidded cans to cheese-factories in America was found, especially in hot weather, to commonly develop a taint whose effects on the curd were sometimes very extraordinary. The taint generated gases, and these inflated the curd so that it would rise in a mass and float on the surface of the whey, and “floating curds” became known. At this stage some person or persons unknown made the discovery that acid checkmated taints in milk, and it was found that cheese made from acidified curd, although the milk might previously have been tainted, was more uniform in texture and more compact than that made without acidity from milk that had no taint. The cheese also cured well, its keeping properties were increased, and it retained, not, indeed, that fine nutty flavour for which fine cheese is so much esteemed, but a mild, sweet taste, that made it pass muster in a very tolerable manner, all things considered. Acid was, consequently, regularly and systematically developed in an artificial manner.

Consciously or unconsciously, most cheese-makers employ acid more or less. The Cheddar dairymaid produces it by “slip-scalding” and the use of sour whey; the Cheshire by allowing the curd to remain unpressed and warm for a day or more; and the Derbyshire by pressing the fresh curd and later on salting it on the outside. But the great thing in cheese-making, where acid is intentionally employed, is, or ought to be, to make the acid subordinate to the rennet, not the rennet to the acid; and as the acid in a high temperature is much more rapid and powerful in its action, it can easily overwhelm the rennet if it is developed too far.

Salt checks the action of acid and rennet alike, and acid checks the action of rennet, hence it follows that the rennet should not be subjected to both checks together, except to a moderate extent. While very fine cheese is made by the aid of acidity directly developed, equally fine is made at a rather low temperature throughout, with a liberal use of rennet and a little or no acid; this gives the rennet the advantage it needs over the acid, because it comes into play faster than acid does at a moderate heat; and where the salt is not applied till the following morning, even though the temperature be low, the result is frequently found to be a cheese of very good quality.

Excessive salt and excessive acid each prevent the ripening of cheese, hence it follows that the rennet, which is the ripening agent in the cheese, should have a chance of getting good hold of the curd, and be well forward in its work, before either acid is developed or salt is applied. This it does very successfully in several methods of cheese-making which are quite distinct from each other. Many cheese-makers, knowing the effect of acid in expelling the whey quickly from the curd, have employed it too freely with the view of saving trouble to themselves. They have succeeded in this, but they have nearly ruined the cheese. Acid in cheese-making is indeed a good servant, but it is a bad master; it must always be used with the greatest discretion.

Having thus reviewed the general operation of the forces and principles employed in cheese-making, or affecting it, we have in the following chapters to trace their more detailed application to particular cases or particular qualities of cheese.


CHAPTER XVI.
CHEDDAR AND CHESHIRE CHEESE.


At the foot of the main chain of the Mendip Hills in Somerset, and on the margin of the "Marsh," once covered with water when Glastonbury was Avalon, and now the richest grazing grounds in the country, lies the village of Cheddar, which, according to a local poet, is

"Famous for capital C's,
Cliffs, and Caverns, and Cheddar Cheese."

Here, some hundreds of years ago, originated the system of cheese-making which, borrowing its name from its birthplace, has since made that name a household word among thousands who have never seen the grand cliffs and stalacite caverns which are among the most interesting natural curiosities of the county.

But it is with the cheese we have to do. Its origin is lost in obscurity, but we can trace its existence through nearly three centuries. The historian Camden, who wrote in the reign of Elizabeth, speaks of Cheddar cheese as being famous in his day, and of such great size as to require two men to set one on a table, from which we may infer that the custom of making up the milk of several farms into one cheese was practised in the sixteenth century as it was about one hundred years ago, for the holdings in the neighbourhood of Cheddar were doubtless then, as now, comparatively small. Here we have the first instance of associated dairying; and it is curious to note that the idea remained undeveloped for more than 250 years, was then put into practical shape by an American, that it has, after great success in the United States and Canada, met with strong adverse prejudice in the country that gave it birth, and at the present time, after a trial of some years, seems to thrive but slowly, and to give scanty proof of the power it possesses to benefit the dairymen of England.

Fuller, in the seventeenth century, remarks that "the worst fault of Cheddar cheese is that they are so few and so dear, hardly to be met with save at some rich man's table." These facts, gleaned from the writings of two well-known authors, tell us all we can now learn of the early history of the cheese and its fame.

The little village, nestling beneath the lofty rocks, is a fit cradle for the system; well watered, sheltered by the hills on the north and east, and catching the breezes from the Bristol Channel on the west, a place for healthy people and healthy stock, for pure milk, and clean, cool dairies. These natural advantages, especially the shelter from cold winds and the abundance of water, were certainly favourable to the production of fine dairy goods, but the great secret of the success of those early makers was that they (perhaps unconsciously) pursued a system of manufacture the principles of which were both scientifically and practically correct; they made for their goods a reputation for excellence, and passed away, their names unknown to fame, leaving as a rich legacy to succeeding generations the method by which they acquired that reputation.

THE CHEDDAR SYSTEM.

This system has not yet been improved upon; all that has been done within the memory of man has either only affected the manner of reducing its laws to practice, leaving the laws themselves
united, or it has been a failure. True, many of the awkward appliances of old days have been thrown aside, and better and more convenient ones now occupy their places; and many of the dairies and cheese-rooms of the present are superior in construction to those of half a century or more ago; but to a very limited extent have these affected the principles of the system.

Since the beginning of the present century the introduction of fixed rules, wherever practicable, has done much towards simplifying the method. Many of its various operations are still left to the judgment of the maker, but the rules have rendered even these easier to contend with, on account of the comparative uniformity of the times, quantities, and temperatures which occur in the daily routine of the manufacture. The importance of having fixed rules for the guidance of the cheese-maker cannot be overrated; but they must possess enough elasticity to allow them to accommodate themselves to all kinds of accidental circumstances, for no two days' experiences may be alike.

Prominent among those engaged in their introduction was one whose rare perception enabled him to grasp the general principles of the process, and so reduce them to practice as to render the "rule of thumb" mode of working, as a matter of necessity, a thing of the past. We speak of the late Mr. Joseph Harding, of Marksbury, who not only brought the theory of Cheddar cheese-making into definite shape, but also successfully practised it on his own farm, as do many of his pupils in their various localities at the present time. He was a man of great intelligence, and with painstaking perseverance aimed at making all circumstances combine to produce the finest goods. He did not claim to be the originator of the system, nor even an improver; on the contrary, he was a firm adherent to its principles as he found them, simply endeavouring to make them better known and understood. He did not at any time hold the opinion that the quality of cheese was to be attributed entirely to the management in the dairy, though he laid great stress upon the system of manufacture as being the chief element in the question of success. In addressing an audience during his visit to Ayrshire in 1854, he said: "Cheese is made in the dairy yonder where A is feeding his kine on broad clover, tares, and rye-grass; or where B, on the very edge of the moor, is making what was almost desert to blossom as the rose with the varied arable forage crops of a first year's cultivation; or yonder, again, where C and D are managing old-land cash farms in the groove first made generations ago,—I will take the milk from any of them and make the same cheese anywhere. Cheese is not made in the field, or in the byre, or even in the cow—it is made in the dairy." But these words do not at all indicate the presence of such a belief in his mind as that which has been ascribed to him, and to which we have referred above. We can say with certainty that no man attached more importance to good farming and cattle management than did Mr. Harding; the dairy-work was, however, in his day, as now, in need of improvement, and many dairymen supposed that the farm and the cattle ruled the quality of the cheese, hence the assertion above quoted. An important item in his creed was that with a change of location, soil, or system of farming, a change of management was often necessary, thus involving some little alteration in the routine of manufacture, but leaving untouched the main points of the process.

Others have been or are engaged in spreading the knowledge of the system among their fellow-dairymen, or in bringing science to the aid of practice, but limited space forbids our making more than a general acknowledgment of their services.

Mr. Harding was the author of some pamphlets on the method; lectured upon and taught it in various districts of the kingdom, notably in Ayrshire, on the invitation of the Agricultural Society of that county; and included among his pupils many Continental dairymen. An American author, the Hon. X. A. Willard, M.A., of Little Falls, New York, who visited Marksbury in 1866 as a deputation from the American Dairymen's Association, says of the system, as he there saw it carried out, that in his opinion it is "the only process from which American dairymen can obtain suggestions of much practical utility."*

Such was the reputation of the system when its first great exponent was at the zenith of his fame, and we doubt much whether the labours of any others have since then raised the standard of Cheddar quality. It is notorious that a large proportion of the cheese made in Cheddar dairies is below the standard of that time, and the causes are not difficult to discover; departure from primary

principles and inattention to details being prominent among them. No system can contend with ignorance, false prejudice, and carelessness; and the Cheddar method of making cheese will never be successful in the hands of dairymen who cannot bring a trained judgment to the aid of fixed rules.

failure. Fast curing, loss of mildness, sharpness under the tongue at an early age, and decay later on, generally accompany each other, and are in many cases the result of an error in the manufacture, with which we shall presently deal.

We now come to the consideration of the

A well-made Cheddar cheese should possess mildness of flavour, quality or richness, and solidity of texture, should cure slowly, and keep for a long time. When a Cheddar is not mellow, is full of holes, or "shaky" in texture, when it cures fast, loses its mild flavour, acquires a sharp taste and has a tendency to early decay, we may safely say that it was made either from bad milk, or without due regard to principles; and in the vast bulk of cases the latter is the cause of partial or total

The size and shape of a Cheddar cheese are
not matters of importance. The impression shared by many persons that it must necessarily be large is a mistaken one, and probably arises from the fact that originally the goods made under this process were of cylindrical shape, of 100 lbs. and upwards in weight, and became famous in that form. Cheese made by the system which we are about to describe, whether "truckle" shape, flat, or deep, whether of 10 or 100 lbs. weight, are "Cheddars."

The essentials, though few, are important, and they fix the definition of the system. They must be principles, rules, or modes of working which affect the quality of the produce; they must, when followed with judgment, produce goods having in full the characteristics of Cheddar cheese as before described. It must be clearly understood that Cheddars cannot be made in any manner that may be suggested to the mind of a cheese-maker; if such a person proposes to introduce a practice which in any way involves a deviation from any principle of the system, he can no longer claim to be a Cheddar-maker—he no longer follows the system in its integrity. There is a certain laxity of opinion on this question which needs setting right. We have heard a cheese-maker say that any cheese which in its curd state had been ground in a mill was necessarily a Cheddar; and another person has given, in our hearing, the definition of the term as "a cheese made within a radius of ten miles of the village from which the system derived its name." There is a heresy yet more common than either of these, with which we shall deal in the detailed description of the process.

The distinguishing characteristics of the system have ever been, and ever will be, the foundation of success; they hang together and work in harmony, and they cannot be departed from without injury to the produce. They are:

1. The use of heat to raise the temperature of the milk to about $80^\circ$ Fahrenheit (or $27^\circ$ Centigrade)* previous to the addition of rennet.
2. The limited use of a cutting instrument in the first stage of whey separation.

* Of the thermometrical readings, in all instances, the first in order is the Fahrenheit, the last (in brackets) of the Centigrade scale. The latter, though not accurate to fractions, are sufficiently so for practice. We give them because the Centigrade thermometer is largely coming into use among scientists, and is more suited to experimental work than the Fahrenheit instrument.

3. The use to as large an extent as possible of an instrument which will split or break the curd into small fragments.
4. The application of heat to raise the temperature of the curd and whey, after breaking, from $95^\circ$ ($35^\circ$) to $100^\circ$ ($35^\circ$), for the purpose of hardening the curd and completing the separation of the whey from it; the former being stirred, during that time and after the desired temperature is reached, in the hot whey by a bluid instrument until the required hardness and freedom from whey is obtained.
5. The removal of the whey in a sweet condition, at about half an hour from the time the stirring ceases.
6. The developing of acidity in the curd by piling and occasionally covering it to preserve its warmth.
7. The thorough draining of the whey from the curd, and the cooling of the latter before grinding.
8. The division of the curd into small particles before pressing.
9. The mixing of salt with the curd, at the rate of about 1 lb. of the former to 50 lbs. of the latter.

For the purpose of illustrating and enlarging upon these leading points of the system, we will here describe the process, as performed in Mr. Harding's dairy from his coming into public notice until the close of his useful career. His practice has been generally chosen by writers on dairying when a description of the system has been necessary. We shall enter into the details of the process, speak of various appliances and their uses, of operations and their results, and of certain modes of working, their advantages and disadvantages, as we proceed, omitting nothing the presence of which, in a work of this character, may appear desirable, and making Mr. Harding's practice the basis of the description.

The dairy at Marksbury is a part of the dwelling-house, and consists of the making-room, the press-room, a boiler-shed, and a curing-room. In the shed is a hot-water apparatus, by Cockey of Frome, attached, by two pipes to a large double-bottomed tub of 200 gallons capacity, which stands in the making-room. From the boiler another set of pipes pass around the cheese-room for heating purposes. Above
it stands a tank, in which water is heated for cleansing the utensils. Where hot water is used for heating the milk this apparatus is valuable. The space A in the accompanying illustration (Fig. 91) is filled with hot water, which enters by the pipe B, and returns by a similar pipe to the boiler. A large tap is fixed at the bottom for drawing off the whey, and a smaller one, C, for the removal of the hot water.

In the same room stands a tank in which to set whey for cream, butter of a fair quality being made from it. The whey, after skimming, is run off through pipes to the piggery cistern. A long wooden tub, or "cooler," is used to spread the curd upon after it is taken from the tub, and upon this is fixed a simple curd-mill, having a cylinder in which square teeth are inserted spirally, these working through a rack of square bars. It is turned by hand, and grinds the curd well, though it is not necessarily the best in the market. The press in use is a screw and lever machine of simple construction (Fig. 95). The screw-opening vat (Fig. 96) is used; this was introduced by Mr. Harding, and is the best yet invented for large cheeses. A tin milk-receiver, consisting of a hopper, to which is attached a pipe, is so placed—the hopper being outside and the pipe passing through the wall, with its other end resting on the side of the cheese-tub—as to allow the milkers to pour the contents of their pails into the tub without entering the dairy. In the curing-room are "turning" shelves, which are easily moved either way, so that all the cheese stored on them may be turned with one motion, saving much time and labour in this department of the work. This description of the dairy will, we think, suffice.

The evening's milk is poured by the milker through a fine strainer into the cheese-tub. There is no previous cooling of the milk, though, doubtless, where it is done much danger of souring is avoided during hot weather; but into the space A of the Cockey tub (Fig. 91) cold water is introduced, and the milk cooled down thoroughly. Mr. Harding fully recognised the necessity for a pure and sweet material from which to manufacture his cheese. By reducing the temperature to 55° (13°), or lower during the summer, the preservation of the milk under fair conditions is secured; this can be done if a stream of water of a quarter of an inch diameter is available.

Here let us say a word about the cream rising on the night's milk. This is, despite the opinions of some to the contrary, objectionable. Without going into the theory of the question, we may say that the cream of some specimens of milk rises faster than that from others, and is less easily stirred in again; but while the difference between them on this account is marked, it is certain that, with either, to be able to prevent its rising is a great advantage. In the cheese factories the "Austin" agitator is used with good results; a description of this apparatus will be found in the section on American factories. A simple appliance on the same principle—a change from a rotary—represented by a small water-wheel, to the horizontal motion of a floating rake, the action intermittent, a movement of the rake occurring once every two or three minutes, will answer the purpose, the quarter-inch stream of water used to cool the milk driving the wheel, and thus performing two useful offices at the same time. It is found that by the use of the Austin apparatus the milk is rapidly cooled and aerated, that no cream rises, and that a clearer whey can be produced in making the cheese than would otherwise be the case. At Marksbury nothing of the sort
is used; the cream is skimmed off, poured through the strainer with the morning’s milk, and thoroughly stirred in. But the advantage is on the side of intermittent agitation.

When the morning’s milk has been run into the tub, hot water from the Cockey boiler is turned on, and the whole mass heated to from 80° (27°) to 82° (28°). The higher temperature is necessary with small quantities of milk in cold weather, and in draughty, ill-constructed dairies. 84° (29°) is not too high in the early and late parts of the season. When a dairy is not fitted with glazed windows and free from cold draughts, cheese-making cannot be satisfactorily carried on; it may be cool in summer, but there is an uncertainty at all times, and very little chance of uniformity in the quality of the goods produced. It is also probable that the cheese-maker will suffer in health under such a condition of things. We lately made the acquaintance of an old lady who is a victim of chronic rheumatism, which she attributes to having for many years made cheese in a cold and draughty room. Away, then, with perforated zinc and wire netting, and let every dairy be snugly built and fitted with glazed windows, which can keep out and keep in heat and cold; and if in summer the room needs cooling, close the windows and swell the floor with water. In a well-constructed building there should be no need of heating the milk to more than 82° (28°), when setting for coagulation, at any time in the season. When the milk is at the desired temperature the flow of hot water should be stopped, and about one-third of it drawn off through the tap c (Fig. 94), that it may not by its contact with the bottom of the inner shelf raise the heat of the contents unduly, whilst that which is left will assist the milk in retaining its temperature.

In the old-style dairies, where no hot-water apparatus is used, a portion of the milk should be drawn into a pail, placed in an ordinary boiler containing sufficient boiling water to rise around the pail to within a few inches of the top, and heated until, by pouring it again into the tub, it will raise the temperature of the remainder to the desired point. A little careful calculation is needed to avoid over-heating, or the annoyance of finding that the pailful from the boiler will not sufficiently heat the rest by one or two degrees; but this is not difficult. By this system of boiler-heating good cheese can be made, but a steam or hot-water apparatus is decidedly to be preferred on all accounts.

The rennet and sour whey are now added to the milk. The farmer, as made at Marksbury, is reliable in its action and pure. Best old Irish vells are used, selected by Mr. Tolley, of Bath. Salt brine is made which will float an egg; and to every gallon of this is added four vells, a half-ounce of saltpetre, and half a lemon sliced, which soak in the brine for a month, at which time the liquid is ready for use. A half-pint of this will, with the use of sour whey, coagulate 100 gallons of milk in sixty minutes or less. Now the artificial rennet has largely superseded that made at the farm—at least in the West of England dairies. If the curd is ready for manipulation in much less than an hour it will be tough and hard, and if coagulation occupies much more than sixty minutes the curd will be tender and difficult to separate from the whey without loss; in other words, to break it as usual would ensure a “white whey.” So it will be readily seen that the coagulating power of rennet should be definitely known to the cheese-maker, in order to ensure uniformity of action.

Concerning the use of sour whey various opinions prevail, but experience has shown that a curd produced without it, a larger quantity of rennet being used, is not as firm and manageable as that produced by a less quantity of rennet and a limited amount of whey. The acidity in the curd after scalding is more rapidly developed when it is used, and few things tend more to render a cheese scopy and tasteless than that the acid development occupy a long time. At the same time, we may remark that great judgment is required in the use of sour whey in coagulating milk; to exceed the necessary quantity is risky. This varies with circumstances; in a warm dairy the variation is less than in a cold room. In the former the use of from a quart in warm weather to 3 quarts in the colder parts of the season to every 50 gallons of milk is sufficient; but very few accurate calculations have so far been made on the question of quantity. The figures given are from the practice at Marksbury, and we have not yet found it necessary to depart from them.

Annatto is used by most makers. Mr. Harding protested against its use, but when an artificial colouring was demanded recommended Nieholls’ liquid preparation. He penned in 1860 a para-
graph ("Recent Improvements in Dairy Practice," Vol. XXI., Part I., R.A.S.E. Journal) on the subject which is certainly worth transcribing:—"To the cheese-consumers of London who prefer an adulterated food to that which is pure, I have to announce an improvement in the annatto with which they compel the cheese-makers to colour the cheese. The improvement is not in the smell, which remains as unpleasant as ever, neither is it in the taste, that is as filthy as ever; but it consists in this, that we now get annatto in a liquid state instead of a cake, which saves the trouble of rubbing out." This is better than argument. But if annatto is used, the proper measure should be mixed in a bowl of milk, poured into the mass, and carefully stirred in. The stirring should continue for five minutes or so after the rennet and sour whey have been added to the milk, that the coagulation and colour may be uniform, and that no cream may rise before the curd begins to form.

A further result of this stirring is the production of a grain in the curd. The movements of the particles of milk have not entirely subsided before coagulation sets in, and the currents of milk-atoms are gradually affected by the rennet until their movements cease, and the direction of their flow is marked by a grain, the presence of which is shown by the curd splitting before the finger smoothly, as in the line A, Fig. 97, and breaking with a ragged edge if the finger be forced through it in an opposite direction, as at b. This theory is supported by experience, and is of the utmost importance in determining the manner in which the curd shall be broken up in the process of whey-separation. Now one of the leading principles of the Cheddar system is that the process of "breaking," as it is technically called and hereafter described, shall as far as possible be performed with blunt instruments, which, in passing through the curd, shall cause it to split in the direction of its grain. But the limited use of cutting implements is at present requisite because no blunt instrument has yet been introduced which will divide the curd into blocks of a workable size and shape. The curd-knife of the Cheddar method is a single blade (Fig. 98) with an oval-shaped handle, the former being as long as the depth of the tub in which it is to be used. When the curd is "ready to cut," this knife is passed through it in opposite directions, leaving the mass in blocks of 6 or 8 inches square. Then the "skimming-dish" (Fig. 99), so named because it is used for skimming cream as well as for breaking curd, is called into the work; the manner of handling it requires careful description. The blade is passed edgewise into the contents of the tub, and then drawn gently upwards, as shown in Fig. 100, allowing the block of curd to split in its grain, and when that is done, carefully drawn out edgewise, and the operation repeated until the mass is reduced, by as little cutting and as much natural splitting as possible, into lumps of 4 or 5 inches in thickness. This part of the process is performed slowly, but with gradually increasing rapidity, the condition of the curd and whey indicating to the trained maker the necessary speed. To persons who have never used it the skimming-dish appears awkward, and likely to smash the curd as to cause loss. But such a notion is erroneous; there is nothing yet invented which, taking its place, will do its work as well. We cannot imagine any alteration of its form which might be a practical improvement, or give any advantage not now possessed.

Now the use of cutting instruments is left off, and the "breaker" comes into requisition. This is shown in Fig. 101, and consists of a bent wooden handle, through the lower part of which some nine or ten brass rods of ¼th of an inch diameter are inserted at about 1½ inches apart, their ends being fastened into two strips of wood, the edges and ends of which, as well as those of the handle, are carefully rounded off. In fact, the implement is thoroughly adapted to the work of curd-splitting or breaking. Two others, the "revolving" and "hoop" breakers,
now nearly obsolete among Cheddar-makers, were made with round wires or rods for the same purpose. By the former of these we must not be understood to refer to the "Keevil apparatus" or the revolving frame of blades used in some Wiltshire dairies; they are not Cheddar appliances in any sense of the term.

But there have been introduced into many dairies implements similar in form to the shovel-breaker first described, but differing from it in the most important point—the shape of the rods and side-strips, which are made to cut or tear the curd instead of splitting it. Sections of the various sorts of rods used in the construction of breakers are given in Fig. 102, where A is the wire of the Cheddar shovel-breaker, B the diamond wire, and C the cutting blade. Of the two latter, B is decided the most objectionable, as we know from personal experience; but the use of either interferes with one of the chief principles of the Cheddar system. The "American" method pursued in Transatlantic dairies and factories has, as one of its leading characteristics, the use of cutting instruments, and the factory curd-knives have many blades, situated about half an inch apart, so as to cut the curd into small cubes at the outset. The cutting breakers are, then, we contend, "American" in principle, and should be known as such. Whether they are improvements on the round wire breakers or not matters nothing. They deviate from the true Cheddar principle of breaking.

But are they improvements? When these cutting or tearing breakers are used it is impossible to break the curd properly and continuously and not produce a "white whey." We have been able to trace the resulting evils to their source in various cases, but the makers fall back on some mysterious and unknown influence as the primal cause of the mischief, while the "new" breaker remains to perpetuate it. But as we do not recognise the cutting breaker as a Cheddar implement, nor its work as part of the Cheddar process, we will dismiss this part of the subject by remarking that the flavour and keeping qualities of the cheese made in the West of England have not improved since its introduction, but rather the contrary.

The great objection raised against the round wire breaker is that it "smashes" the curd. This may be true of it when in the hands of ignorant and careless makers, but if properly handled no more loss of butter and casein passing off with the whey need be incurred than is consistent with the production of the finest cheese, and the whey may always be, as it should, as clear as Rhenish wine. It is, with our present knowledge of cheese-making, impossible to produce a whey totally free from butter and first-class cheese at one and the same time. This may possibly be achieved in the future.

In "breaking," the implement should be held as in Fig. 101 during the early part of the process, and moved slowly, the speed increasing gradually. Care should be taken to break evenly throughout the mass, and the whey should at any time be so clear as to reflect the face and figure of the operator. This rule is simple but sufficient.

When the curd is reduced to lumps of the size of large peas, "scalding" commences. The hot water is again applied, the breaker turned over, being held as in Fig. 103, and the curd stirred until the correct temperature is gained. In old-style dairies the curd is allowed to settle, and a quantity of whey drawn off and heated in a pail placed in the boiler. The custom of "slip scalding," or raising the temperature by pouring into the tub two pails of whey, one at a rather earlier and the other at a later stage of the process than that at which the heat is applied by hot water or steam, was in vogue in 1860, and for some years before and after, but the practice has largely fallen into disuse, though in cases where the old style exists the effects are beneficial, as by it the chance of getting too hard a curd is somewhat lessened.

In scalding, as in heating for coagulation, a higher temperature is necessary in cold than in warm weather, in a draughty dairy than in one properly constructed, with small than with large quantities of milk; the range, however, lies between 97° (36½°) and 100° (38°), and it is seldom necessary to go above or below it in home-
dairy practice. In making large quantities, as in factories, 95° (351°F) is sufficient for summer work. When the necessary temperature has been reached, the hot water should be turned off, and the stirring continued until the curd feels "shotty," or is hard enough to rub between the fingers without adhesion, and the whey pressed from it is clear; then the breaker is withdrawn, and the curd allowed to sink to the bottom of the tub. As the curd often enters into this condition suddenly, being apparently far from it at one time and within a very few minutes afterward found to be hard, it cannot be too carefully watched. While scalding, great care must be taken to prevent any curd lodging on the bottom of the tub, where the heat will cause it to adhere and become lumpy; the motion of the breaker must not, however, be violent. And here let us remark, that from the first cutting until the scalding and subsequent stirring is completed, the process must not cease for a moment, excepting for whey-heating under the old style of management. The Cheddar method does not admit of cheese-making and domestic work being done alternately by the maker in the same time; the entire attention of one person is required throughout the earlier half of the work, and the cheese should be the first object of consideration until it is in press.

But to return. At this stage of the process the curd is allowed to remain under the whey for half an hour, when the latter is drawn off, no particles of curd being allowed to pass off with it. For this purpose a simple syphon and a cylindrical strainer is the best arrangement known. The strainer is placed in the tub, close to the side, the syphon filled by immersing it in the whey, and then, the ends being held tightly in the hands to prevent the contents running out, the shorter arm is adroitly put into the whey, which begins to flow from the longer arm, and continues to do so until almost all has been drawn from the tub, leaving the curd undisturbed. The shorter arm of the syphon should, when resting on the side of the tub, reach to within half an inch of the bottom of the strainer, which should be eight or more inches in diameter and as deep as the tub. When these are not used, the whey is drawn through the tap, care being taken to prevent any curd being carried with it.

When this has been done, the curd is piled in a compact heap, and if the weather is cold covered by a cloth to enable it to retain heat and develop acidity. This cannot be done too quickly; the longer the time it occupies, the colder will be the curd, and cold checks acid.

In from twenty to thirty minutes the curd is cut into two or three pieces and re-piled, those parts most exposed before being now turned inwards, and all packed closely together. To decide when curd is sufficiently acid is difficult to an untrained maker, and no definite rules exist on the point, some dairymen using a hot iron, to which the curd adheres and from which it draws out in fine threads when a certain amount of acid is present, others—the majority—trusting to their experience. Various chemical tests have been suggested, but they occupy too much time, and are too troublesome for the ordinary maker; while as yet no acid-meter has been invented which will register acid as a thermometer does heat, and there seems no probability of the appearance of such an instrument.

But, lacking such aid, we know that curd should not occupy more than an hour in developing proper acidity, and at that time should be uniform throughout the mass. If the air is so cold that it would necessarily take a longer time, some strainer cloth should be put on it, or the top of the tub covered over. The use of any material of close texture should be avoided; curd covered by it will smell musty.

When sufficiently acid, the pile of curd is cut into three or four lumps and spread over the bottom of the tub, and there left for ten or fifteen minutes; then, divided into smaller lumps, again spread abroad; after another short interval torn into pieces of 3 or 4 inches square and 2 inches or less thick, and spread upon boards or in a cooler, this being a gradual method of drying, the windows opened if the weather is fairly warm, and rapid cooling induced. It will require once turning; and when the surface is dry, the temperature about 60° (15½°), and a tinge of brown appears, it is ready to grind.

As on an average a pound of cheese is made from a gallon of milk, we may take the number of gallons of milk as the basis for salting. The salt should be thoroughly mixed with the curd when ground, at the rate of 1 lb. to 56 gallons of milk, and too pure or too fine a salt can hardly be used. Mr. Harding used and recommended Titley’s double refined salt, which is, as is also
the "Eureka" salt of Messrs. Higgin, of Liverpool, specially adapted to dairy use. The curd should now be put into press, and the grinding, salting, and vatting cannot be done too quickly consistently with thoroughness. Any further cooling or drying should be avoided, and in ten minutes from the time it is ready to grind it should be under pressure.

The cheese remains in press until the day after making, is then taken out and bandaged (if this has not already been done), turned, and again put under pressure. To makers of heavy goods we commend the screw-opening vat (Fig. 96), as less liable than others to injure the cheese when removing or replacing it. When the cheese is to be removed from it, the screws A A (Fig. 96) being turned, open the vat at its side and bottom, so that the latter can be lifted up from the former with ease.

After the second day under pressure, the cheese will be ready for removal to the curing-room, and we will follow it thither. It is only curd yet, and the process of mellowing down into a ripe, clean-flavoured, and luscious article of food fit for the table has yet to come. Here may be stored perfect and well-pressed curd, promising to become all that we could wish—a credit to the maker, the desire of the dealer, and a source of gastronomic pleasure to the consumer; and here it may by over-heating acquire a sharp, strong, and unpleasant taste; or by the temperature being kept too low may become soapy and characterless in flavour; here, in fact, it may be spoilt by simple neglect. Authors on dairying who point out bad curing as prominent among the causes of failure are by no means wide of the mark.

Cheese cannot be cured perfectly in ill-constructed, draughty, or damp rooms, which are too cold in winter and too warm in summer, without any artificial means of warming the contained air, and keeping the temperature at a desirable point, and in which the thermometer shows a variation of many degrees. We have seen a modern dairy, built within the last twenty years, the walls of which were mildewed, and the cheese in which was furred, and this in the county of Somerset, the home of the Cheddar system; and we have reason to know that a large number besides in the county and country are more or less unfit for the purpose for which they are intended. Mr. Harding found from personal observation that newly-made Cheddars give out moisture at the rate of 2 lbs. per ton in twenty-four hours, and accounted for the lack of character in and uniformity of much of the cheese made late in the season, by want of artificial heat and proper curing-rooms, the evaporation of the moisture being slow, from the low temperature of the surrounding air. Subsequent experience establishes the correctness of his belief. Let us then say what has already been so often said, that if the cheese is to be of first quality, we must store it in a proper room, with a correct and uniform temperature. The room should be so constructed that the air it contains should be affected as little as possible by that outside. Ventilators are useful, though they must be more generally closed than open. Warmth should be obtained by the use of a heating apparatus; the pipes connected with the Cockey boiler at Marksbury will warm a cheese-room admirably, though where no hot-water system is in use a slow-combustion stove will, though inferior, answer the purpose. But neither must be situated very near the cheese-shelves.

The best temperature for the curing of Cheddar cheese is from 60° (15½°) to 65° (18½°), in which, if well made, they will ripen and be ready for sale in three months or less from the date of making, while in a cold room the same goods will require twice as much time, and a correspondingly large amount of storing space will be needed. The cheese should be turned over every day until it is a month old, and afterwards not less than once in two days. The bandages may be stripped from large cheeses at five or six weeks, and from thin ones of less than 50 lbs. weight at a month from the time they are made. It is an advantage to have the date of manufacture marked on the bandage, for ready reference.

In some cases it may appear desirable to make milk-cream butter and "half-cream" or "skim" cheese, and no description of the system would be perfect which did not include some remarks on the manufacture of the two latter, and the points on which the process of making each differs from that of whole-milk cheese.

"Half-creams" are made from the evening's milk skimmed and the morning's meal of whole milk mixed, and "skims" from two meals of skimmed milk. The routine of the work is the same with
CHEESE FROM SOUR AND TAINTED MILK.

both; the differences are of time, condition, and temperature. In making these goods there is great danger of producing too hard curd; this, it will be readily seen, is greater with skimmed than with half skimmed milk. The maker should be careful to cut the curd rather earlier than is usual with whole milk, as a tender curd is more necessary. In scalding, the heat should not be lowered, but the curd needs less stirring and more careful watching than in making full-cream cheese. The acidity should be hastened, and all the subsequent work done as quickly as possible, as the curd will cool and dry rapidly. It should be put to press at not less than 65° (18½°), and cured in a room the air of which stands at about the same temperature.

A few remarks upon the treatment of sour and tainted milk under the Cheddar system will perhaps be useful. Many makers have both, but especially the former, to contend with occasionally, and want to make the best of a misfortune. It is certain that we cannot make a prime article from either, but with care and proper management an eatable cheese can be produced.

Experience has shown that sour milk cannot be made up too quickly. A loss of solids will be the result, but of two evils we must choose the least; so when the curd is firm enough, cut and break it, remembering that the tendency to become tough is proportionate to the sourness of the milk, and that if this part of the work is not quickly despatched, the lumps of curd will become unbreakable before they are sufficiently small—a condition of things to be avoided at all risks. At no time in a cheese-maker’s experience is the minute division of the curd in breaking more necessary than when he has sour milk to convert into cheese. Scald high—say 100° (38°) to 102° (39°)—and carefully watch for the hardening of the curd during the stirring, which will occupy but a short time. Let the curd lie under the whey the usual half-hour, or the natural acid will be too much checked; but after the whey has been drawn off, expose it to the air a short time, then pile, though not as closely as is usual with good cheese, and when the sourness is checked by the exposure, pile as with the curd of whole milk. Place it, when torn abroad, upon some sloping surface where it can drain itself, and dry it thoroughly before grinding. Use more salt than would be required for a curd made from sweet milk—say 1 lb, to 50 gallons of milk—and put at first under less than ordinary pressure.

Tainted milk is not so common in England as in America, where “floating curds” made from it are the terror of the cheese-makers. We have had personal experience in handling such milk, and know that it may be successfully treated. The great counteractant of taint is acid, which should be developed by high scalding and close piling. The curd should then be dried as rapidly and ground as finely as possible. If stirred too long after scalding, the cheese will be hard, and liable to crumble. The condition of the curd must therefore be narrowly watched during that part of the process.

The causes of sourness and taint are spoken of elsewhere; we therefore give these facts for the guidance of practical cheese-makers, and refer them to that section of this work treating of these subjects for any scientific information relating to them.

We have in these pages endeavoured to give a true description of the Cheddar system of cheese-making, avoiding unnecessary technicalities, and dealing with all the details of the process for the information of all, from the tyro to the trained maker. The system became famous at a time when the work was done in what to us would appear a most unsatisfactory manner, and scientific aids were, as far as we can judge, unknown in the dairy; it has gained notoriety within the last fifty years, through the teaching of Mr. Harding and others; and we venture to predict for it, if fairly distinguished from other systems (such as the American, from which it greatly differs on some important points), and its principles faithfully carried out by intelligent dairymen, a future of fame greater than its past has been.

J. O.

CHESHIRE CHEESE.

For a very long period the county of Chester has been famous for its cheese. Many hundreds of years ago Cheshire cheese had obtained a reputation which was barely approached by that of the cheese of any other county in the kingdom; and in modern times its fame has spread to many lands, in some of which imitations of it have been and are still being made. Cheshire cheese is also made in the adjoining counties, more particularly in Shropshire and Staffordshire, where the same
geological formation prevails. There can be no doubt that the properties peculiar to Cheshire cheese, whether it is made in that or in the adjoining counties, are in a great measure owing to the new red sandstone, and to the boulder clay by which it is accompanied, from which the soil of that part of the country has been derived in the course of ages. Cheshire is also famous on account of its salt deposits; no doubt the saline element counts for something in the agricultural products of the country. It is sufficiently clear that the soil contains some property or properties which influence the character of the herbage, and that the herbage gives to the milk produced from it, and to the cheese that is made from the milk, certain features that can only in part be imitated in other districts and countries.

It is beyond the need of argument that a fine old Cheshire is a magnificent lump of excellent food. Of late years, however, Cheshire cheese has lost some of its old and excellent reputation. Whether this is owing to the general use of crushed bones and other fertilisers on the dairy pastures of the county, whether the Cheshire dairymaids have lost their ancient cunning, or whether too much skimming of the milk for butter is done, we know not; but it is the universally-received opinion that the cheese of the county, long famous for its meatiness, quality, flavour, firmness, and size, is as a rule less excellent than it used to be.

In the olden times the shape and size of Cheshire cheese were features peculiar to it and to the Cheddar cheese of the period, but the other peculiar properties of the Cheshire were not shared by any other kind of cheese, and are not to this day. So far as shape and size are concerned, the depth is commonly greater than the diameter, and each cheese will weigh 40 to 80 or 100 lbs. The weight, however, depends in a great measure on the number of cows whose milk can be devoted to a single cheese; in small dairies the cheese, while still retaining the orthodox Cheshire shape, would necessarily be small in size.

It is seldom in the Cheshire system that the cheese is made oftener than once a day, and that once in the morning. The evening’s milk has, therefore, to be kept through the night, and mixed with the morning’s before the cheese-making commences. For a long period it has been customary to keep the milk over-night in pans or coolers of one kind or another, in which it would be in small quantities and shallow, and in the case of small dairies it has been not uncommon to keep it a day and a half, until there was enough to make a cheese. Longer than this, especially in hot weather, it is not advisable to keep it for cheese-making purposes. But whether it be kept one night only, or as much as two nights in some cases, a milk-room specially adapted and kept for the purpose is a great convenience. After standing the twelve or more hours, as the case may be, the cream is usually skimmed off for buttermaking, more of it being taken off as the cheese-making season approaches its close. Up to midsummer very little cream is taken off, but after that period the milk will bear more robbing. In modern times it has become common not to put the milk in small pans to cool, but to put it immediately after milking into a properly-constructed vat, which has an inner and an outer shell, with a space between them.

In Fig. 104 is seen the modern Cheshire milk-vat, which, after the manner of the factory milk-vats, has an inner and an outer shell, the one of stout tin and the other of wood or of sheet-iron, well bound together and water-tight. Its inside measurement is 7 feet by 2 feet 10 inches. The inlet and outlet for hot or cold water are seen in the angular funnel and in the tap, one above the other, at the end of the vat. In Fig. 105 is seen the inner shell detached from the outer one; the “whey-plug” seen at the right-hand end is soldered to the lowest part of the shell-bottom, so as to drain off all the whey, and passes through the outer shell, to which it is attached in a water-tight manner by the nut seen on the lower part of it. This plug is at the opposite end of the vat from the water-tap, and is not seen in the engraving of the vat complete.
In this vat the milk is cooled over-night, and coagulated the following morning. In the evening the space between the two shells is filled with cold water, which is changed a time or two, until the milk is cool enough. In cases where it can be done, a small stream of cold water is kept running through—in at one end and out at the other—until the milk is cool enough; in hot weather the stream is kept running all night, so that the milk is not only cooled at the onset, but kept cool all through the night; and there can be no doubt about the advantage of cooling milk in this manner in warm weather, in stirring it whilst it is cooling, so that its heat and odour may both escape the more freely, and in keeping it through the entire night, by means of the stream of water, at a temperature which will prevent its souring or tainting.

It is not advisable to cool the milk too much; under ordinary circumstances of weather 65° will be found quite low enough, and some do not cool it below 70°. A good deal depends, however, on the milk-room; if it is a cool, well-ventilated room there is less need of cooling the milk below 70° than if the room is a warm one and ill-adapted to the purpose, because in the former case the milk will go on cooling until it meets the temperature of the room, whereas in the latter case it will grow warmer until it meets the temperature of the room. In very hot weather it is well to cool it below 60°, or even to 55° if possible, before leaving it for the night, because it cannot remain at that temperature unless in case of cold water continually running under and around it through the night; but under ordinary circumstances of weather, and in a milk-room well adapted to the purpose, it will not, as a rule, be necessary to be at pains to cool it even so low as 65°.

When the evening’s milk is skimmed on the following morning, a portion of it, if it has been kept in pans, is heated up in a kettle of some sort; if it has been kept in the milk-vat it is all warmed by having hot water or steam in the space that was previously occupied by cold water. This heating up of the evening’s milk is usually done before the morning’s is added to it; but if the evening’s milk is found to be about 70° there is not much, if any, need to heat it, for the new milk added to it will generally bring the temperature up to the point which, according to the fancy of the dairymaid, is considered best for adding the rennet and for coagulation. This, however, has in the past been a haphazard sort of system, depending for uniformity on the mere judgment of the dairymaid, the test being her hand or finger. In modern times thermometers have come into general use, and accuracy is thus obtained; but this does not appear to be a matter of much consequence, because authorities differ so widely in their opinions as to the temperature at which it is best to set the milk for coagulation, so that uniformity obtained by using a simple scientific instrument appears to be a matter of indifference. One authority (White) places it at 70° to 75°, another (Aston) at 88° to 94°; but the use of a thermometer will enable each individual cheese-maker to secure on all days alike a uniform temperature, but what that temperature may be will still depend on the fancy of the maker. More or less annatto for colouring is added to the milk at the time the rennet is; the quantity used will depend on the season of the year or on the fancy of the maker. If in summer, less of it is used, because the flowers among the grass in the fields are supposed to give enough colour to the cheese. Flowers, no doubt, have an effect in colouring both cheese and butter, but the colour of both depends chiefly on the time which has elapsed since the cows calved, and the longer it is since they calved the paler grows the milk, so that as winter approaches it is found necessary to use more artificial colouring-matter, in order that the later-made cheese may not be paler than that of the summer.

Sufficient rennet is used to coagulate the milk in forty to sixty minutes. When sufficiently advanced, the coagulum is carefully broken down by the aid of a curd-breaker, which we illustrate in Fig. 106. This breaker is made of tin, the handle being of wood; the little squares seen in the woodcut are formed of strips of tin set edgewise, and intersecting each other so as to form meshes of about
an inch square. The operation of breaking is first performed very slowly and carefully, and in the course of a quarter of an hour or so the curd in the bottom of the vat is raised with a skimmer; gently broken up by hand, and intermixed with the rest, during which, where a double-shelled vat is used, hot water is poured into the space to raise the temperature of the curd more or less, and the process of breaking with the tin breaker is resumed and continued for some ten or fifteen minutes longer. The curd then settles to the bottom, and is gathered toward the upper end of the vat, while the whey is being removed by means of a syphon, a ladle, or a whey-plug, as seen in Fig. 105. The last-named is the latest method employed, and it is a feature in the new milk-vat, Fig. 104, which has been received with much favour in Cheshire dairies.

In Fig. 107 is seen an improved curd-breaker, whose base is shaped to fit the bottom of the milk-vat (see Fig. 105). It is also used to gather the curd toward the upper end of the vat.

It has hitherto been usual to have a special curd-drainer, a rather shallow apparatus, built of wood throughout, and standing on four legs—size, 5 feet by 2 feet 2 inches, and about 15 inches deep (see Fig. 108). The drainer has a false bottom—that is, loose—consisting of the racks which are seen standing inside. On the false bottom is spread a strong coarse cloth, and on the cloth the curd is placed. The cloth is large enough to completely wrap up all the curd, which then remains about an hour covered up and at rest, except that it is now and then turned over.

But the new milk-vat (Fig. 104) dispenses with the need of a special drainer. As the whey runs off at the lower the curd is gathered toward the upper end of the vat, and two racks (Fig. 109), together

4 feet long, and in width equal to the inside measurement of the vat, are placed in its lower end, which is at liberty, the curd being then at the other end. A cloth is spread on the racks, and the curd placed in the cloth, exactly as in the case of the special drainer, the only practical difference being the saving both of the cost of the drainer and of the room that it would take up in the dairy. The curd is not placed on the racks immediately after the whey is removed from it, but it rests awhile in the upper end of the vat, during which time it is becoming compact and firm, and the whey is draining away. It is then cut in lumps and placed on the racks to drain. In this place it remains two to three hours, and is cut again into blocks, and turned over several times in the period; it is also kept well covered up by the coarse draining-cloth, and in some cases a light
framework of wood is placed on the top of the vat, and over this an additional cloth, in order to keep the curd warm whilst it is draining. If the weather is cold, warm water or steam is turned on in the space between the inner and outer shells of the vat, and this effectually maintains the curd at the proper temperature. The tendency of the curd at this stage is always to settle down into a compact mass, particularly when a little acidity is developed in it.

In many of the Cheshire dairies (as, in fact, in those of other counties too) more or less whey-butter is made, and in the most modern ones the whey is set to cream in blue slate cisterns, commonly in the room in which the cheese is made, but not in that in which the milk is kept overnight. Mr. Cluett, of Tarpole, the maker of the improved milk-vat, recommends that these cisterns be let into the floor, so that when the whey is ready to be taken from the curd the milk-vat can be wheeled to the cisterns, one end of it projecting over them, and the whey empties itself into them through the plug-tap, saving all lading and carrying of the whey, and greatly reducing the labour and untidiness of the dairymaid’s occupation. The whey generally remains in the creaming-cisterns until a fresh lot is ready to take its place.

The process through which the curd next passes is that of grinding it in the curd-mill (Fig. 110). Before the grinding the curd is weighed, and immediately after the grinding the proper amount of salt is mixed with it—about $3\frac{1}{2}$ to $4\frac{1}{2}$ lbs. of salt per cwt. of curd, according to the fancy of the dairymaid. In some cases a portion of the salt is applied earlier than this—when the curd is placed on the racks to drain—and the balance at the time of grinding; in yet other cases a little salt is put in the milk at the time of setting it for coagulation, a little more perhaps before the grinding, and the remainder after grinding. In the most approved methods the curd, after being ground and put in the cheese-vat, is placed in an oven which has been erected for the purpose, and not under a press, as is the custom in other parts of the kingdom. Fig. 111 represents the vat of freshly-ground curd as it is placed in the oven; $a$ is the wooden cheese-vat, $b$ the cylinder of perforated tin, and $c c$ the skewers that are inserted to help out the whey. When the vat is removed from the oven, the curd will generally be found to have settled down a good deal, and a narrower cylinder of tin then replaces the wider one.

The oven in question is sometimes, in order to economise heat, placed in the inner wall dividing the kitchen from the dairy, so that the kitchen fire serves to heat the cheese-oven without any additional expenditure of fuel. The curd is put loosely in the vat, and without any pressure at all is placed on a shelf in the oven, where it usually remains until the following morning only. Sometimes there are two or three cheeses in the oven at once. The warmth of the oven helps the remainder of the whey to leave the curd, and skewers are inserted through the mass of the curd in a lateral direction through holes in the
side of the cheese-vat, in order to still further facilitate the escape of the whey. The warmth of the oven is regulated according to the weather, between 70° and 80° or so, and this in some instances, where the curd is lightly salted, induces a slight acidity in the curd; during the night the curd settles down in the vat into a tolerably compact mass. The curd sometimes remains in the oven longer than the following morning, in which event it is taken out, turned over, placed in a dry cloth in the vat, and replaced in the oven.

When the cheeses are finally taken from the oven they are placed in the lever-press, providing there is a vacancy for them; but as it sometimes happens that these large cheeses have to remain in press a week, or even longer, those coming out of the oven have to wait their turn to go into press, unless ample press-room is provided to meet all contingencies. The compound lever-press shown in Fig. 112 is an exceedingly valuable one for thick cheeses, two of which it will accommodate very easily; and as there are two bottoms in the press, each one independent of the other, the two cheeses are pressed quite even, whereas they would not be if they were placed one on the other without a rigid partition between them. This implement will press either one or two thick cheeses at will, or two, three, up to six thin cheeses, and as it can be raised or lowered by the handles, shown in the illustration, it is extremely simple and easy of adjustment. In some dairies a few cheese-stands (Fig. 113) are provided for the cheese in case any of them have to wait before going under press, and as the stands are on wheels they are very convenient for conveying the heavy cheeses from one part to another of the dairy.

During the time the cheeses are in press they are daily turned and dry-clothed, and when finally taken out of press are scalded with hot water; after the scalding they are greased all over to prevent cracking of the skin, and they are next swathed in stout bandages to preserve them in shape during the subsequent drying. Lastly, they are taken up-stairs to the cheese-room, or drying-room, where they are turned over at intervals until they are sold to go away. In some of the more advanced dairies there is a handy little lift, by whose help the cheeses are raised by a rope and pulley to the chamber above, thus doing away with the labour of carrying them up the stairs. The lift consists simply of a light framework of wood, which slides up and down between uprights, and the pulley is overhead, in the room above.

The drying-room, or cheese-room, as it is most generally called, is commonly the one immediately over the kitchen or general living-room of the farmer's household, in which case it obtains a good deal of the necessary warmth from below, and this means the saving of coal above. Many farmers have hot-water pipes laid round by the wall on the floor of the cheese-room, and when properly laid they are on the whole the best means of warming
Fig. 11.—GROUND-PLAN OF CHESHIRE DAIRY PREMISES.
the room. Others, again—and these are the most numerous—have only a stove in the cheese-room, and though this is a useful heat-producer it is objectionable, on the ground of unequal distribution of the heat produced.

In Fig. 114 is given the ground-plan of one of Lord Tollemache's recently erected and most approved farm-houses, dairy-offices, and piggeries attached. The milk-vat containing the evening's milk remains in the "milk-house" all night, and next morning is wheeled into the making and press room. The general arrangement will be easily traced in the plan—the whey-vats for creaming, the pipe conducting the whey to the tank, the chain-pump to raise it to the cisterns, the meal-house, the cooking-boiler, and the general arrangement for feeding the pigs, all of which are contrived with a view to economy and efficiency. The adjacent cattle-sheds and other farm-offices are withheld from the plan, as not being pertinent to our present object of showing dairy arrangements.

The time required to ripen Cheshire cheese varies with the method of making and with the season of the year, generally from two to four months. It does not necessarily follow that the bigger the cheese the longer it will be in ripening; this depends on the method of making. Yet it may be stated that, on the ordinary farm-house system of making, the larger cheese will be the longer in ripening; at the same time, however, it is true that when the curd is properly warmed and acidified, as described in the earlier part of the present chapter, the cheese made from it will ripen as quickly as a much smaller one that has been made without such manipulation. And in many cases, particularly where the curd is placed in an oven for a time, the ripening of the large Cheshire cheeses is promoted with a like result, though in a different manner, to that which is at once the ornament and the strength of the famous Cheddar method. It cannot be too strongly urged on the notice of cheese-makers that a proper degree of warmth is as essential to the ripening of cheese as to the ripening of fruit, and that the warmth should be judiciously applied from the time when the curd is precipitated from the milk until the cheese is ready for the market.

Some farmers have a light wooden trough, down which they slide the cheeses from the cheese-room, through the window, down into the waggon outside, when they are sent to market. This, too, like the "lift" we have spoken of, is a simple and useful device for saving labour. Apart from the consideration that these large cheeses are awkward things to carry, and are beyond the strength of most dairymaids, they cannot be carried about by hand without the risk of damaging them, especially when they are fresh from the press. It follows, therefore, that the labour-saving devices we have mentioned, including alike the self-turning cheese-shelves, the lifts, and the slides through the window, can be strongly recommended; they are, as a matter of course, the more valuable in the larger dairies and in the factories, but even in small dairies of twenty cows or so, they will be found very useful economisers of both time and trouble.
CHAPTER XVII.

DERBYSHIRE, GLOUCESTER, STILTON, AND OTHER BRITISH CHEESES.


Though it has long held in our own country a good position among the more popular of English cheeses, the several excellencies of Derby cheese are of a somewhat less pronounced type than those of Cheshire, Cheddar, or Stilton, and it has not, in the sense they have, obtained a world-wide reputation. It has long been a favourite cheese in several districts of the United Kingdom, but it has not secured an extended popularity in foreign countries. It is true that none of our kinds of cheese have ever been extensively exported, for we cannot spare them, and we import largely instead; but our Stiltons and Cheddars and Cheshires are well known in polite circles in many of the cities of Europe. The essential character of Derby cheese is that of a middle-class cheese; it is not in any sense a fancy cheese, as the Stilton and the Slipcote and many of the Continental cheeses are, but it is a good substantial food; it does not appeal to the suffrages of the “upper ten,” and its consumption has been mainly confined to the middle and the lower classes of the people, and to special districts within the limits of the British Islands. Yet a first-class Derby will not unfavourably compare with a first-class cheese of most other English makes.

The method on which Derby cheese is made is less complicated than that of most other kinds; the appliances in use are fewer and simpler, and the dairy premises are usually of a more primitive character. It is not common that the cheese is made oftener than once a day, though we have known cases where careful dairymaids have made it twice a day during the whole of the summer; these have considered, and with truth, that cheese is all the better if made from milk that is quite fresh and sweet, which it not always is when it is twelve or fourteen hours old in warm weather; and on this method the cheese has the further advantage of retaining all the cream of the milk. This, however, has been found to be, or has been supposed to be, a disadvantage on land that has been highly farmed; full-milk cheese has been found very liable to crack and heave, and be generally unmanageable, and dairymaids have been driven for relief to the sure expedient of skimming a portion of the milk.

It is well known that milk produced on highly-farmed land, and by the consumption of cake and corn, is richer in fats than milk that is produced from sound old pasture land that has not been improved by high-farming; and it is more than suspected that this increase in fats imports into the cheese some occult element or other that is very unmanageable at times; the additional butter obtained by these artificial aids does not appear to be balanced by a correspondingly increased percentage of the nitrogenous constituents of milk; and as the Derbyshire system of cheese-making is essentially a “sweet-curd” system, this disturbance of the normal balance of milk-constituents has the effect in many cases of hastening the decay of the cheese. It may be objected here that the Stilton system of cheese-making is essentially one that disturbs the normal balance of the milk-constituents, by putting an extra quantity of cream into the milk from which the cheese is made. To this we would reply that Stilton cheese can only be made with entire success from sound old pasture land, without arti-
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ficial aids, and that the Stilton system admits of the development of acidity in the curd, which is a great help in causing cheese to be more manageable. In no dairying district in the Islands has, we believe, the land been more improved than in Derbyshire, and in that county it is commonly believed to be at all events expedient to skim a portion of the milk, in order that the cheese may "stand" better, and that it may not bulge and crack, or become otherwise unmanageable.

The old-fashioned circular tin or brass "cheese-kettle" is generally used in Derbyshire farm-houses, and the cheese is usually made in the ordinary kitchen of the house; it is seldom that a room is provided specially for making the cheese in, and the equipment generally is less finished than we find in certain other districts; nevertheless, great improvements in these matters have been brought about in the past twenty or thirty years. Though we have seen in use within a recent period various dairy utensils of wood, and even a cheese-tub of the same material—hence the name—wood is now almost wholly discarded, and tin, or brass, or glazed earthenware, as the case may be, has taken its place. The vessel in which the milk is coagulated is generally of tin, though sometimes of brass, the milking-pails are no longer of wood, but of tin, unless in very conservative establishments, and the pans in which the milk is set to cream are of glazed earthenware or of tin. When the manufacture of malleable glass is a success, that will be the best material of which the last-mentioned vessels can be made.

Thirty years ago the cheese-making appliances in Derbyshire dairies were as a rule very primitive in character. Curd-breakers and curd-mills were unknown, except in a few of the more advanced dairies, and lever-presses were luxuries possessed by few. The curd was generally "broken" by the aid of a wooden bowl or a skimming-dish, and in the earlier stages afterwards the whey was expressed by balancing a large weight on the cheese-vat containing the curd, the vat itself resting on a ladder crossing the top of the cheese-kettle. In some cases we have seen the dairymaid kneel on the flat piece of board which was placed on the curd, carefully poised above the cheese-kettle, and the heavier the maid the faster flowed the whey! An advance on this was found in using a pole some 3 or 4 yards long; one end of the pole was thrust into a hole in the wall, on the other end weights would be suspended, the vat on the cheese-kettle being midway between the weights and the wall (Fig. 115). This was an improvement on balancing

![Fig. 115.—The Pole-press.](image)

a weight, or the dairymaid balancing herself, on the top of the cheese-kettle. Later on, two upright wooden screws were attached to the ladder, far enough apart to admit of the cheese-vat resting there, and between them a piece of wood which passed over the curd in the vat. This implement (Fig. 116) was called a "screw-press"; it was found

![Fig. 116.—The Screw-press.](image)
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did immediately while many other cheeses were placed under heavy stone-presses (Fig. 117), many of which are in use to this day, and here they would remain, being dry-clothed and salted at intervals, until ready to go to the cheese-room up-stairs. These lumbering stone-presses do their work in a satisfactory sort of way, but they are very heavy to raise when the cheeses need turning. This was the old order of things.

Later on the curd-breaker (Fig. 106, page 228) was introduced, and the curd-mill was invented. The curd-mill commonly used in Derbyshire dairies is the double-roller one seen in Fig. 118; the rollers are of wood, and the iron studs wind round them spirally in lines, and are so arranged that those of one roller do not clash with those of the other; while at each side they work through iron racks, which clear them of curd. These double-roller mills are supposed to crush the curd less than the single-roller ones, though they break it up fine enough. Before the introduction of curd-mills the curd was always broken by hand, or "crimmed," in local parlance, before it was vatted preparatory to being put under the stone-press; and this operation of hand-breaking, though it was laborious, did the least possible amount of harm to the curd in the way of crushing it and setting some of the elements at liberty. When curd has been ground in the mill, and is again put under pressure, the whey flowing from it is charged with particles of casein, and hitherto no system has been invented by which this loss to the cheese can be prevented where a curd-mill is used at all.

The greatest of all improvements in dairy utensils was the invention of the lever-press, and it immediately superseded all other kinds; many a farmer's wife, weary with the labour and nauseated with the untidiness of old-fashioned cheese-making, has rejoiced in the new acquisition of a lever-press, and dairymaids have regarded it as a godsend, relieving them as it did of a great portion of the previously inevitable labour of cheese-making. A light, handy press, of simple lever action, is commonly used in large dairies, instead of the wooden screw-press, for expressing the whey in the early stages after the curd has been broken down; and in small dairies, where only one or two cheeses
per diem are made, it is also used for all the subsequent pressing to which the cheeses are subjected. In large dairies, however, a larger lever-press, that is compound in action (Fig. 119), is used for the later stages of pressing. It is a very strong implement, exceedingly simple and easy to work, and thoroughly efficient in all respects. Having two fixed upright bars on either side, the cheeses are always pressed perfectly even, whether there be one or half a dozen of them, and the amount of pressure can be regulated with the greatest ease and to the greatest nicety. That any one should still use the old stone-presses seems odd, but habit is strong.

Over twenty years ago, Mr. George Travis, a practical dairy-farmer in Derbyshire, invented a cheese-making apparatus which was at once simple and efficient. It created a good deal of interest at the time, and is still used in many farm-houses. In Fig. 120 we give an illustration of this apparatus; and the following are the advantages claimed for it:—

1. A great saving of labour and time is effected.

The breaker is of the simplest construction, and is worked in such a manner that the curd is effectually broken without being bruised in the slightest degree; and it requires very little trouble to work and clean it. In the separation of the whey from the curd, a self-acting leverage is used, which requires no attention while the whey is running off. Three cheeses can with ease be made by one person; and the curd is ready for the vat in considerably less space of time than the old method of making occupied. Lading off the whey with bowls is obviated, and pressing and kneading the curd with the hands are not required. The whole of the utensils used can be cleansed in less than fifteen minutes.

2. A greater weight of curd is obtained from the same quantity of milk than can possibly be produced by the most experienced dairywoman with the old utensils. The cheese is also far superior, and more uniform in quality.

The evening's milk is sieved into the apparatus, unless it is preferred to set it up in pans for creaming, and the morning's milk added to it. The milk is coagulated, the curd broken, the bulk of the whey removed, and the curd made ready for press, by the aid of this apparatus, saving a great deal of sloppy, dirty work, relieving the dairymaid of much labour, and economising time.

An improvement on Mr. Travis's invention is seen in Fig. 121, Pugh's patent cheese-making apparatus. This apparatus consists of a circular pan, made of tin, copper, or other suitable material, having improved taps at the side for running off the whey at intervals, as required. This pan,

![Fig. 120.—Travis's Apparatus for Cheese-making.](image)

![Fig. 121.—Pugh's Cheese-making Apparatus.](image)
sure to a vertical rod, to which is attached the pressing-plate, or sinker. To enable the dairy-maid to get at the curd more readily, the pressure-plate, when raised, may be placed in a perpendicular, horizontal, or inclined position by means of a novel and self-acting movement; it is also made to revolve, in order that it may the more easily be cleaned. The framework of knives, seen in the illustration, revolves round the pan, and breaks down the curd in an efficient and satisfactory manner.

These apparati, however, have made their way only into the more advanced dairies in Derbyshire, Staffordshire, &c., and a great deal of Derbyshire cheese—that is, cheese made on what is known as the Derbyshire system—is still made in these counties on the old lines, of which the following is a description:

Where cheese is made only once a day—and this is the case in probably 99 per cent. of the dairies of the country—the evening’s milk is sieved, as a rule, into the ordinary cheese-kettle; in warm weather it is cooled as well as circumstances admit of, stirred about to facilitate the escape of the warmth and the odour peculiar to new milk, and is placed in the coolest part of the premises until morning. Not uncommonly it is left out of doors, if it is likely to be cooler there, and is covered up to keep intruders out of it. In other cases it is sieved into shallow tin or earthenware pans, where, being in smaller bulk, it is likelier to remain sweet through the night. In either case a portion of the cream that has risen during the night, and sometimes the whole of it, is skimmed off on the following morning, after which the morning’s milk is mixed with the evening’s, and the whole mass is raised or lowered, as the case may be, to 80° Fahr.—raised by heating up a portion of the evening’s milk that has been skimmed, lowered by standing a pail of cold water in the morning’s milk for a time. It is, however, seldom that the temperature requires lowering, even in hot weather, providing the evening’s milk has been properly cooled, and in cool weather it almost invariably requires warming up. If the evening’s milk is at about 65°, the morning’s, which is at about 95°, will bring it up to about the desired temperature with little or no trouble.

The rennet is added when the thermometer in the milk indicates 80°, and sufficient of it is used to coagulate the milk in about one hour. When the coagulum is firm enough, the curd-breaker is very gently used for about ten minutes, the curd being now and then turned gently about by hand, so that the breaker may act more efficiently throughout the whole of it. The breaking is a delicate operation; if it is hurriedly done, the whey will be white, with detached particles of curd; if it is done carefully, and not too early, the whey will be green, and there will be no loss of curd. When it is considered to be broken into pieces that are small enough—say half an inch square—it is allowed to settle for a time, during which the green whey comes out of it freely, the whey coming upwards, the curd settling downwards in the kettle. As soon as the great bulk of the whey has thus separated itself from the curd, it is ladled off, and the curd is wrapped up in a cloth, put into the cheese-vat, and placed under pressure of some sort to express the remainder of the whey, or as much of it as can be conveniently got out at that stage of the process.

Whilst the curd is going through this preliminary stage of pressing, it is cut across the middle several times with the knife seen in Fig. 122, the outsides are trimmed off and piled up on the top, and it is placed again in press. This process is repeated as often as may be deemed necessary to get out nearly all of the whey. The curd is then passed through the mill, vatted, and placed under heavier pressure than before, so as to be firmly moulded into the form the cheese is required to assume, and to get out the rest of the whey. This process of pressing generally lasts two or three days, during which the cheeses are turned over and dry-clothed two or three times a day.

The chief difference between the Derbyshire and most other systems lies in the period at which the salt is applied to the cheese. In the Cheshire and the Cheddar systems it is applied to the curd immediately after the latter is ground; in the Derbyshire system it is applied the following evening or morning, as the case may be, and to the outside only of the cheese.

And this is an important difference, involving a fundamental principle. We have seen that no heat is applied to the curd after coagulation on the
Derbyshire plan, that the whey is dipped off as early as possible, and that the curd is vatted whilst perfectly sweet. This is exactly what is meant by a "sweet-curd process;" and it is the converse of any process by which acidity is admitted, by any means whatever, at or before this stage. But mark the sequel: though the curd is vatted whilst it is perfectly sweet, a given amount of acid will develop in it, because no salt is applied to it, as a rule, for six to eighteen hours afterwards. By withholding the salt for some hours the young cheese will begin to sour a little, whereas if the salt had been mixed with the sweet curd no acidity would occur.

Much depends on the state of the milk from which the cheese is made, as to whether the acid shall develop quickly or slowly; and on the salting, as to whether it shall develop at all. If the milk is already turning a little acid, the curd will acidify at an early date, say in the course of the afternoon; if the milk is perfectly sweet, the acid will be some time longer forming in the curd. The proper time, then, at which to apply the salt to the outside of the cheese, as in the Derbyshire system, will depend on the skill with which the dairymaid detects any sourness of the milk; or, if the milk is perfectly sweet, on her judgment as to the time when sufficient acid shall have developed in the newly-formed cheese. But the skill and judgment here indicated are somewhat rare to be met with, though they are in truth not very difficult to acquire.

The Derbyshire system is, as we have said, essentially a sweet-curd system—that is, the whey is dipped sweet, the curd is vatted before any acid has formed, and no salt is applied for several hours afterwards, and then only on the outside; but this system has been improved on with advantage in at least one case that we are acquainted with. Some years ago we knew a thoughtful and intelligent dairy-farmer in Derbyshire, now gathered to his fathers, who effected a striking improvement in the condition and quality of his cheese by the very simple expedient of keeping over a portion of unsalted curd and mixing it with the following day's cheese. The kept curd, being exposed to the air, became sensibly acid during the night, and when it was intermixed with the fresh curd of the following day, it imparted to it just the right amount of acid to produce a perfect cheese. The farm in question had always previously produced cheese that was scarcely more than a good second-class article, but the first year that the plan was adopted of keeping over a portion of curd, the whole dairy was sold for 87s. per cwt., which was 15s. or 20s. more than it would have commanded under the old system.

There is now less cheese made in Derbyshire than there was ten years ago. The Midland Railway runs through the heart of the county, and a very large traffic in milk has been established to supply the needs of London, Manchester, and Sheffield; and as the climate and soil of the county are excellently adapted to the raising of stock, many farmers make butter instead of cheese, and rear a number of calves on the skim-milk. These matters have diminished the volume of Derbyshire cheese-making.

Not only the accommodation for making the cheese, but also that for storing it after it is made is, as a rule, rather deficient in Derbyshire farm-houses. In many cases the cheese-room is over the kitchen, and no heat is provided beyond that which the kitchen fire supplies—an intermittent heat at the best. In summer the heat would be too great and in winter too little—constantly varying, in fact. In the more advanced cases coke-burning stoves are used, similar to the one shown in Fig. 123. These stoves will burn twelve hours without attention, and at a very moderate expenditure of fuel, so that if they are made up at bedtime they will be alight when morning comes. In still other cases a system of hot-water pipes is laid down in the cheese-room, round by the walls and near to the floor. This, though more expensive than a stove, is a much more effectual way of securing an even temperature all over the room; and it is a kind of temperature that causes the cheese to ripen fast enough without drying too much, and without so much cracking of the crust as a stove produces.

![Cheese-room Stove](image-url)
Heat from a stove is not the best for curing cheese, inasmuch as it dries the air too much, and causes the too rapid evaporation of moisture from the cheese. This fault does not appertain to the hot-water pipes. The room over a farmer's kitchen is altogether too hot in summer, and the heat cannot be removed from it; but it forms an excellent cheese-room in all the cooler parts of the year. Stoves and hot-water pipes have the advantage of allowing the heat to be removed and replaced at will.

**Gloucester Cheese-making.**

Single and double Gloucesters have been famous for a long period, and they have given to the Vale of Berkeley a reputation that has penetrated into many lands; but Gloucester cheese is no longer celebrated as it once was. This in part is owing to the enormous importations of foreign cheese into this country, whereby many good old traditions relating to English cheese-making have been somewhat rudely dispersed, and in part it is owing to the great extension of the milk-trade with London and other cities. Double Gloucesters may indeed be almost regarded as a thing of the past, for they are now made only to a small extent; but single Gloucesters continue to be made in many farm-houses. The only difference between these two sorts of cheese—a difference not generally understood—consists in their difference in thickness and weight. They are each about 16 inches in diameter, the double Gloucester being between 4 and 5 inches thick and weighing about 24 lbs., while the single Gloucester is between 2 and 3 inches thick, and weighs about 15 lbs.; the distinction between them is one of size only and has no reference whatever to quality beyond the difference in this respect that is created by the longer time required to ripen the thicker cheese. The following are the average analyses of double and single Gloucester cheese, four samples of each:

**Double Gloucester.**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>35.70</td>
</tr>
<tr>
<td>Butter</td>
<td>28.45</td>
</tr>
<tr>
<td>Casein</td>
<td>28.68</td>
</tr>
<tr>
<td>Milk-sugar, lactic acid, &amp;c.</td>
<td>3.26</td>
</tr>
<tr>
<td>Mineral matters (ash)</td>
<td>4.51</td>
</tr>
</tbody>
</table>

**Single Gloucester.**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>32.27</td>
</tr>
<tr>
<td>Butter</td>
<td>30.40</td>
</tr>
<tr>
<td>Casein</td>
<td>27.97</td>
</tr>
<tr>
<td>Milk-sugar, lactic acid, &amp;c.</td>
<td>5.66</td>
</tr>
<tr>
<td>Mineral matters (ash)</td>
<td>4.10</td>
</tr>
</tbody>
</table>

If we take the smaller quantity of water and the larger of butter as tests of comparative quality, the single is decidedly a richer cheese than the double Gloucester; quality is, however, a matter which depends not on richness alone, but on condition and degree of ripeness. The richness of cheese is in some cases greatly developed in the ripening, while in others it seems to remain in abeyance. Single Gloucester cheese is generally ready to sell when it is two to three months old, while the double is more than twice as long in ripening. Whether the longer and slower ripening really accounts for somewhat inferior quality of the latter is a point not yet determined, but in any case it is a disadvantage to have cheese on hand for six months when it can just as well be brought into the market in half the time; and this simple commercial axiom has no doubt had more than anything else to do with diminishing the make of double Gloucester cheese. It is probable that the Gloucester system of cheese-making will gradually be displaced by improved methods which involve a less expenditure of time and labour, for the cheese of the county does not really possess any special features or qualities which will render it proof against the march of modern improvements.

The utensils generally used in the making of Gloucester cheese are few in number and simple in character, but in some instances Keevil’s cheese-making apparatus has been adopted. This implement is very similar in most respects to the one shown in Fig. 121, page 230, and we need not therefore describe it. In many cases the cheese-presses consist of large square boxes, which are raised and lowered by means of pulleys and ropes. They are tastefully made of dark-coloured wood, and, being varnished, are intended to be ornamental as well as useful. They are filled with stones, gravel, iron, &c., to a weight of several hundred pounds, and rest directly on the cheese. The remainder of the vessels and equipments do
not differ materially from those more or less in use all over the kingdom, and consequently do not call for any special remark.

Under the general system the cheese is made twice a day, from perfectly fresh milk each time. Yet in other cases "half-coward" cheese is made; and this means cheese made in part of skim-milk. It is made once a day only, from the morning's milk fresh and the evening's skimmed, the two kinds being mixed together. The milk in any case is warmed up to 80°—in some cases to 85°—at which point the colouring, if any, and the rennet are added to it, and the curd forms in about an hour. The coagulum is broken down by a wire breaker similar to that shown in Fig. 100, page 228, except where Keevil's apparatus is used, when the curd is broken by a revolving framework, which contains on the one side vertical and on the other horizontal wires. On the old system the curd, after breaking, is left to sink, and the whey is laddled off; with Keevil's apparatus the whey runs off through the taps. It is considered important to get out of the curd before passing it through the curd-mill all the whey that can be got out conveniently. To this end the curd is variously pressed, according to the facilities at hand; in the Keevil apparatus it is pressed by a plate of perforated and galvanised iron, and in the old system by hand, or by a piece of wood on which a weight is placed. When as much whey as possible has been got out, the curd is ground and put to press. The next and two or three following mornings the cheese is taken out of press, turned, and salted on the outside. This is the best way of salting such cheese; but in other cases the curd, after having been under pressure for some time, has salt scattered over it at the rate of about 2½ to 3 per cent., and is afterwards re-broken, re-filled into the vat, and a gradually-increasing pressure is brought to bear on it. During the pressing period, which lasts nearly a week, the cheeses are daily taken out of press and wrapped in dry cloths—a plan that is common to most of our old systems of cheese-making.

The Gloucester dairies are conspicuous for cleanliness—a most important feature, noticed and commended by various persons who have inspected the system. To this very cleanliness, rather than to the quality of the cheese, is no doubt owing much of the reputation which Gloucester cheese has obtained in the past, and it is a feature equally valuable and commendable wherever it is found in cheese-making districts. The careful dairymaid everywhere carries on, consciously or unconsciously, an unceasing crusade against dirt; and this is necessary, for nowhere more essentially than in a dairy is dirt "matter out of place." That the Gloucestershire dairymaids have a thorough appreciation of the benefits which come of carefully avoiding all taints and impurities is proved by the custom which is common in the county, of making the cheese twice a day, instead of once as the custom is almost everywhere else. By so doing they have perfectly fresh milk to deal with, providing the weather is clear and fresh, the cows not over-heated by rapid driving or by exposure to a burning sun, and the utensils are kept clean and sweet. The industry involved in making cheese twice a day is not compatible with dirtiness or untidiness anywhere; and in other districts, where twice-a-day cheese-making is the exception, we have always found it in conjunction with almost fastidious cleanliness.

The characteristics of Gloucester cheese of good quality are—sharp, well-defined edges, and no bulging anywhere; a clear yellow hue around the edges, and a well-developed blue mould rising through the paint on the sides; a smooth, close, firm, and waxy texture rather than a loose and open one; a mild, though rich flavour; and a somewhat tough and solid skin, destitute of cracks, that will, when the cheeses are ripe, bear a man's weight without giving way underneath the foot—this, indeed, is the standard test of firmness and solidity.

A remarkable custom of painting the cheese has existed in Gloucestershire for a long period—a custom more nearly akin to Dutch practices than is found elsewhere in England. About a month after they leave the press the cheeses are scraped and painted over with Indian red or Spanish brown, or a mixture of both with small beer, to give them a pale vermilion colour, on account of which they have long been supposed to be more acceptable in the London markets. This of course is a mere fancy, but it is established by the practice of many generations of cheese-makers. In cheese-making, whether it be applied to the outside or to the inside of the cheese, and especially in the latter case, we should be glad to see artificial colouring-matter dispensed with.
Leicestershire Cheese-making.

The finest qualities of what is known as Leicester cheese are generally admitted to be, with the single exception of genuine Stilton, the best cheese produced in these islands. Stilton, however, is a double-cream cheese, and as such is not a fair competitor; it also is made in Leicestershire, yet it is known to the world by the name of the district, and not by that of the county in which it is made, and in this respect it resembles the true Cheddar cheese. But "Leicester cheese" has long borne a foremost reputation, and the finest samples of it have usually commanded from 10s. to 20s. per cwt. more than the best cheese made in any other county in the kingdom. These finest samples, however, are not now so numerous as they were twenty years ago, and a really fine dairy is coming to be the exception, while second-class ones are the rule in the county. In this matter of deterioration of dairy products it appears that Leicestershire occupies no more favourable a position than most of our other dairying districts.

The falling off in quality of the cheese of the county is not considered to be due in more than a small measure to the want of skill and care on the part of the dairymaids. The farmers of the county whom we have consulted on this point are decidedly of opinion that draining, re-seeding, and otherwise improving the land have had the effect of reducing the quality while increasing the quantity of the cheese; and this opinion applies equally to land that has been drained and top-dressed simply, without re-seeding. Even where the old sward has remained intact, and no fresh seeds have been sown, it is believed that draining and manuring have so altered the character of the native grasses that they will no longer produce the magnificent cheese for which the county has so long been famous. And where the land has been ploughed generations ago, and probably been allowed to seed itself down to grass as it liked, subsequent draining and manuring have developed some property or other which tells against the quality of the cheese.

It may be taken as a sound proposition that the finest cheese and butter, both, are produced from old-turf land—that is, land that has not been ploughed for a long period, if ever; and of this the Leicestershire farmers seem to be more generally conscious than those of other counties. In reply to the question, "What kind of land do you consider most suitable for making finest Leicester cheese?" one large dairy-farmer writes to us: "Low-lying land, having a cold marly subsoil, and showing a growth of rushes in the furrows." And another says: "It is a known fact that cold grass land, showing a few rushes, generally produces the finest cheese, and this very land, after being drained and otherwise improved, fails to do so. No doubt more cheese can be produced, but it is of an inferior sort; and in these times, considering there is a difference in value of about £15 per ton between fine and medium cheese, it becomes a question whether the extra quantity makes up for the absence of quality." The chief significance of the "question" here involved lies in the fact that it becomes each year increasingly difficult for English farmers to compete with foreign countries, unless they can make fine qualities of cheese; in which ease they have to themselves a demand with which foreign cheese cannot directly interfere.

With regard to making Leicester cheese, one of the authorities quoted above, Mr. Pilgrim, of Hinckley, writes to us as follows: "There is no regular course to be laid down, as almost every dairymaid has her own method, scarcely two carrying out in detail exactly the same system; the milk from different farms, owing to some difference in the herbage, requires different treatment both as regards the heat of putting the milk together and also the curing, some dairies requiring more salting than others. My idea is that a true and successful make of cheese depends on putting the milk together at its proper temperature, extracting all the whey, and well curing without over-salting, yet with all these being properly carried out it does not follow that fine cheese is the result; this depends on the herbage from which the milk is produced."

The usual method of making Leicester cheese is as follows:—In spring and autumn the temperature of the milk when set for coagulation is 80° to 81°, but in summer not higher than 76° to 78°, and sufficient rennet is added to cause coagulation in about an hour and a quarter, more or less. The curd is then slowly and carefully broken down, so as not to bruise it and liberate the butter, and after the curd has had time to settle down to the bottom of the vat, a process that generally
takes about twenty minutes, the whey is either laddled off or run through a tap in the bottom of the cheese-pan—if it has a tap; in very cold weather the whey and curd are in some cases heated up to $80^\circ$ or $84^\circ$, after the curd is broken. The curd is then gathered into a cloth, is pressed and broken several times until the whey is removed, and before it is finally vatted for press about 2 to 4 ounces of salt are mixed with the curd of each 40-lb. cheese, in order to make sure that it is cured. The cheese is after a time turned and dry-clothed, and when it has been twenty-four hours in press is well salted on the outside, a process that is repeated each day for four or five days; the cheese is then well washed in warm whey or greasy water, and put on the shelf to dry. The ripening takes usually six or eight months, and a fine-quality, well-made Leicester cheese improves by keeping twelve months.

Leicester cheese is as a rule rather deeply coloured with annatto—a practice that ought to be abolished on account of its utter uselessness and stupidity. Annatto is a disagreeable and disgusting thing to put into milk; it is unpleasant both to the taste and smell, and adds absolutely nothing to the intrinsic worth of the cheese. It is to all intents and purposes an adulteration, and though it is used with the express intention to deceive, the deception, strange to say, is both known and tolerated by dealer and consumer alike. This seems strange, but it is true nevertheless; dairymaids would soon leave off artificially colouring their cheese if the consuming public would drop the infatuation of liking it so coloured. The practice, however, will not die out until the penalty due to adulterations is applied to it.

The quality of a fine Leicester cheese is always very superior; the flavour is rich, clean, full, and nutty; the texture is firm without being close or dry, flaky rather than waxy, and moist as opposed to wet; it is a very "meaty" cheese, and rich, and the flavour left on the palate after tasting it is very agreeable; in diameter it varies from 16 to 20 inches, and it is usually 4 to 5 inches thick. The excellence of the cheese does not rest on any uncommon richness in butter, for in this respect it is not superior to most other kinds of English cheese, but on some occult property communicated to it by the peculiar herbage of the county; there is a fulness of flavour about it, a meatiness, a warmth and wealth of quality, that reminds us of fruit that is produced from a rich soil and ripened in a genial climate. It has no borrowed qualities, no peculiarities attained by a special system of manufacture or of ripening; it is a plain and substantial article, thoroughly English in character, and as such, is superior to every other kind of cheese similarly produced.

**Stilton Cheese-making.**

In some respects the most famous of our different kinds of cheese; prized highly among the "upper ten" and by epicures everywhere; unique in shape, in flavour, and in quality; Stilton is yet one of the most modern of English cheeses. Barely one hundred years old, it has attained a celebrity, at once singular and extensive, that is not enjoyed by any other kind of cheese made in this country. It is regarded more as a delicacy and a relish than as an article of ordinary food, and it is found alike on the tables of the refined and wealthy and in the menu of the leading hotels and restaurants throughout the kingdom.

In Marshall's "Rural Economy," published in 1790, it is said:—"Mrs. Paulet, the first maker of Stilton cheese, being a relation or an acquaintance of the well-known Cooper Thornhill, who kept the 'Bell' Inn at Stilton, on the great north road from London to Edinburgh, furnished his house with cream cheese, which, being of a singularly fine quality, was coveted by his customers, and through the assistance of Mrs. P. they were gratified at the expense of half-a-crown a pound; but where the cheese was made was not for some time publicly known, hence it obtained, of course, the name of Stilton cheese. At length, however, the place of produce was discovered, and the art of making it learnt by other dairywomen of the neighbourhood. Dalby first took the lead, but it is now made in most villages about Melton Mowbray; and in Rutlandshire many tons are made every year, and the sale is no longer confined to Stilton."

In Pitt's "Agriculture of the County of Leicester," published in 1809, the author speaks as follows of Stilton cheese:—"This is, I believe, the richest and highest-priced thick cheese of British manufacture; it is made in most of the villages about Melton Mowbray, and sold at the principal inns in the county, to accommodate their customers. The price, like other cheese, is subject to fluctuation, but seldom, I believe, so low as 1s.
per lb., or more than 1s. 6d. The first cheese of this kind is said to have been made by Mrs. Paullet, of Wymondham. The following is given as the best receipt for making it at that period:—

"Take the milk of seven cows and the cream of the same number; heat a gallon of water scalding hot, and pour it upon three or four handfuls of marigold flowers that have been bruised a little; then strain it into a tub to your milk, and put some rennet to it, but not too much, to make it hard; put the curd into a sieve to drain—it must not be broken at all; but as the whey runs from it tie it up in a cloth, and let it stand half an hour or more; then pour cold water upon it, enough to cover it, and let it stand half an hour more; then put half of it into a vat 6 inches deep, and break the top of it a little to make it join with the other; then put the other half to it, and lay a half-hundredweight upon it, and let it stand half an hour; then turn it and put it into the press, and turn it into clean cloths every hour the day it is made; the next morning salt it, and let it lie in salt a night and a day; keep it swath'd tight till it begins to dry and coat, and keep it covered with a dry cloth a great while. The best time to make it is in August."

Mr. Jubal Webb, of Kensington, kindly supplies the following particulars relating to modern Stilton cheese-making, as stated by a practical maker:—

1. To make a fine rich Stilton, suitable land must be found on which to graze the cows; and to be suitable it must be rich, old pasture, such as will keep them strong, full of milk, and healthy, without extraneous help in the form of cake, corn, grains, or roots, all of which tend to spoil either the flavour or the quality of the cheese.

2. There are only the months of May, June, July, August, and September in which really fine Stiltons can be made, and in wet seasons the making should not commence before the middle of May.

3. Suitable vessels must be procured to "put the milk together" in, to drain the curd, to "make the cheese up in," &c.—cans, cheese-pan, curd-drainer, strainers, hoops, stand-drainers, shelves, &c.

4. The cows must be milked at regular intervals, that is, at 5 a.m. and 5 p.m. regularly; this is important, as it is considered necessary to the production of a dairy of cheese even in size.

5. The night's milk being brought home is put into a "lead" to stand all night; when the morning's milk comes in it is put into the cheese-pan, and into it is put the cream of the night's milk, and both are stirred up together; when the mass has got to its proper temperature, 85°, rennet made from calves' stomachs is poured into it, the quantity of the latter being governed by the quantity of the milk in the pan; if the quantity and strength of the rennet are right, the curd will "come," ready for the second process, in one hour.

6. The curd is then broken up very little, and left to stand, say, for ten minutes; it is next put into "leads," covered with cloth strainers, to allow the whey to drain away gradually, and as it drains, the ends of the strainer cloth are gradually brought together and tied closer and closer, until the curd becomes tolerably firm and dry; it is next placed in a large tin strainer, and is cut into square pieces. In this form it remains until, in the opinion of the maker, it is ready to put into the hoops.

7. Before being put in the hoops it is broken into small pieces; then it is put in, first a layer of curd and then a sprinkling of salt, until the hoop is full, care being taken that the salt does not get to the ends or sides of the cheese, and it is lightly pressed down in the hoop. Too much or too little salt are equally injurious to the cheese, and a knowledge of the right quantity to use can only be acquired by experience.

8. When in the hoop it is placed on the shelves of what is called the "drainer," on clean dry cloths, and is turned "other end down" two or three times a day. This process goes on until the curd is sufficiently compact to turn out of the hoop, which is generally at the time when the cheese shows signs of being smooth on the surface. The time occupied in this process depends entirely on the temperature, and varies from four to eighteen days, and perhaps longer.

9. After being taken from the hoops the cheeses are bound up in linen cloths that are broader than the height of the cheese, and long enough to go round it in each case; the cloths are attached with "cheese-pins," and as they get wet are repeatedly changed for dry ones—sometimes as often as thrice a day, until the coat of the cheese begins to form. This process requires much labour and attention in many cases,
for on it depends the form and shape of the cheese.

10. When the cheeses are ready the binders are finally taken off; the cheeses are then placed on shelves in the cheese-room, and are for a time turned over twice a day; later on, once a day will suffice. The room should be kept at an even temperature. When the cheeses show signs of "miting" they should be daily brushed and changed from shelf to shelf; the brushing opens the pores of the cheese and admits the dry air, thus promoting the development of the fungus called blue mould which is so highly prized in Stilton cheese.

The skim-milk, whose cream goes to enrich other milk from which Stiltons are made, is generally fed to calves or pigs, but is sometimes made into cheese, the quality of which is inferior. The rearing of calves, in connection with Stilton cheese-making, is perhaps the most profitable use to which the skim-milk can be put, and applied to this purpose it is extremely useful throughout the year.

There is no one method of making Stilton cheese that can claim to be better than all the others, though each successful maker generally considers her or his own to be more nearly the orthodox way; and in such cases, where people are convinced that they are in possession of some valuable secret in connection with their art, it is difficult to arrive at exact data, and general statements are all we have to depend on. For instance, Mr. Webb's practical friend says, "An experienced maker knows to half a grain how much salt to use; my wife knows to less than that, and nobody on earth knows the right quantity but herself." While we admit that the loss to the Stilton interest will be irreparable if our friend's wife dies without revealing the secret, we are brought face to face in this incident with the extreme difficulty that exists of procuring any statement of figures; as, for instance, to the quantity of salt to be used to a given quantity of curd. Stilton cheese is a fancy article, and all sorts of fancies appear to be connected with the making of it.

Mr. J. C. Morton tells us that the rennet used by Stilton makers is prepared in the usual way, only instead of calves' stomachs those of lambs are used; and in addition to the ordinary quantity of salt, a lemon, stuck full of cloves, is put into the jar amongst it, the lemon adding to the efficiency of the rennet. (This may be true so far as coagulation is concerned, and in promoting the expression of the whey, but it is a hindrance—not a help—to the rennet in the ripening of the cheese.) The utensils used in the process of making Stilton are similar to those used in making most other kinds of English cheese, with two exceptions: first, no curl-mill is used, as the curd is never ground; second, the hoop or cheese-vat, instead of being made of wood and having a fixed bottom, is usually a cylinder about 10 inches high by 8 inches in diameter (Fig. 124), made of stout tin-plate, and having neither top nor bottom—except loose ones to help in turning the cheese over. During the first day the cheese is turned over every two or three hours, by placing one hand on the loose top and the other on the loose bottom of the vat; these flat pieces of wood or metal, as the case may be—do not fit down inside the hoop, and the cheese requires no pressure beyond its own weight. Mr. Morton also tells us that when they are taken out of the hoops a thin piece of calico is dipped in boiling water, wrung out, and then pinned tightly round each of the cheeses, where it remains until it is thoroughly dry. Some persons insert into a new cheese, with a cheese-tryer, plugs of old cheese to hasten the ripening and the formation of mould, but in a well-made Stilton this is unnecessary for either purpose.

The demand for Stilton cheese three-quarters of a century ago was so great that it sold readily at 1s. 2d. per lb., and it was made in many places in the Melton Mowbray district. It is at the present day very difficult to get hold of a genuine Stilton; in the Leicester district alone it seems to be possible to make the orthodox article. The demand for this kind of cheese has gone on increasing, and has spread to other lands, so that so-called Stiltons are now being made in nearly every cheese-making district in the country. The consequence is that there is
a great deal of cheese sold that is Stilton in name and appearance only, and produced far enough away from the grand old pastures of Leicestershire. These putative Stiltons have the bittleness but not the softness, the mouldiness but not the rich and buttery ripeness of the real ones; they are hard and unyielding, not mellow and plastic, and they do not ripen so generously as the true Stilton. Nor is this by any means always owing to faults in making, but chiefly to the absence of those peculiar properties that are not found elsewhere than in the Stilton district.

The blue mould in imitation Stiltons is in some instances produced by inserting copper skewers through the openings in the hoop; the ostensible use of these particular skewers is to promote the outflow of the whey, but it is really to produce this mould. Iron skewers would liberate the whey just as well as the copper ones, but they would not produce the desired mould. The use of these copper or brass skewers is to be condemned as positively dangerous.

The making of imitation Stiltons in other districts and countries has kept down the price of all kinds but the very best, and these are generally secured for those customers to whom price is a consideration of secondary importance. A true Stilton, well made and thoroughly ripe, is not always mouldy inside when it is cut, but it is always so mellow that it will spread on the bread and melt on the tongue as if it were so much butter. The cheese most nearly resembling it, according to our taste, is a really good Neufchâtel, but there is no cheese made in any other place or country that can be compared, without suffering in the comparison, to a fine old Stilton.

**Southern Counties' Dairying.**

One of the most interesting facts connected with English dairy-farming is that in almost every county is found a different system of management, and in some counties there are several systems in vogue. Cheshire and Derbyshire are, perhaps, the only counties having a system peculiar to themselves in which there is any approach to uniformity of method throughout the county. Even the famous Cheddar system of cheese-making does not prevail throughout the whole of Somersetshire, though it is the most general system practised, and it has established itself more or less in most other counties in the kingdom where cheese-making can be regarded in any sense a special feature. Somerset, however, has a world-wide reputation on account of its Cheddar cheese-making; Dorset is famous for its butter; single and double Gloucesters have made their native county known far and wide; and Devon is everywhere celebrated for its cream; but with these exceptions none of the southern or western counties are specially famous for any particular branch of dairying.

**Dorset.**

Dorset is chiefly known on account of its butter; there is, however, a considerable quantity of cheese made in the county, some of which is very good. In some parts of the county the Cheddar practice is wholly or partially adopted; in others the milk is skimmed time after time until nearly every particle of cream is got out of it, and very poor cheese is made from what is left in the milk—this is the "all skim" cheese. But there are the "blue veiny" and "double Dorset" cheeses, and these are usually of good, sometimes of excellent quality. A really good blue veiny Dorset resembles a ripe Stilton in appearance, and by some it is preferred to Stilton. The system of making the cheese has not changed in any material sense, so far as the principle is concerned, but the methods employed are in many cases carried out with more care, system, and regularity than they formerly were. The cheese is made once a day, generally speaking; but where butter is the leading product, and the milk stands a longer or shorter time to cream, the cheese is a matter of minor importance, and is not always made daily. There are no special features in the process to call for remark, and Dorset cheese-making has not been formulated into a system and promulgated as a guide for other counties.

**Wiltshire.**

The principal dairying district in Wiltshire is on the western side of the county, bordering on Somerset and Gloucester, and running along from Warminster, by Trowbridge and Chippenham, to Swindon, over a fairly level tract of country, some ten or twelve miles in width and forty
DAIRY FARMING.

or fifty in length. From this district a large quantity of milk is sent daily to London, and at Swindon the Aylesbury Dairy Company has a receiving-house for milk and a creamery, in which a considerable quantity of milk is set to cream; the cream is sent to London, and the skimmed milk is made into cheese, a market for which is found in the adjacent South Wales district. Where cheese is made in farm-houses in Wilts, it is usual to make it once a day only, and that once in the morning. The evening's milk, after being denuded of a portion of its cream for butter-making, is mixed with the morning's, and the two together are, if necessary, raised to 80°, at which temperature the rennet is added in sufficient quantity to coagulate the milk in about an hour. The curd-breaker, similar to the one shown in Fig. 106, is then used very gently. When the breaking is done the curd and whey are heated up together to 90° or so, according to the weather, and kept in stirring by the breaker. The curd then remains at rest until it is firm enough to handle, when it is taken out of the whey and put to press; it remains in press for some twenty minutes, during which the remaining whey is escaping from it; and it is then taken out of press, passed through the curd-mill (Fig. 125), and salted at the rate of about 2 lbs. of salt per 112 lbs. of curd. The press-vats are commonly turned out of a solid block of wood, the bottom pierced with holes for the escape of the whey. The following day the cheese is taken out of press, salted on the outside, swathed in a dry cloth, and put back to press; this process is repeated a time or two on succeeding days, after which the cheese remains in press for about a week, but receives no more salt, and is then removed to the cheese-room, where it ripens. The cheese-turner shown in Fig. 126 is made and used in Wilts. The frame is constructed partly of iron, braced with wrought-iron bars; at each end is a centre, or gudgeon, on which it revolves, and it rests on two cast-iron standards. The shelves are of 1½-inch board, and may be fixed or movable, the latter to accommodate different-sized cheeses, from flat Wilts to "truckles" and Cheddars, as seen in the illustration. The largest-sized turners, 9 feet in height, will accommodate upwards of a ton of cheese, all of which can be turned at one operation and in less than a minute. The makers of these turners are Carson and Toone, of Warminster.

The Wilts "truckles" are cheeses that have obtained a certain reputation. They are usually about 9 inches deep and the same in diameter, and are not uncommonly called "loaves." August is considered a favourable month for making them, but in some dairies they are made all the year round. They are very apt to bulge out at the sides if they are not skilfully made; and as very few people know how to make really good ones, they are mostly made in the autumn months, as there is less probability of their losing shape at that period of the year. It is considered necessary in making these cheeses that the curd should be quite sweet, and this is the chief cause of the liability to go out of shape in ripening, because the sweeter the curd, the more the fermentation in the cheese as it ripens. Before vatting the curd it is made as dry as possible, that is, all the whey is got out of it, it is thoroughly crumbled, is firmly pressed into the vat by the hands, and usually remains in press four or five days, being turned

Fig. 123.—REVOLVING CHEESE-RACK.

Fig. 125.—CURD-MILL ON TUB.
every day and repeatedly salted on the outside. The cheeses are then taken to the cheese-room, bandaged for a time to maintain the shape, and are ready for the table in about twelve months.

In a few of the more modern and better equipped dairies the evening's milk is poured, from the outside, into a vat, which consists of an inner shell of tin and an outer one of copper, varying in size according to the requirements of the dairy, and fitted over a fireplace like an ordinary boiler; there is a space between the inner and outer shells of the vat, and this is filled with cold water during the night; if the weather is very hot a tap at the top and another at the bottom of the outer shell let in and let out a stream of cold water, which, if expedient, can be kept running through the space all night, thus keeping the milk in good condition. In the cold weather of winter, when there is a probability of the temperature of the milk being too far reduced, it is not unusual to light a fire in the furnace and heat up the water in the space between the shells, by which means the milk does not become too cold during the night; the double-shelled vat is used simply to regulate the temperature of the evening's milk, and not to make the cheese in, for when the morning's milk is in the cheese-tub the evening's milk is partly skimmed, and then, having been heated up to about 80°, is put to the morning's in the tub; the subsequent process agrees with that described above.

The device of the self-heating vat—or self-cooling, as the case may be—strikes us as being a very good one, but as the whey and curd together have to be heated up after coagulation, we cannot see the necessity or usefulness of the wooden cheese-tub; the vat, it appears to us, would do very well indeed to make the cheese in, saving at the same time a great deal of trouble. It would be a simple matter to run the morning's milk into the vat already containing the evening's, the latter having in the meantime been skimmed and heated up to the required temperature.

In some of the southern counties it is a common practice for the farmers to let the cows for the season to a dairymen, who pays a stated sum per cow, and makes the best he can of the bargain. The dairymen and his family usually milk the cows, and the season terminates at a given period. In other cases the farmer hires a dairymen to do all the work connected with the dairy, paying a given sum per cow per week or for the season, and retaining to himself the control of the products of the dairy, the manager being responsible only for the proper management of the cheese and butter making.

**Slipcote Cheese.**

A very curious little cheese is made at Wissenden, in Rutlandshire; it is round or square, about 4 to 6 inches in diameter, and 1 to 2 inches thick. The method of making it is as follows:—The milk is coagulated by means of rennet, and is then put into a strainer until it is comparatively dry; then enough of the curd to form one cheese is taken and placed in the hollow of a small dessert-plate, where it drains still more; when firm enough the little cheese is taken from the dessert-plate and placed between cabbage-leaves, which are changed daily until the cheese is ready to eat. The time of maturing varies with the weather—generally from three days to a week are required; the ripeness of the cheese, or its readiness to be eaten, is indicated by its beginning to run as it were into a thick liquid, and when its coat or skin becomes loose and shows signs of slipping off; hence the name, Slipcote cheese.

More than any other kind of English cheese, the Slipcote is of a Continental character, though it is at the same time an original and not a copy. A few of the Continental cheeses have been on a small scale imitated in this country; it is obvious, however, that they will not be extensively produced until the taste of the people has been so educated as to create an equivalent demand for them. Such education is, however, no doubt going on. The Gorgonzola, a famous Italian cheese, in some respects resembling the Stilton, has been very successfully imitated in Leicestershire, and there can be no doubt that, with the exception of the Roquefort, all the more worthy and popular of the Continental kinds of cheese can be successfully produced in England. Whether or not it will be profitable to produce them is a problem whose solution we leave to time. Some of our well-known authorities are advocating the production of soft cheeses in the place of a portion of the hard ones peculiar to this country, and it is to be hoped that an opening for some of the better kinds will be provided. Made for early con-
Dairying in the North.

None of the counties north of Derbyshire and Cheshire have obtained a special or distinctive reputation in either cheese or butter making. Much good cheese and butter are made in the northern half of the kingdom, but it contains no district or county that is famous on account of its cheese in the sense that Cheshire, Leicestershire, and Somersetshire are, nor is there one whose reputation for butter is equal to that of Dorset.

In the Vale of the Tees, in Yorkshire, Cotherstone cheese is made, and it is highly esteemed in its native county, beyond which its reputation has not far extended; that reputation is, in fact, to a great extent a borrowed one, for the cheese is an imitation of Stilton, and though it possesses various merits of its own, it resembles Stilton more in appearance than in anything else. Similar attempts to imitate Stilton cheese have been made in various parts of the country, but they have all met with but indifferent success. Minor differences in milk, which at present are not well understood, cause considerable variations in cheese, even though the same process of making the latter is employed; it is not that the milk is poorer, or that less skill is used in making the cheese, but some property is absent which prevents fidelity of imitation.

The dairying of Wensleydale, a district in the North Riding of Yorkshire, is thus described by Mr. W. Livesey:—"The cows, when in the old pasture land, are milked in the fields, standing most quietly during the operation. Thus the animals have never to be driven to and from shippens, as in Lancashire. The milk is carried to the farm-house in a way I have never seen elsewhere. Here they have large tin cans, or 'kits,' called 'budgets,' of various sizes, generally holding from 4 to 6 gallons; they are much the same shape as some cans used in carrying milk by rail, except that one side is made concave in place of convex, so as to fit the back of the carrier of the milk, who has it fixed by strong leather straps, exactly after the plan of a soldier's knapsack. The milk is thus carried various distances, just as the pastures or meadows are relatively situate to the farm-house. Some are distant above a mile. To a stranger it is a novel sight, morning and evening, to see the men flitting about with their 'budgets' on their backs, and more singular still to see a few females laden with them, for the thrifty, hard-working women shoulder their loads like men, and show what they can do in the dairy line.

"There are two modes of making cheese here, which are still distinguished by the 'new mode' and the 'old' one; though the 'new' has been now practised for about twenty years. This 'new' method is the simplest and shortest one I have ever seen. Whether it would answer in cheese of larger size I cannot tell; I doubt if it would. The small cheese here made after the 'new' mode (those I have seen) are of good quality. I ought to state that the largest cheese made here is less than 20 lbs. weight; the bulk I have noticed vary from 10 lbs. to 15 lbs. each; some are as small as 4 lbs. and 5 lbs., for cheeses are made here from a dairy of five, four, or three cows, and sometimes even from one. These small cheeses are not deep, like the little 'truckles' of Wiltshire, but flat-shaped, except where they copy the very deep Stiltons. Generally the dairy consists of seven to ten cows, but a few run up from sixteen to twenty cows. So wedded are the people to small-sized cheese that in the largest dairies they will make the milk into three cheeses per day, where in Lancashire it would be made into one. At a farm I called at, where seven cows were kept, two cheeses per day were made. They do not use a large cheese-tub, as in Lancashire, for curdling the milk; this is done in the 'cheese-kettle.' The 'kettle' is a large brass or copper pan, exactly like those used in Lancashire for heating the whey. In some few cases the kettle is of tin. The night's milk is passed through the sieve into the kettle, where it remains until morning, when it is placed upon the fire to heat. When got to the proper temperature it is removed and placed upon the floor, and the morning's milk is run through the sieve into the kettle, mixing with the heated night's milk. In the large dairies, where the kettle will not hold all the milk, a small tub is also used, and there two persons can be employed in making the cheese at the same time. It is strange what various provincial terms are used for the same article; for instance, what is generally known as a 'vell' is here called a 'keslop,' and in Lancashire a 'bag-
skin.' Again, while the rennet is known in the latter county as ' steep,' here it is called ' prezzur.' I once took an intelligent Scotch farmer to one of our choicest Lancashire dairies, and after he had thoroughly questioned the maker as to the various processes, he exclaimed, 'Oh, my, my! it's aw done b' the rule o' thumb.' In other words, all by guess-work. Here they say they 'mak um b'th' greap,' which, explained, means by the feel—testing the heat of the milk and the state of the curds by the hand. The 'prezzur' is made either every day or alternate days, by cutting a piece from off two or three 'keslops,' and letting it stand about twenty-four hours in cold water which has been previously boiled. It is made in a pint mug or cup, and its strength is, of course, guessed at.

'The new' mode of making is shortly as follows:—The night's milk being heated in the 'kettle,' and the morning's milk added to it, the pint of 'prezzur' is poured into it and well mixed. It then stands about from half an hour to three-quarters to coagulate. It is then very gently broken up by the hand into very small pieces. At some farms a breaker is used made of wire crossed as in a riddle, something like the Lancashire breaker; but the shape is circular, and they are of very small size. They have not an upright handle, but a part of the outer wire rim is drawn out and bent, so as to form a short handle. In the breaking by the hand the movement is, of course, upwards, but by the breaker it is downwards. The breaking, which occupies about an hour, being over, the whey is removed by ladling it off. Then the curds are placed in a circular tin about 11 inches across and about 4 inches deep, the sides and bottom of which are very full of perforated holes about the size of the bore of a large quill. The tin full of curds is then left to drain for about three hours, when it is reversed and left for more three hours; then its contents are transferred to the cheese-vat, put to press, and kept there for nearly twenty-four hours, after which it is floated in 'pickle' for three days, just the same as the system of ' brining' in Lancashire. I got the maker to test for several days the temperature at different stages, with the following results:—

<table>
<thead>
<tr>
<th>Temperature State</th>
<th>Temperature</th>
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<tbody>
<tr>
<td>Heat before curdling</td>
<td>95° to 98°</td>
</tr>
<tr>
<td>Heat after adding hot whey</td>
<td>94° to 97°</td>
</tr>
<tr>
<td>Heat when vatting</td>
<td>64° to 69°</td>
</tr>
</tbody>
</table>

The maker stated that in summer the temperature at curdling was kept lower than at this date (October 20), it being, in the warm weather, set to coagulate at the same heat as the milk stood when brought from the cow. The pickles or brines are made on the customary plan in Lancashire—boiling the salt in water, the liquid when cold being made the strength that an egg will float in it. A little dry salt is placed on the top of each cheese as it floats in the pickle, and this melting, gets mixed, and so keeps up the strength of the pickle to the original standard. All the cheeses are slightly coloured by the use of cake annatto. The climate here is low in temperature, with a very large rainfall, and, the cheese-rooms not being heated, the cheese is kept colder than in any other county in England or Scotland where I have travelled. Up to fog-time the cheeses are kept a week in the cool room, where they are pickled; and then removed up-stairs to ripen; after the period named they are, in some places, kept for a short time upon a shelf, which is suspended from the ceiling of the kitchen and about the middle of the apartment.

"Now for the 'old' mode, at which I assisted in making a cheese from the milk of five cows. The night's milk being heated in the 'kettle,' the morning's milk—which stood at 82° before it was poured out of the 'budget'—was added when the whole contents of the kettle were 102°. The maker 'b'th' greap' found it was too hot, and so added some cold water, remarking, 'You see the cheese will be no poorer, for this [the water] will all go into the whey.' This reduced the milk to 100°. A pint of 'prezzur,' together with the piece of 'keslop' which had been used in making it, were put into the milk, which was well-stirred to secure a thorough mixing. It was covered over with the wooden lid of the 'kettle,' and left to stand thirty-five minutes, the temperature of the place being 40°. When beginning to break up the curd with the hand, I found the contents of the 'kettle' had got down from 100° to 89°. The breaking-up occupied half an hour, when the maker, having previously put a pan of whey upon the fire to heat, poured it upon the broken-up curds, and brought up the heat again to 100°. She remarked that at this cold season of the year it was needful to keep up the heat of the curds higher than in summer, otherwise, in place of feeling 'sharp,' they got to be pasty, and stuck in the curd-mill (or
of the dairy-farming. In May, July, and August the weight required for 1 lb. of cheese ranged from 10 lbs. 4 ozs. to 10 lbs. 1 oz.; in September, 9 lbs. 8 ozs.; and in October, 8 lbs. 10 ozs. Another maker on the "old" mode, but who makes them the ordinary shape (not deep, as the Stilton shape), lets the curdling of milk occupy nearly, and sometimes quite an hour, and the time from breaking up to putting it to drain in vat alone another hour, and lets the draining and cutting up and re-draining of curds occupy four to five hours. Though the cheeses are only about 12 lbs. weight, she presses them for forty-eight hours, and keeps them in pickle three days. The temperature at which she operates now (October 20) is as follows:—Settling to coagulate, 98°; commencing to break up, 90°; placing to drain, 80°; final vatting after grinding, 60°. It will be noticed that no hot whey was used by this maker. Though the Wensleydale cheese are so small, and the ordinary shape rather thin, yet most makers keep them in the press for forty-eight hours. I find that a very great majority of the dairies are made on the "old" method and of the flat shape."

In the adjoining county of Lancaster, cheese-making is not a prominent branch of agriculture; the immense population of the county provides a constant demand for fresh milk and butter, so that although a large number of cows are kept in the county, the milk of but a small proportion of them is used in cheese-making. There are, however, at least two kinds of cheese made in the county, "brined" and "hand-salted," which have obtained a certain local reputation; the former is made chiefly on the north of the Ribble, and the latter on the south of it. In both cases the cheese is made after a simple and primitive fashion, by "rule of thumb" in fact. The curd, as well as the milk from which it is made, is kept throughout the process comparatively cool; the time of coagulation is from one to two hours, and a thermometer is seldom used in the process. The method of making the two kinds of cheese varies chiefly in the way in which salt is applied to them. In the case of brined cheese, the method of salting, as the name implies, is by means of brine—a saline liquid in which the cheese floats during several days, in weaker brine at first and then in stronger, until enough salt is absorbed by the cheese. In the case of hand-salted cheese, the salt in a dry form is used. In some dairies a little salt is used in the curd, when the latter is ground, and the rest on the outside of the cheese; in others the whole of the salt is applied to the outside of the newly-formed cheese. The latter plan we think is the better where the cheese is cold-made, because it gives a chance of a slow degree of fermentation arising in the cheese, which salting in the curd would prevent; the brining system, too, admits of a little fermentation, and this is always useful in enabling the cheese to be firm and shapely.

Scotland.

The broad lines on which Scotch dairy-farming is conducted differ in few, if any, respects from the systems in vogue in various parts of England and Wales, and we shall therefore have no need to enter at length into a description of them; it will suffice to mention a few of the more salient points, without coming to elaborate details.
As a prominent speciality, dairy-farming does not appear to have been as long practised in Scotland as in England, yet for more than a hundred years it has been a distinct rent-paying branch of husbandry in the county of Ayr, and in that period it has become prevalent in Dumfries, Lanark, Kirkcudbright, Argyll, Renfrew, and Dumbarton; it is general, in fact, over the whole south-west of Scotland, from the Solway to the Clyde, and along the northern side of the latter river. The well-known Ayrshire breed of cows is almost universally employed in the dairy-farming of the districts named, a breed essentially composite in origin, but possessing many excellent qualities.

The well-known Dunlop cheese is still made in some parts of the country, though to a very small extent; its quality, owing less to the want of richness in the milk than to the inferior system on which it is made, is considered to be beneath that of most kinds of English cheese, as it is also beneath that of other Scotch cheese that is made on an improved system; it is gradually fading away from the land, and will in a short time, in all probability, have disappeared.

Cheese is now generally made on the Cheddar system that was introduced into Scotland many years ago by Mr. Joseph Hardinge, of Marksbury, who was employed by the Ayrshire Agricultural Association to practically expound the system to our northern farmers. As in all districts and countries where it has had a fair trial, the Cheddar system has done well in Scotland, and Scotch Cheddars are now famous in many parts of the United Kingdom.

A practice of letting cows to professional cheese-makers, locally termed "bowers"—a system which is not uncommon in several of the southern counties of England—has long prevailed on many of the large farms in Scotland, but the system of payment differs from that of the English practice. The bower undertakes the whole management of the cows for a year, generally commencing at Martinmas. The farmer provides the cows, a given area of land for pasture, and a stipulated quantity of hay, straw, turnips, feeding-stuffs, of one kind or another, besides in some cases coal and salt. It is, in a sense, sub-letting the land for a year, and letting along with it the cows as live-stock, and also some of the dead-stock of the farm. As rent for these things, the bower agrees to pay back to the farmer a given quantity of cheese per cow, which varies from 340 lbs. to 400 lbs., according to the quality of the cows and the pasture, and to the quantity of corn agreed upon in the bargain; and his own profit is derived from what he can make from the cows over and above the cheese he has to give back to the owner. It is not a system that is calculated to improve the cheese-making of a country, because the farmer takes the risk of the cheese fetching a good or bad price according to its quality, to say nothing of the fluctuations of the market, so that it is quantity, not quality, that the bower aims to produce. Yet if the bower himself were saddled with the risk of losing money if the cheese were inferior, then this system of letting the cows would tend to the improvement of cheese-making, because the bower's profit, and the amount of it, would depend on his skill, his care, his industry, and his success. Another arrangement is for the bower to pay so much money per cow, irrespective of the cheese, so that he takes himself the whole risk; and providing he is a trustworthy and substantial person, the farmer's position in the bargain is comparatively free from risk and anxiety.
CHAPTER XVIII.

Cheese-Factories in England.


On the 1st of July, 1868, on the motion of Lord Vernon, the Council of the Royal Agricultural Society instructed the Secretary to take information as to the working of the cheese-factory system in the United States; but farther progress in the matter was for some time hindered by various causes, and Mr. Jenkins' valuable Report did not appear in the Society's Journal until the spring of 1870. Meanwhile the subject had not been allowed to drop in the counties, particularly in Derbyshire; it was discussed in the papers and at the meetings of Farmers' Clubs and Agricultural Societies, and in time became a constant quantity in the general conversation of dairy-farmers.

The project began to take definite form when, at the annual meeting of the Derbyshire Agricultural Society, held in the town of Derby on the 24th of December, 1869, Mr. Crompton, always a warm friend and a most able exponent of the new system, brought forward for consideration, and in an able speech described, the advantages of the American method of cheese-making. At this meeting a committee was appointed to investigate the matter, and to report on the desirability or otherwise of giving the system a fair trial in the county. Meetings were held and discussions promoted in various dairying localities in the neighbourhood of Derby, among the people who were directly interested in the scheme, and the collective opinion of dairy-farmers was obtained as accurately as possible.

On the 18th of February the members of the society assembled in the Derby Town Hall to receive the report of the committee, the chair being occupied by His Grace the Duke of Devonshire. The great interest which the proceedings had awakened was shown by a numerously-attended meeting, to which the committee reported that there were satisfactory reasons, should the system have a fair trial, for expecting the following advantages:—1st. Greater uniformity in the quality of the cheese. 2nd. Enhancement of value in dairies which, from poor plant and the absence of good accommodation, are now producing inferior cheese. 3rd. The removal of an arduous occupation, frequently deterring men of capital, owing to domestic considerations, from entering upon farms on which cheese-making is a prominent feature. 4th. Improvement in the value of land, from improvement in the value of produce. And 5th. The general introduction of uniformity of system, better plant, skill, and supervision.”

The committee recommended that the system should have a full and fair trial in the county, eventually to stand or fall on its merits. But it was so wholly new to the ideas of dairy-farmers, so revolutionary in appearance, so totally different from the old time-honoured practice of making the cheese at home, so very great a reform, that in order to induce farmers to give it a trial, it was deemed expedient to establish a guarantee fund to secure contributors of milk against any loss that might arise from failure of any kind. No one knew anything about cheese-factories except from hearsay or from reading; everything was assumed, everything taken for granted, but nothing
THE ORIGIN OF CHEESE FACTORIES IN ENGLAND.

Mr. Higginbotham with equal kindness offered to supply gratis for the same period, from his silk-mills adjoining, the steam required for the cheese-making operations; and as the idea of a cheese-factory had first taken definite shape in the town of Derby, it was at length decided that Mr. Roe's and Mr. Higginbotham's offers should be accepted, and that the factory should be within the precincts of the borough. Meanwhile a competent American cheese-maker had been secured through Messrs. Webb, Turner, and Co., of New York; and he having arrived in Derby on the 11th March, 1870, was superintending the manufacture of the necessary plant, according to patterns he had brought with him. Mr. Cornelius Schermerhorn was the cheese-maker whose services had been secured, and his salary was arranged to be £200 for the cheese-making season, with his fare paid to England, and also back to America should he decide to return home at the end of the first season.

Meanwhile, the original committee having satisfactorily fulfilled their mission and having presented their report, a new committee was appointed by the guarantors to superintend the erection of the necessary buildings, to order the required plant, to assist the American manager in the general arrangements, and to carry on the work of the season. The establishment of a substantial guarantee fund, and the commencement of active preparations, had in the meantime created considerable interest in the work throughout the district, and matters generally were beginning to wear a brighter and more encouraging aspect. Much of the more open opposition in the neighbourhood had been silenced, some enemies of the project had become friends, others had become neutral, others again remained as they were, and throughout the length and breadth of the dairying districts of the country the result was being looked forward to with feelings in which hope and anger, confident belief and persistent opposition, were curiously jumbled up together. The chief opposition, all the more dangerous because it was used privately, came from the cheese-factors. They saw, or fancied they saw, in the movement a principle of co-operation that would interfere with their mode of doing business, and they did all the harm they could to the new venture. But, as Mr. H. M. Jenkins wittily and tersely stated the case in 1871 before the Society of Arts, "It is far better for the farmer to have a
factory for his bank than a factor for his banker." And so the thing went on.

The Longford Factory.

It was at first proposed that only one factory should be started, at all events for the first year; but as the interest grew, and encouragement rolled in, it was considered only fair to the system itself, to say nothing of the desirability of proving conclusively its success or failure at as early a date as possible, that there should be two factories, one in the town and the other in the country. It was felt that a cheese-factory in a town seemed rather paradoxical, and that if it succeeded its friends would perhaps be more jubilant, while if it failed its enemies would be the same. The Siddals Road factory alone could not, in fact, in any sense be regarded either as a fair or a sufficient test of the system; and it was at length decided, though the cheese-making season was just about to commence, to establish a second factory in one of the villages of the district, where conditions could be secured such as cheese-factories would be expected to meet in the future. In the first place, it was obvious that, although there was milk enough to be had within a not unreasonable distance of the town, the immediate surroundings of the Derby factory were not of the most favourable character for cheese-making; and though it was contemplated that milk-selling could to some extent be worked in conjunction with cheese-making, and thus add somewhat to the success of the venture, yet this very advantage detracted from the fairness of the test, and so far reduced the applicability of the system to a purely dairying locality.

But here another difficulty arose. In order to give the system a fair trial in a rural place, it was felt to be necessary that an entirely new building should be erected, specially designed for the purpose, and replete with all the appurtenances and equipments on which the success of such an institution must needs in no small measure depend; but the committee could not in fairness to the guarantors think of erecting a bran-new building out of the guarantee fund; nor could they, on the other hand, reasonably call on a landowner to erect one at his own expense, for the purpose of trying an experiment whose object was to serve the public, unless they could assure him that in case failure was the result he should, at all events in part, be recompensed for his outlay. Such a building would, in case of failure, be comparatively useless for any other purpose, and in this event whoever built the building would have to suffer loss. An old building, it is true, of some sort might possibly have been found and converted into a factory, thus in part saving the cost of erecting a new one; but it was considered that the system could not be fairly tested under such conditions, and that as it was to receive a three years' trial, a new building only would meet the requirements of the case.

The Hon. E. K. W. Coke, of Longford, who from the first had been one of the warmest friends of the movement, and Mr. Newton, of Etwall, also a warm supporter, now came forward, and each of them not only offered to put up the new building at his own expense, but to place it at the disposal of the committee rent-free for the first year; and on their part the committee undertook to refund 40 per cent. of the outlay if, at the end of the three years, the system should be found to be unsuccessful; and the money for this purpose was proposed to be raised by, if necessary, a still further call on the guarantors. As, however, the offers of both gentlemen could not be accepted, a vote of the committee was taken. The majority was in favour of the Longford location, and the proposed conditions having been accepted by all parties concerned, the building of the Longford factory was immediately commenced. This was, of course, the first cheese-factory, as such, ever built in the British Islands; and as the season was advancing before it was finally decided on, it was built of wood, chiefly with a view of saving time. Considered apart from its liability to decay in a damp climate like that of England, there can be little doubt that wood is a very suitable material of which to build a cheese-factory. Stone of any kind is perhaps the worst material of all, because of its dampness and porousness, its facility for absorbing moisture on the outside and transmitting it to the inside of the building. Brick is much better than stone in this respect, and concrete better than either; but wood is a very dry and, if properly coated outside, a sufficiently damp-proof material, and it is on account of its dryness that it is especially suitable for buildings of this kind. Damp walls
of any kind, and new walls full of fresh mortar, are eminently unsuitable for cheese-rooms; hence, all things considered, wood was the best material of which, so late in the season, the Longford factory could be built. A bronze plate affixed to the front of the building bears the following inscription:—“The first cheese-factory built in England. Opened May 4th, 1870, under the management of Cornelius Schermhorn.”

It was deemed desirable that the country factory should not commence operations with fewer than 400 nor with more than 600 cows’ milk; above or below these numbers would, on the one hand, be so large as to be unwieldy, and on the other would be too small to warrant the large outlay which a new building entailed, while between the limits would secure most of the conditions which factories in the future would in all probability have to meet. Before deciding on the Longford site, the committee held meetings at Sudbury, Shardlow, Etwall, Longford, and Weston Underwood; at each of these places the proposed site and the available supply of water were both carefully inspected, and other local considerations calculated to influence the undertaking were duly taken note of; in addition to these matters the number of cows promised at each place was ascertained, and as Longford was found to stand at the head of the list, it was decided to erect the first experimental factory in that village.

The location is, all things considered, as favourable as could easily be found—close to a good public road, and in the midst of a noted dairying district. The only drawback was the water, and this is a difficulty which most factories have had to contend with, and still have. Close by the Longford factory runs a stream whose volume of water for the most part was considerable, and whose temperature would answer the purpose perfectly in all the cooler portions of the season; but in the summer the stream becomes sluggish as the volume of water diminishes, and the rays of the sun, playing long on the small stream, raise its temperature to a height at which it is quite unsuitable for cheese-making; and this at the very period of the season when a plentiful supply of cold water is a sine qua non. This objection against the stream-water was fatal, and water of a suitable temperature had to be brought upwards of a mile in pipes, from a cool pond in the park; this added alike to the delay and the expense.

The decision to have two factories instead of one, and those situated at a distance of ten miles from each other, made two things necessary: first, that a second cheese-maker should be sent for, because one man could not manage two factories so far apart; secondly, that the managing committee should be divided as to superintendence of matters of detail at each factory separately, still remaining one committee in all matters of a general character touching the interests of the movement. The second cheese-maker—Mr. Levi Schermernhorn, brother to the first one—was telegraphed for to America, and he arrived in time to liberate his brother, who then took charge of the Longford factory from its opening. The members of the Derby Committee were Mr. Crompton (chairman), and Messrs. Burnett, Murray, Nuttall, and Tomlinson; the Longford Committee were the Hon. E. K. W. Coke (chairman), and Messrs. Brough, Coleman, Lowndes, and Salt. The duties of each sub-committee were to pay the milk-suppliers each month, to examine and pay all bills, to dispose of the cheese, and to keep an eye on all matters connected with the factory.

These sub-committees were responsible to the central committee, whose members were guarantors each of £50 or upwards. These several committees, together with the factories under their control, were known as the Derbyshire Cheese Factory Association, and the rules of the Association were as follows:—

"That this Association be called 'The Derbyshire Cheese Factory Association."

"That it be managed and governed by a Central Committee, the members of which shall be those persons subscribing no less a sum than £50 to the Guarantee Fund, or their agents, and the representatives of the Managing Committees, of not more than three members from each. Seven members of such Central Committee to be a quorum."

"That the Central Committee shall appoint a Managing Committee for each factory, not to exceed six members, two of whom shall be selected from the suppliers of milk to such factory. These Committees to have the entire control of their respective factories, and of the officers of such factory; the manufacture of the cheese, and the disposal of the whey. A Sub-Committee of not more than three members, including the Chairman of such Managing Committee, or his Deputy, to be appointed the Finance Committee, and for the sale of cheese at such factory."

"That the Managing Committee of each factory shall have power to make such bye-laws as they may consider expedient, and carry them into effect. Such bye-laws to be submitted to the Central Committee."

That the Central Committee shall appoint a Secretary to the Association, who shall be required to audit the Manager’s books of each factory every month, prepare reports and accounts for such Committee, record the minutes of their meetings, and carry out their instructions; pay the suppliers of milk their due, and transact generally the business of the Association.

That all payments above £1 shall be made by cheques signed by the Chairman (or his Deputy) of the Managing Committee of the factory to which such payments belong, and the Secretary.

That the accounts of each factory be kept separate and distinct.

That persons supplying milk to either of the factories shall be required to send, twice each day, the pure milk from the whole of their dairy-cows (excepting such milk as shall be required by them for their family consumption) during the manufacturing season, the termination of which shall be determined by the Managing Committee of each factory.

That the terms for the current year on which the milk is to be obtained shall be a guaranteed payment of 6½d. per gallon, of 10 lbs. weight, payable the first Friday in every month, between the hours of ten and one o’clock, at the Secretary’s office in Derby, together with a share of the profits of the factory, according to the quantity of milk supplied (after payment of working expenses of such factory), which shall be paid as soon after the close of the manufacturing season as the Central Committee can arrange.

That the Manager of each factory shall have power to refuse milk that is of inferior quality, sour, dirty, or otherwise impure, without reference to the Central Committee; and any person detected in sending milk that has been skimmed or adulterated shall be reported to the Central Committee, and render himself liable to a forfeiture of his share of the profits that may be derived from the factory, and not be allowed to supply milk to it afterwards.

That every supplier of milk shall sign a declaration that he will submit to the rules of the Association, and the bye-laws made for the proper working of such factory with which he is connected. And in case of his failing to comply with such rules and bye-laws, he shall forfeit all claim to any profits that may be derived from such factory, and not be allowed to supply milk to it afterwards. But in case of his inability to supply the milk from the number of cows he had previously declared, under circumstances over which he has no control, or which the Central Committee shall deem to be satisfactory, he may be relieved from his agreement on such terms as the Central Committee shall decide to be just and proper.

That persons on the working staff of either factory shall not allow the admission of any person, other than a guarantor, or by the written consent of one of the Managing Committee, to such factory, excepting he be on business connected therewith.

The Derby factory was a building that had for some years been used as a cheese warehouse, and so far as the upper rooms are concerned was well adapted to its new purpose; the lower room only required adapting to the plant that was placed in it, hence there was comparatively little delay in getting all things ready for a start. The interval between the 11th of March and the 8th of April was found long enough to get all the items of the plant made, the building adapted, and everything in its place. On the latter date the first milk was received and the first cheese made in an English cheese-factory—in the year 1870. In the meantime public interest had become very keen, and great numbers of visitors saw the process during the first few weeks; and during the first season upwards of 5,000 persons, many of them coming from distant parts of the United Kingdom and some from foreign countries, entered their names in the visitors’ book, and it is supposed that a still larger number visited the factories but did not record their names. So great was the interest felt in the new movement.

Early Experience of the Factories.

During the first year the committees worked under great difficulties. Everything was new and strange, and many alterations were required to make matters work smoothly. Happily, that which at the onset would have proved the greatest difficulty of all—the finding of money to pay the milk-suppliers’ monthly dues—was removed by the guarantee fund. But the amount of opposition brought to bear against the movement was, for a long time, very great; and as much of this was of a secret character it was the more difficult to contend with. In the first year’s Report of the Joint Committees of Management the following words occur:—“Your committee cannot but regret that an experiment made entirely upon public grounds, and purely in the public interest, should have been viewed in its outset with so much uncalled-for and unworthy suspicion. This feeling, however, your committee is gratified to say is fast passing away.”

And again:—“An item acting prejudicially on the balance-sheet is the cost incurred in disposing of the cheese in a distant market, caused, in some measure, by the extraordinary and unexpected jealousy and dislike with which the movement was viewed by some factors of considerable influence in the trade.” These quoted words indicate clearly enough the outside difficulties with which the committees had to contend. On the opposite page are the balance-sheets of the two factories for the first season.

The question of the 4 ozs. deficient in each gallon of milk is thus explained:—“There is
FIRST SEASON'S BALANCE SHEETS.

LONGFORD CHEESE FACTORY.
Statement of Accounts, 1870.

<table>
<thead>
<tr>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Paid for Milk, 1,693,010 lbs.</td>
<td>4,584</td>
<td>4 9</td>
</tr>
<tr>
<td>† Labour, including Salary to Mr. Schernerhorn, £100; Warehouseman, to commencement of present season, and Butter-maker</td>
<td>206</td>
<td>0 0</td>
</tr>
<tr>
<td>† Annatto, Bandages, Salt, Ronnet, and other Materials</td>
<td>86</td>
<td>18 4</td>
</tr>
<tr>
<td>Commission on Sales, Insurance of Cheese, Carriage, &amp;c.</td>
<td>164</td>
<td>8 3</td>
</tr>
<tr>
<td>Balance at the Bank</td>
<td>8</td>
<td>6 0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£5,049</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

* This amount includes the sum over-paid for the 4 ozs. deficient in each gallon of Milk.
† The labour in manufacturing the Cheese cost £179 11s. 6d. per cwt., and the material £86 18s. 4d., or 1s. 5d. per cwt., together making 4s. 4d. per cwt.
‡ 77s. 5d. per cwt. of 120 lbs.

**Derby Cheese Factory.**
Statement of Accounts, 1870.

<table>
<thead>
<tr>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Paid for Milk, 1,369,660 lbs.</td>
<td>3,547</td>
<td>1 5</td>
</tr>
<tr>
<td>† Labour, including Salary to Mr. Schernerhorn, £100; Warehouseman, to commencement of present season, &amp;c.</td>
<td>197</td>
<td>15 1</td>
</tr>
<tr>
<td>† Annatto, Bandages, Salt, Ronnet, Water, and other Materials</td>
<td>87</td>
<td>14 2</td>
</tr>
<tr>
<td>Commission on Sales, Insurance of Cheese, Carriage, &amp;c.</td>
<td>23</td>
<td>5 1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£3,925</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>

* This amount includes the sum of £88 over-paid for the 4 ozs. deficient in each gallon of Milk.
† The labour in manufacturing the Cheese cost £177 11s. 6d., or 3s. 9½d. per cwt., and the material £87 14s. 4d., or 1s. 10½d. per cwt., together making 7s. 6½d. per cwt.
‡ 70s. 6½d. per cwt. of 120 lbs.

one circumstance which, as it will affect the pecuniary results of the year, your committee will at once bring to your notice. According to the rules of the Association, and following the example of the Americans, the gallon of milk was estimated at 10 lbs., and accordingly each milk-supplier has received the stipulated amount of 6½d. per 10 lbs.; but upon accurate measurement it was ascertained that an imperial gallon of new milk at 82°, being the average heat at which the milk is delivered, weighed 10 lbs. 4 oz.; consequently for every gallon received or paid for your committee have received 4 oz. short of the true gallon. This deficiency forms a serious item, amounting at Derby to £88, and at Longford to £111—amounts paid to the suppliers of milk for quantities never received, and which remain in their hands as over-payment or bonus, over and above the value of the milk they supplied. This they are aware of, and agree to rectify on the working of the present year.”

Before the price to be paid for the milk was settled, the committee, “after collecting the experience of intelligent holders of large dairies, spread over a wide field of inquiry, found the well-nigh unanimous opinion to be that on ordinary dairy-farms, and in ordinary cheese-making seasons, and taking the average yield of cheese for the entire season, namely, embracing the poor and the rich curd-yielding periods of the season, a pound of cheese could not be produced on the old system of farm-house dairying from a less quantity of milk
than 1 gallon 1\frac{1}{4} pints. Assuming this experience of the cheese-yielding powers of the milk to be correct, and also that your committee working in the same district could not work at a less percentage, it follows that at the cost price of the milk alone (viz., 6\frac{1}{4}d. per gallon) a cwt. of 120 lbs. of cheese would stand at 77s. 6d. per cwt., exclusive of whatever might prove to be the cost of labour and materials used in the manufacture. Assuming that these, under the factory system, could not be covered for a less sum than 4s. per cwt., it would follow that your committee would be under the obligation of realising from the products of the milk an amount equivalent to 81s. 6d. per cwt. of 120 lbs., or of being obliged to fall back heavily on the guarantee fund. Now, inasmuch as the average price of the entire make of Derbyshire cheese has ruled for the past season at 72s. 6d. per cwt. (the exceptional dairies realising 80s. and upwards being an insignificant percentage of the entire make), your committee had no little anxiety (buying milk on such terms) lest they should be unable to sell the produce at prices so much in advance of Derbyshire rates as to cover the large amount of money expended in the purchase of milk; and they feel much gratified that they have been enabled to do so."

The committee attributed their being able to repay the large outlay in milk, besides cost of manufacture, without any material aid from the guarantee fund, chiefly to the following causes:

1. That in working up milk in such large quantities, and on the Cheddar system, a larger yield of curd is extracted from the milk than is obtained under the ordinary private dairy system.

2. The saving in cost of labour, which, being spread over so large a production, is capable of being reduced to the minimum.

3. The advantage, from buying them in bulk, of obtaining materials on the best terms.

4. The material reduction, under this system, in waste and loss of curd, as compared with the same quantity of milk made into cheese in small dairies.

5. The absence of loss by cheese cracking and heaving, which places a large percentage of an ordinary dairy in the infirmary instead of in the market.

6. The general rule, applicable to cheese-making as to every other class of manufacture, that an article can be produced at less cost in bulk than in small quantities.

The cost of bringing over the cheese-makers from the United States was necessarily heavy, and as it was an item of expense which would not fall on cheese-factories in after-years, a portion only of their salaries—£100 at each factory—was charged in the working expenses of the year, the rest being borne by the guarantee fund. There were also other expenses, such as alteration and re-arrangement of plant, improvement and enlargement of buildings, &c., which the committee considered could not be fairly charged to the account of the experiment, because they would not necessarily be incurred by the factories of the future; it was thought that in an experimental undertaking these various expenses were, more or less, unavoidable on the score of inexperience, and that in the case of new factories that might be built the mistakes of the pioneers would be avoided.

The salaries of the makers were charged to the working expenses at a rate which, it was thought, factories of the future would have to pay, and the various extras incidental to a new undertaking were properly borne by the promoters of the scheme.

It is, indeed, probable that the best-managed dairy, the milk of which was sent to the factories in that first season, would not have made a clear 6\frac{1}{4}d. per gallon of 10 lbs. of milk had the cheese been made at home; and the bare fact that the factories were able to pay for the milk at that rate, and still pay fair working expenses, was a highly satisfactory result, all things considered.

**Early Difficulties.**

In connection with this, it must be borne in mind that the system of cheese-making introduced by the two Americans was essentially that which was then in vogue in many of the factories in their country, and that, consequently, the cheese made in the two English factories was essentially American in character. It was, in the first place, American in shape and general outward appearance, and it had all the features when cut—the want of compactness of texture, the peculiar taste and smell, the too early maturity, and the lack of fine flavour—which characterised the American cheese of that period. There can be no doubt that, being a copy of, though to some extent an improvement on, the American cheese of the day, the sale of the Derby and Longford cheese was to some extent prejudiced; for American cheese then, as before and
LONGFORD CHEESE FACTORY, THE FIRST BUILT IN ENGLAND

(OPENED MAY 4, 1870.)
since, was selling at a price decidedly inferior to the average price of English cheese.

At that period, indeed, a reaction had set in, and a reform was in process of being established in the method of making American cheese. The Cheddar system was the one which, with various modifications, had been adopted in the American factories; but these modifications being seldom, if ever, improvements, had been carried too far in have been obtained; yet the committees, as we have seen, were enabled to pay a maximum price for the milk and a fair amount of working expenses.

In the system first tried in the English factories, the required acidity was wholly developed in the whey and curd before any of the former was removed, and not, as now, started in the whey and curd together, and afterwards completed in the

some respects, and some of the best cheese-makers in the States were advocating and practising with success a nearer approach to the true Cheddar system. The American system introduced into the English factories was what we may term the American Cheddar system, and did not contain the principles of the reform which had set in on the other side of the Atlantic. Hence the first year's factory cheese made in this country was less English in character than it might have been had the latest American methods been introduced. The result of this was found in a somewhat depreciated sale, and in smaller returns than might otherwise have been obtainetl; yet the committees, as we have seen, were enabled to pay a maximum price for the milk and a fair amount of working expenses.

In the system first tried in the English factories, the required acidity was wholly developed in the whey and curd before any of the former was removed, and not, as now, started in the whey and curd together, and afterwards completed in the
cloth, which held the curd and let the whey escape. The whey was conducted from the dry-vat by an india-rubber tube to an underground pipe, which conveyed it to the whey-tank outside. In the dry-vat was used a given quantity of salt, about 2 lbs. of salt per 100 lbs. of curd, and the two were well mixed up together; this was done as soon as the whey had all left the curd. The leading peculiarity of this system was that the curd did not require to be ground. During the time when acidity was developing in the milk-vat the curd was repeatedly stirred up by hand, in order to prevent its packing together at the bottom of the vat; the object was to keep the particles loose from each other, so that they would easily swim out with the whey into the dry-vat, and when there, would permit the whey to quickly escape. So the curd particles were like so many grains of wheat in size and appearance, and though their tendency was to adhere together in a mass, because of the acidity which prevailed among them, they were kept in a loose state after they were got into the dry-vat, partly to obviate grinding and partly to enable the salt to be evenly mixed with them. After the salt was thoroughly mixed with the curd the press-vats were filled and placed in the powerful screw-presses, a row of which is seen on the right of the illustration; a light pressure was at first applied, and afterwards a heavier one, until the cheeses were compactly formed. The press-vat was a cylinder of galvanised wrought-iron without ends (Fig. 128); the necessary bottom was formed by the board on which it rested when in press, and the top consisted of a "follower," which fitted inside the hoop, and sank as the cheese became more compact.

Changes in the System.

The experience of the first year proved to those in charge of the experiment that the American system, as introduced into this country, required considerable alterations to adapt it to our needs. Whilst the co-operative system in general, and the labour-saving appliances in detail, which were the salient features of this new departure in English dairying, were found to be admirably suited to bring about the end in view, it was considered indispensable to the future prosperity of the system that "every possible trace of the American type of cheese" should be eradicated, and that under an English maker our own Derbyshire system should be copied as closely as possible, and that our slower and more careful process should be supplemented by the advantages of machinery, the concentration of labour, and the general economy of manufacture which the factory system supplied. This, however, was not a change that could be perfected by bringing into the factories the Derbyshire method pure and simple; there were various unexpected difficulties cropping up here and there in the process of adaptation, and these involved the production of some faulty cheese. The difficulties were, however, gradually and one by one surmounted, and the committee "had the satisfaction of seeing the admirable method and the best points of the American machinery and system fully and successfully applied to the manufacture of Derbyshire cheese in two Derbyshire cheese factories."

But the cheese now produced in the factories, though flat and thin, and weighing the regulation 30 lbs. apiece, was not really Derbyshire cheese in character. The Derbyshire system, indeed, being essentially a sweet-curd system, cannot well be practised in factories, unless many more lever-presses and certain other appliances are provided than are found to be required in the American or in the Cheddar systems; hence it came to pass that one or two of the salient features of the Cheddar method must needs be introduced. The experiments made in dropping the American and adopting the Derbyshire, and again in grafting on the Derbyshire those leading features of the Cheddar system, were inevitably accompanied with difficulties and disappointments which could only be surmounted by "indomitable and untiring perseverance, based upon a firm conviction of the soundness and ultimate victory of the system." These qualities were present in no common degree among the members of the committee.

The situation was a peculiar and most anxious one. The eyes of the agricultural world in this and many other countries were closely watching the experiment. Many dairy-farmers were hoping the experiment would succeed, others were hoping it would fail; the factors were jealous of it; some landlords were strongly opposed to it, others were
as strongly in favour of it; public opinion was divided, swerving this way and that, anticipating the verdict of practice. The committee felt that the second season was the crucial one, and the anxiety attending it was increased by the change of system that was inevitable. Had the first year's method turned out all, or nearly all, that could be desired, the course to be pursued would have been comparatively clear; but instead of that it was felt that certain radical changes must be made, and the success of these was problematical. Hence the advocates of the system, and particularly those who had the control of it, were put on their mettle, and more earnest thought and watching in the interests of cheese-making have not been exercised in an equal period for many a long year in this country. It was a great and almost heroic effort on the part of some of our leading agriculturists in the county of Derby to place the cheese-making of the country—not the county only—on a foundation where the improvement would be permanent. Every effort, therefore, was used to make the system a success under the new order of things; the combined acumen of many practical minds was brought to bear on the subject. Efforts were, indeed, unceasing, and perseverance unlimited; and success was certain under such conditions. The second season was one of hard work and much anxiety, but the result was satisfactory to those on whom it had depended.

Progress of the System.

Before the commencement of the third season (1872) the milk-suppliers, who for the two previous seasons would patronise the system only on condition that they were shielded from all risk by a guarantee of 6½d. per gallon for all milk supplied, had become familiar with the working, and were so satisfied with the results of the system that they voluntarily relieved the guarantors from all risk in the third season for which the guarantee fund was available, assumed the responsibility themselves, undertook the entire management of the factories, formed themselves into local and independent committees, each dealing with its own factory separately, and became Dairy Associations on a purely co-operative basis. This was, of course, the result which must needs follow the introduction of the system, if it turned out a success, and the sooner the result was arrived at the better it was for the system. To be valuable at all, the system must needs liberate itself from the leading-strings that were indispensable at first, and the sooner it learned to stand on its merits, or was compelled to fall on its demerits, the better it was for all parties concerned.

To a great extent the new local committees were composed of the same persons who had served on them in the two previous years, and their accumulated experience was turned to good account. But though these committees now relieved the guarantors of further liability, so dispensing with the central committee, and took the entire management and responsibility into their own hands, they did not till the following year take full possession of the stock-in-trade. The season of 1872 had its difficulties, for the cows of most of the contributing dairies were afflicted with foot-and-mouth disease, which seriously reduced the quantity of milk. The quantity of cheese sold from the Longford factory in the season of 1872 was over 82 tons, at an average price of 7s. 10½d. per cwt. The whey and butter sold paid the working expenses, with the exception of about £52, so that the contributors received a net price of 7s. 3½d. per cwt. of 120 lbs. The quantity of milk delivered was 211,338 imperial gallons, on which a net dividend of 6½d. and ½d. of a farthing was paid. The average quantity of milk required to make 1 lb. of green cheese was 9 lbs. 13 oz., the shrinkage of weight during ripening was about 10 per cent., and the total cost of manufacture was 6s. 0½d. per cwt. of the cheese.

The quantity of cheese sold at the Derby factory in its third season was over 49 tons, and the average price realised 7s. 7½d. per cwt; the total cost of manufacture 7s. 1½d. per cwt. of the cheese; and the dividend paid on the milk within a fraction of 6½d. per gallon.

Notwithstanding various drawbacks, the year 1872, the third season of the two factories, was one which added credit to the factory system, for, after paying all expenses, a higher price per gallon of milk was paid than when the guarantee fund was in force, and this in spite of the price of cheese having declined several shillings per cwt. This result was highly creditable to the skill, the industry, and the perseverance of the respective committees, as it was an encouragement for the future.
In the fourth season (1873) the milk-suppliers purchased the plant from the guarantors, taking full possession as well as entire management, and doing away wholly with the connection which till then had been maintained with the guarantee fund. Meanwhile the price of cheese had been advancing, and the results of the fourth season at Longford were more favourable than any of the preceding ones; the management and the manufacturers were alike thoroughly successful, and the business was a pronounced success. We are enabled to present our readers with the balance-sheet of the Longford factory for the year in question, and it is well worth preserving in this permanent form, because it presents a concise picture of what a thoroughly experienced and united committee of management may accomplish in good times. It will be noticed that the cost of making the cheese is reduced to a very low figure, and this is evidence of great care and perfect management. See the annexed balance-sheet of the Longford factory.

During the first three years of the two factories' existence the system had attracted an immense amount of notice from farmers in all parts of the British Islands, and many foreigners had come over to see and study it. It is true there was some possibly needless enthusiasm indulged in by the advocates and supporters of the scheme when it was a pronounced success; and it is also true that certain rose-tinted predictions were made as to the benefits the factory system would confer on farmers' wives and daughters and on the dairying of the future; but these were chiefly called forth by the certainly needless opposition which was encountered in various quarters, and it cannot be denied that both the enthusiasm and the predictions were justified by the success which the factories had already attained.

How much of the success may have been due to that enthusiasm it is not for us to say, but it is probable that the committees and all the friends of the movement worked harder for its success in those early years than it was reasonable to suppose they would continue to do in the future. There can be no doubt of the sincerity of those who advocated the factories, to begin with, and who worked so hard to demonstrate their great usefulness, their intrinsic value, and their adaptability to the needs of English farmers and to the peculiarities of our insular dairying. If ever a great reform in agriculture was undertaken in good faith, this one was; there was no half-heartedness in its advocacy, no "wishing we hadn't undertaken it," no doubt of the soundness of the system. And it must be admitted that the opposition to it was equally persistent, though it was not in all cases so disinterested, nor was it always ingenuous and straightforward—it was rather a sort of guerilla warfare, conducted in secrecy and through various crooked paths.

The objects of the promoters were (1) to place the making of the cheese of the country in the hands of skilled makers, who, having charge of the milk of several hundreds of cows, could be paid at the rate which skilled and intelligent workmanship properly commands; (2) to relieve farmers' households of the sloppy untidiness, and their wives and daughters of the toil and anxiety, which are inseparable from home cheesemaking; (3) to reduce the cost of making the cheese; (4) to raise the average quality of the cheese-production of the land; (5) to introduce into farming the beneficent principle of co-operation; (6) to break the power of the "middle men;" (7) to obviate dependence on incompetent dairymaids; (8) to increase the profits derivable from dairy-farming; and (9) to promote a healthy emulation, to create a feeling of mutual interdependence, to encourage a freer intercourse, and to introduce habits of system, inquiry, calculation, regularity, and order among the farming circles of the country. That great good was within the reach of such means as these no one can deny, and that the means themselves were thoroughly practical is equally beyond the need of argument; the reasons why all the expected good has not been brought about we will presently inquire into.

The enemies of the system declared the movement was projected by landlords who wished the more easily to ascertain the profits their tenants were making; but this imputation was as unworthy as it was untrue, and it was absurd on the face of it. Landlords who wished to raise their tenants' rents did not take the trouble to inquire into their profits first of all, and all right-feeling landlords were glad to learn that their tenants were saving money—but not for the purpose of raising their rents.
## LATER FINANCIAL RESULTS.

### LONGFORD DAIRY, 1873.

*Opened March 24, Closed November 29.*

<table>
<thead>
<tr>
<th>Cost per cwt.</th>
<th>PAYMENTS.</th>
<th>RECEIPTS.</th>
<th>Averages.</th>
</tr>
</thead>
<tbody>
<tr>
<td>£</td>
<td>s. d.</td>
<td>£</td>
<td>s. d.</td>
</tr>
<tr>
<td><strong>Purchases of Plant from Guarantors</strong></td>
<td>258</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td><strong>Labour</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manager, 25s. per ton</td>
<td>107</td>
<td>18</td>
<td>0</td>
</tr>
<tr>
<td>All other labour</td>
<td>129</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Materials</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rent</td>
<td>45</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Ammonia</td>
<td>3</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Salt</td>
<td>5</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Cheese Bandages</td>
<td>10</td>
<td>2</td>
<td>9 1/2</td>
</tr>
<tr>
<td><strong>Fuel</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coal</td>
<td>36</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Coke</td>
<td>7</td>
<td>18</td>
<td>6</td>
</tr>
<tr>
<td><strong>Sundry</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soap, Soda, Brushes, &amp;c.</td>
<td>4</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td><strong>Rent, Rates, and Insurance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One Year's Rent</td>
<td>50</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Rates</td>
<td>1</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>Insurance</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Repairs to Plant</strong></td>
<td>29</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Other Expenses</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weighing of Cheese, Carriage, &amp;c.</td>
<td>8</td>
<td>15</td>
<td>8 1/2</td>
</tr>
<tr>
<td>Discount and other allowances</td>
<td>21</td>
<td>16</td>
<td>5</td>
</tr>
<tr>
<td>Commission on sale of Butter</td>
<td>9</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Printing, Stamps, and Stationery</td>
<td>7</td>
<td>1 1/2</td>
<td></td>
</tr>
<tr>
<td>Bank Charges</td>
<td>18</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Secretary's Salary</td>
<td>15</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Interest on Money borrowed to purchase Plant</strong></td>
<td>78</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td><strong>Expenses of Staffordshire Show</strong></td>
<td>7</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Manager's share of Stafford Prize Money</td>
<td>3</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>The Manager's Bonus*</td>
<td>98</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Amount divided amongst Contributors on 221,148 gallons of Milk, rather over 1/4d. per gallon, or £13 11s. 8 1/2d. per cow†</td>
<td>7,024</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>27,892</td>
<td>8</td>
<td>4 1/2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quantity of Green Cheese made</th>
<th>Tons. cwt.</th>
<th>qrs. lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot; shrunk do. sold</td>
<td>93</td>
<td>18</td>
</tr>
<tr>
<td>Amount of shrinkage (about 8 1/2 per cent.)</td>
<td>7</td>
<td>12</td>
</tr>
</tbody>
</table>

Average quantity of Green Cheese made per cow, 3 cwt. 76 lbs.

Average quantity of Milk required to make 1 lb. of Cheese, 10 lbs.

No. of Milk-suppliers, 28.

No. of Cows kept at any one time, 517.

* The Manager received 10 per cent. on the money value realised on the Milk over and above 6 1/2d. per gallon.

† As each supplier returned the highest number of Cows kept at any one time during the season, and as the Milk of 105 Cows did not come in until May 1st, the average number of Cows working in the Dairy would be less than 517, the number returned. Consequently, the actual money average per Cow for Milk supplied would be considerably in excess of £13 11s. 8 1/2d.
DAIRY FARMING.

EXTENSION OF THE FACTORY SYSTEM.

Meanwhile other factories were being built in the land. The success of the system had been demonstrated to the whole country, and in districts where cheese-making accommodation in farmhouses was of an inferior character, or where dairymaids were scarce, high-waged, and incompetent, farmers became anxious to have factories to which they could send their milk. Windley and Ettington were the first to follow, then the Holms, Hope Dale, Sutton-on-the-Hill, Itonbrook Grange, and factories in Cheshire and in Somersetshire were built. This was while the enthusiasm which had been aroused was in full bloom. The Holms factory was the first to be built by dairy-farmers for their own and their neighbours’ use; but the Hope Dale factory, we believe, was and is the first and only one built on a purely co-operative principle, each milk-supplier contributing capital on a pro rata scale according to the number of cows whose milk he intended to send to the factory. Appended we give the first year’s balance-sheet of the Holms factory, which compared favourably with the best home-made dairies of the district for that year, and was greatly superior to the average results of home cheese-making in that part of the country.

It will be noticed that the cost of making the cheese was higher than that of Longford in the previous year, and than that of Windley in the following year; this is explained by the

<table>
<thead>
<tr>
<th>PAYMENTS.</th>
<th>£  s. d.</th>
<th>£  s. d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour Contract...</td>
<td>100 0 0</td>
<td></td>
</tr>
<tr>
<td>Materials—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buret...</td>
<td>15 3 0</td>
<td></td>
</tr>
<tr>
<td>Ammonia...</td>
<td>3 0 0</td>
<td></td>
</tr>
<tr>
<td>Salt...</td>
<td>2 3 0</td>
<td></td>
</tr>
<tr>
<td>Fuel—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coal...</td>
<td>12 6 11</td>
<td></td>
</tr>
<tr>
<td>Coke...</td>
<td>2 12 5</td>
<td></td>
</tr>
<tr>
<td>Rent—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rent of Factory...</td>
<td>10 0 0</td>
<td></td>
</tr>
<tr>
<td>Interest on Plant...</td>
<td>6 12 7</td>
<td></td>
</tr>
<tr>
<td>General Expenses—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheese Cloths, Bandages, Brushes, Soap, Soda, Paper, Printing, Stamps, Expenses on Cheese, Coal, and General Items...</td>
<td>19 18 0</td>
<td></td>
</tr>
<tr>
<td>New Whey Vat...</td>
<td>11 8 9</td>
<td></td>
</tr>
<tr>
<td>Two New Cart Covers...</td>
<td>1 7 0</td>
<td></td>
</tr>
<tr>
<td>Items of Plant...</td>
<td>0 16 2</td>
<td></td>
</tr>
<tr>
<td>Contractors’ Bonus...</td>
<td>24 16 6</td>
<td></td>
</tr>
<tr>
<td>Dividend paid to Milk-suppliers 71/2d. per gallon on 70,728 gallons of Milk sent to the Factory...</td>
<td>2,408 9 0</td>
<td></td>
</tr>
<tr>
<td>Balance in hand...</td>
<td>1 13 5</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£2,629 6 9</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RECEIPTS.</th>
<th>£  s. d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Produce of 30 tons 14 cwt. 3 qrs. 27/2 lbs. of Cheese sold...</td>
<td>2,483 18 0</td>
</tr>
<tr>
<td>Produce of 250 lbs. of Whey Butter...</td>
<td>13 15 3</td>
</tr>
<tr>
<td>Whey—</td>
<td></td>
</tr>
<tr>
<td>Sold in small quantities...</td>
<td>3 1 1</td>
</tr>
<tr>
<td>Supplied to Contributors...</td>
<td>119 12 5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£2,629 6 9</strong></td>
</tr>
</tbody>
</table>

* Being an average of 80. 6d. per cwt. of 120 lbs. on the entire make of Cheese.

Average of Milk per lb. of Green Cheese, 10 lbs. 0.34 oz.
Average shrinkage, 9 per cent.
comparatively small quantity of milk that could be got together in the first season, whilst the labour account was exceptionally high for so small a factory. At that time competent factory managers did not equal in numbers the demand there was for them, and too high a price had to be paid for one in consequence. The committee of this factory worked hard to attain under decidedly unfavourable conditions so favourable a result; but they were well supported by the few milk-suppliers they had, we, believe, with one exception, conscientiously strove to carry out the stipulations of the subjoined bye-laws:

1. Persons sending milk to the above factory shall be required to send, twice each day, the pure milk from the whole of their dairy-cows (excepting such milk as shall be required by them for their family consumption) during the making season, the commencement and termination of which shall be determined by the Managing Committee.

2. No person shall send, and the manager of the factory shall have power to refuse, any milk that is of an inferior quality, diluted with water, sour, dirty, or otherwise impure, or from which any cream has been taken; nor shall any person keep back that portion of the milk known as 'afterings' or 'stripplings.'

3. Milk from a newly-calved cow shall not be sent to the factory until the cow has been calved four days.

4. Milk will be received at the factory from halfpast five to half-past seven o'clock in the morning; and from five to seven in the evening of each day; these hours may, in the autumn months, be subject to certain modifications, the extent of which will be decided by the Committee.

5. The cans used for carrying milk to the factory, and other utensils connected therewith, must be kept thoroughly sweet and clean.

6. A correct account of all milk received at the factory, with the number and weight of cheese made therefrom, shall be kept by the Manager at the factory; which account shall be open at all times to the inspection of any milk contributor.

May 1st, 1874.

The Windley cheese-factory is on the estate of Mr. Crompton, and was formerly a malthouse; at a comparatively small expense the building was adapted to its new vocation, and a great deal of excellent cheese has been made in it. As at the Longford factory the Hon. E. K. W. Coke, so at Windley Mr. Crompton was indefatigable in trying to make the thing a complete success; and the eminently satisfactory results of those first years are chiefly owing to the indomitable perseverance of these gentlemen. It is not too much to say that to them, more than to any other two persons, is due the credit of having clearly demonstrated the success of the system as applied to English dairying; and we may be allowed to doubt whether it would at that period have obtained a trial at all but for them. Whatever position in the future cheese-factories may fill in the sum-total of our dairy-farming, the gentlemen we have named are entitled to the merit of having made a most praiseworthy attempt to largely benefit the bucolic agriculture of the country. We give on the next page the balance-sheet for 1875 of Mr. Crompton's factory situate at Windley.

But after the period to which the following balance-sheet has reference, cheese everywhere declined rapidly in price; in the years 1876 to 1879 inclusive we may rate the average decline to amount to about £25 per ton, and it was on the inferior qualities of cheese that the greatest decline had taken place. Factory cheese had not been exempt from the universal depression. This was to be expected; but in those factories where the cheese had maintained the standard quality of former years the decline in prices was very much less than the average decline in the country generally. Those factories certainly suffered most whose cheese, from one cause or another, had fallen away from the character it bore a year or two earlier. This decline in prices was not attributable to cheese having declined in quality to a corresponding extent, for it had not done so; while we admit that in several factories the quality was inferior to what it had been two or three years ago, we do not admit that the inferiority was by any means commensurate with the inferior prices. The two great reasons of the decline in prices were—(1) the general depression of all kinds of trade, commerce, and manufacturing industry in the country, and (2) the greatly increased importations of Transatlantic cheese. In the subjoined balance-sheet of the Holms cheese-factory for 1877—the latest we have seen—it will be noticed that in three years—compared with the sheet of 1874—the decline in price is barely 10s. per cwt., and this is certainly a less decline than the average of home-made cheese had to submit to in the same period. It will also be noticed that over £56 of the original plant capital was then paid off, and £10 laid out in new plant, and yet the—all things considered—very satisfactory dividend of 6d. per gallon was paid on the milk. These several balance-sheets present a graphic picture of the position of factories at that period, and they are valuable for reference.
DAIRY FARMING.

### Windley Dairy, 1875.

#### April to October.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lbs. of Milk supplied</td>
<td>128,340</td>
<td>219,302</td>
<td>239,901</td>
<td>220,011</td>
<td>192,222</td>
<td>150,066</td>
<td>51,388</td>
</tr>
<tr>
<td>Lbs. of Cheese produced</td>
<td>12,080</td>
<td>20,834</td>
<td>22,678</td>
<td>21,326</td>
<td>13,135</td>
<td>16,011</td>
<td>5,954</td>
</tr>
</tbody>
</table>

Average Number of lbs. of Milk to lb. of Cheese

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>10</td>
<td>8 1/2</td>
<td>10</td>
<td>9</td>
<td>10</td>
<td>5</td>
<td>10</td>
<td>9</td>
<td>6</td>
<td>9</td>
<td>2</td>
</tr>
</tbody>
</table>

Total lbs. of Milk | 1,204,240 |
Total lbs. of Cheese made | 118,078 |

<table>
<thead>
<tr>
<th></th>
<th>Tons</th>
<th>cwt.</th>
<th>qrs.</th>
<th>lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of Cheese when made</td>
<td>49 3 3 28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight of Cheese when sold</td>
<td>44 18 2 27</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Shrinkage (9 per cent.)

|          | 4 5 1 1 |

Value of Cheese | £3,381 10s. 7d., averaging £3 15s. 2d. per cwt. of 120 lbs. |

Cost of making | 5s. 2d. per cwt. |

### Payments.

<table>
<thead>
<tr>
<th>Cost per cwt.</th>
<th>£ s. d.</th>
<th>£ s. d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIVIDEND at 6d. and a fraction, or nearly 7d. per gallon, on 11,839 gallons, of Milk (10 lbs. 4 oz. to the gallon)</td>
<td>3,379 5 4</td>
<td></td>
</tr>
<tr>
<td>LABOUR—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maker's Wages</td>
<td>75 0 0</td>
<td></td>
</tr>
<tr>
<td>Assistant Maker's Wages</td>
<td>54 4 0</td>
<td></td>
</tr>
<tr>
<td>Making and Washing Cheese Bandages</td>
<td>2 9 9</td>
<td></td>
</tr>
<tr>
<td>MATERIAL—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rennet</td>
<td>38 9 6</td>
<td></td>
</tr>
<tr>
<td>Anatto</td>
<td>1 16 0</td>
<td></td>
</tr>
<tr>
<td>Salt...</td>
<td>1 14 3</td>
<td></td>
</tr>
<tr>
<td>Cheese-cloths</td>
<td>7 5 6</td>
<td></td>
</tr>
<tr>
<td>Cheese-paper</td>
<td>1 4 6</td>
<td></td>
</tr>
<tr>
<td>FUEL—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coal</td>
<td>13 16 5</td>
<td></td>
</tr>
<tr>
<td>Coke</td>
<td>1 3 3</td>
<td></td>
</tr>
<tr>
<td>SUPPLIES—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brushes, Soap, &amp;c.</td>
<td>0 13 6</td>
<td></td>
</tr>
<tr>
<td>Stationery, Stamps, &amp;c...</td>
<td>3 9 0</td>
<td></td>
</tr>
<tr>
<td>Carriage and Weighing Cheese</td>
<td>4 5 6</td>
<td></td>
</tr>
<tr>
<td>Haulage of Fuel and Salt</td>
<td>1 19 5</td>
<td></td>
</tr>
<tr>
<td>Insurance</td>
<td>1 11 9</td>
<td></td>
</tr>
<tr>
<td>Sundries</td>
<td>2 7 0</td>
<td></td>
</tr>
<tr>
<td>RENT—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One Year's Rent of Building and Plant</td>
<td>40 0 0</td>
<td></td>
</tr>
<tr>
<td>Dray and Dray Cover</td>
<td>20 18 0</td>
<td></td>
</tr>
<tr>
<td>Bank Charges</td>
<td>6 2 11</td>
<td></td>
</tr>
<tr>
<td>Secretary and Accountant</td>
<td>20 0 0</td>
<td></td>
</tr>
</tbody>
</table>

**Total Payments**

<table>
<thead>
<tr>
<th>£ s. d.</th>
<th>£ s. d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,663 15 7</td>
<td>3,663 15 7</td>
</tr>
</tbody>
</table>

### Receipts.

<table>
<thead>
<tr>
<th></th>
<th>£ s. d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheese—44 tons 18 cwt. 2 qrs. 27 lbs. sold, at 75s. 2d. per cwt.</td>
<td>3,381 10 7</td>
</tr>
<tr>
<td>Butter—1,170 lbs., at 11s. 7d. per lb.</td>
<td>57 18 0</td>
</tr>
<tr>
<td>Milk—906 gallons, at 5s. per gal.</td>
<td>33 18 7</td>
</tr>
<tr>
<td>Whey—88,045 gallons, at 1/4d. per gallon</td>
<td>183 8 6</td>
</tr>
<tr>
<td>Banker's Interest</td>
<td>2 19 11</td>
</tr>
</tbody>
</table>

**Total Receipts**

<table>
<thead>
<tr>
<th>£ s. d.</th>
<th>£ s. d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,663 15 7</td>
<td>3,663 15 7</td>
</tr>
</tbody>
</table>
THE PRESENT POSITION OF FACTORIES.

Opened April 2, Closed November 17, 1877.

<table>
<thead>
<tr>
<th>Payments</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manager's Salary, finding all labour</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>150</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Rent—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Of Factory and House</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>25</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Interest on Plant</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>8</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>Materials—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rennet and Colouring</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>24</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Salt</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>4</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>Fuel—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coal</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>11</td>
<td>18</td>
<td>5</td>
</tr>
<tr>
<td>Coke</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>1</td>
<td>17</td>
<td>9</td>
</tr>
<tr>
<td>Carriage—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Of Coal</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>5</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Coke</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>1</td>
<td>17</td>
<td>9</td>
</tr>
<tr>
<td>Cheese</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>13</td>
<td>19</td>
<td>2</td>
</tr>
<tr>
<td>General Expenses—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheese-cloths, Paper, and General Repairs...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>27</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Plant, New Shelving</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>10</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Amount of Plant Capital paid off</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>56</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>Dividend Paid to Patrons, 6d. per gall. on 150,708 galls. Milk</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>3,757</td>
<td>14</td>
<td>0</td>
</tr>
</tbody>
</table>

The season's cheese averages 70s. 11½d. per cwt. of 120 lbs.

The Present Position of Factories.

We come now to a later phase in the history of cheese-factories in England, and we admit it is a less pleasant one than we have been hitherto occupied with. It is generally understood that most of the factories are no longer producing as good cheese as they were several years ago, and from this the conclusion is hastily arrived at that the system is a failure. We admit the correctness of the premis, but we deny that of the conclusion. About half of the factories are still producing very, and the rest of them moderately, good cheese, but even were they all producing very bad cheese, it would still be unfair to condemn the system for the failure. Results such as those shown by the foregoing balance-sheets could not have been produced under a system that was a failure, and though inferior results have since been produced, we cannot admit that they are an integral part of the system. The latter proved itself to be sound and successful for years, and it would always prove itself the same providing its conditions were complied with. But neither cheese-factories nor anything else involving a system can be successful, if the known principles on which success depends are either intentionally or unintentionally violated. Results rap the knuckles of those whom experience has failed to educate; and so the comparative failure of some of the factories is making itself to be very unpleasantly felt. We will endeavour to indicate the causes of such non-success; and without drawing too general conclusions from individual instances will state as clearly as possible the chief faults that have crept in.

1. In the first place we may state that the pride in work, the care, the watchfulness, the emulation, the heartiness of effort which were introduced by the system, and which were all-important in those first years' successes, have not been maintained as they ought to have been among the factory managers. It was not to be expected, or even wished, that the promoters' enthusiasm should long outlive the opposition that called it into being; and however useful that element might be in carrying the system over the first years' difficulties, it ought not to have been necessary to keep alive in the makers
the qualities that were required for the continued success of the system. Warmth of feeling displayed in action is very useful in most new movements, and it is commonly necessary to establish them; but it is a different thing from the steady, methodical, sustained work by which alone any movement can be expected to be maintained when the novelty has worn off. There was much earnestness of purpose at the onset among committees and managers alike; and it was reasonably hoped that the latter would settle down to their work, as men in other vocations do, with a pride in it, a sense of its importance, a watchfulness, thoughtfulness, and unceasing desire to improve, such as would have maintained the success which was achieved at first. These qualities are found in some of the managers; but others seem to have grown mechanical and careless, others, again, slovenly and dirty; and the factory system in certain instances has only perpetuated on a larger scale some of the leading faults that used to be complained of so much in dairymaids.

2. Factories were calculated to introduce not only an improved method of cheese-making, but also a spirit of fraternity, goodwill, and friendly emulation that would have led on to unthought-of improvements. It was expected that the managers would meet together now and then, in the intervals between the seasons, to talk matters over in an unconstrained and helpful spirit, freely admitting failures where such had occurred, and freely explaining successes. In such an art as cheese-making, which is far from having arrived at perfection, and which is, or ought to be, progressive, the meeting together of those who are practically engaged in it to talk over the pros and cons of the matter is one of the best means to success. But when they keep as it were studiously apart, there are soon as many ways of making cheese as there are men who make it. We cannot but think that had factory managers met together occasionally, they would have spurred each other up, and those amongst them who subsided into indifference would most probably have remained emulous instead; and they would have gone on learning and improving, as they undoubtedly did for the first four or five years, instead of remaining stationary, and in some instances positively retrograding.

3. One obvious fault into which some factory managers have fallen is that of hurrying too much the process of making the cheese, from breaking the curd to vatting it inclusive. It is not that they have hurried the mechanical part too much in all cases, though this has become too common, but that they have hastened the separation of the whey by "letting on," too much acid—developing it too far in the whey; and here it is that great mischief is done. Acid will counteract the ill effects of tainted milk, and it will cause the whey to quickly leave the curd; but it will also hinder, and if developed too far will destroy, the slow ferment which the rennet sets up in the cheese and which is the ripening process. Hence over-acidified cheese, while lessening the labour of the manager, will hinder the ripening of the cheese. The development of acidity may be seen in the change of the appearance rather than of the colour of the whey—a sort of glimmer on the surface indicates it.

4. The want of esprit de corps, which we have noticed particularly in some managers, has seemed to weaken the sense of the necessity of scrupulous cleanliness; in which event a man is little likely to produce good cheese. Some persons appear to have lost sight of the absolute necessity of keeping all the utensils with which the milk comes in contact in the factory as sweet and clean as possible—perhaps they never had it, and kept things clean for a time mechanically and not from conviction. They fail to apprehend that these utensils will soon become sour if they are not thoroughly well cleaned every day, and that they will communicate their sourness to the next milk that is put into them: many a good cheese, or what would have been a good cheese, is ruined this way. And not only the various utensils, but the factory itself—the floors, the walls, the windows, everything—should be kept as clean and fresh and sweet as plenty of hot and cold water and scrubbing and swilling will make them. In some cases these matters have been culpably neglected.

5. Much cheese has been seriously injured in factories by not being properly attended to after it was made. It has been allowed to starve in a damp cold room on the ground floor, and it has been left unturned until it stuck to the shelves. It has become mouldy and covered with mites, and the shelves have been covered with mites and saturated with damp, and a musty atmosphere has pervaded the place. Cheese
cannot ripen in such a room. Again, in the upstairs room the temperature has varied greatly; some of the cheeses have been roasted by being too near the stove, or they have been starved by being too far away from it, and they have been left unturned till they have stuck together and to the floor, when they ought to have been turned "every other day." A great deal of well-made cheese is ruined in the ripening. We wish it to be understood that the foregoing condemnatory remarks apply to a few only of the factory managers of the past, and not by any means to all of them.

6. But the factory managers are not wholly—in some cases they are not at all—to blame for the disasters that have occurred in places here and there. Certain milk-suppliers have been more to blame than the worst of managers, for they have done mischief not by mere carelessness, but from motives of petty personal gain. Some of them have deliberately done harm to the factory to which they were attached by sending skim-milk to it. In order that they might pocket each week a few shillings of "butter-money," they have sent sour milk, which they knew would greatly injure all the sweet milk that came in contact with it, and from which they also knew it was impossible to make good cheese. This has been done secretly, in defiance of bye-laws, and in violation of common honesty toward one's neighbour. No factory manager can be successful when one or two of his milk-suppliers are addicted to skimming their milk and privately sending a basket of butter to market—butter which belongs to the Association; and the only blame we can attach to him in such a case is on the ground that he failed in duty, because he did not detect and reject such milk. It is no unimportant part of a factory manager's duty to keep a sharp look-out for milk that is not what it ought to be, and when he finds it, to reject it, and lodge with the committee a complaint against the offender.

7. Other milk-suppliers have done great harm through pure carelessness and thoughtlessness. These have not been alive to the importance of keeping thoroughly sweet and clean all vessels that come in contact, either directly or indirectly, with the milk they send to the factory. They are not aware that milk itself is one of the worst things imaginable for making vessels sour, if they are not thoroughly cleaned every time after being used. Milk left sticking to the sides or bottoms or in the seams of these utensils will soon make them unfit to put other milk in; if the pails and pans and kettles, and all other vessels that are used in connection with milk, are not well scrubbed and scalded every day, they will in hot weather soon be sour; the milk left in them, in decomposing, sets up a putrefactive ferment, which is communicated to and spoils the next milk that is put into them. And these ferment spread at an astonishing rate when they have something congenial to work in, as milk is, and they do their work in a very short space of time. The cans used in carrying milk to a factory, if not thoroughly cleaned each time they go, will sow the seeds of sourness in the next lot of milk; this, in its turn, contaminates other people's milk, and so the cheese is ruined.

8. There is a growing suspicion that artificial manures and feeding-stuffs have an ill effect on milk that is produced by their aid. It is thought that they communicate to it something or other that greatly increases the difficulty of making satisfactory cheese and butter from it. Without endorsing this belief, we may mention that we have known one authentic instance in which the use of cotton-cake had a most injurious effect on the butter, making it soft and oily; and when the cake was suspected and cut off, the butter was all right again immediately. This occurred in autumn, when the cows were eating grass on the pastures, and were receiving the cotton-cake as supplementary food. One swallow does not make a summer; yet it is not by any means improbable that there may be some truth in the allegations that are brought against purchased feeding-stuffs. We have known many instances in which it has been found more difficult to make satisfactory cheese from land that had been recently boned or limed rather liberally. Such cheese was quite unmanageable, unless a portion of the milk was skimmed—the skimming being like bleeding a patient for inflammation. We ought not, from these instances, to come hastily to any hard-and-fast conclusions; but we think this matter is well worth careful experiment and investigation.

9. One fruitful source of mischief lies in not properly cooling the milk before it is sent off to a factory in hot weather. Warm milk in closely-lidded cans, jolted a mile or two over rough country roads, in a springless cart of the farm,
and half churned in the process, is in no fit state to be made into cheese; and no man can make fine cheese from it. In cases where it is the rule to send the milk only once a day, the intervening meal of milk is seldom taken proper care of at the farmstead, as it would be at the factory; and we think the once-a-day system, for this reason if for no other, ought to be abolished. Many milk-suppliers would take better care of their milk than they do if they had to make it up into cheese themselves.

10. It would appear that, in sufficient instances to do a great deal of mischief, both managers and milk-suppliers have grown altogether too careless. If there is a careless manager the result will be disaster, no matter how careful the milk-suppliers may be; and, in like manner, one careless milk-supplier will undo the carefulness of nineteen others. What is everybody's business is nobody's, it would seem, otherwise many careless practices in connection with cheese-factories would be put an end to. The bulk of the farmers who send their milk to cheese-factories are alive to the importance of the matters we have here discussed, and do their utmost to conform to the conditions laid down for their guidance; but in too many instances they are thwarted by the thoughtless ones, and by others who are even more blamable than these; yet "evil is wrought by want of thought as well as by want of heart." Carelessness in a factory manager is fatal to progress; lethargy brings everything to a standstill; in which case improvements are never adopted—never even considered as they ought to be. The lively and long-sustained interest, the almost affectionate care, the cheerful alacrity, the unceasing watchfulness, the steady industry which American cheese-makers and French and German butter-makers carry into the work, are things that may with advantage be copied by persons who are engaged in similar work in the British Islands. Pride in work is the very foundation of these things. We speak now of what we have seen in other lands, and we would fain see the same sort of thing prevail among our own cheese and butter makers. We know that this pride in work is not a thing that can be created at will; it is a matter of small beginnings and of slow growth, but when we see symptoms of it in places, we desire to foster and promote them by calling attention to what is being done in other countries, and by suggesting what ought to be done in our own.

It has been frequently said that the fact of cheese-factories not having become so numerous in the country as it was predicted they would is a proof that the system is a failure. This we emphatically deny. One of the chief reasons—probably the chiefest of them—why factories have not so multiplied in number, is the enormous expansion in recent years of the milk-trade to the towns and cities. In numerous districts where factories were in contemplation, this expansion has operated to prevent their establishment; and in others where they have been established it will in time disestablish them. This, however, we cannot regret; for the milk-trade, properly conducted, will out-profit cheese-making anywhere, if only a railway is handy enough.

Cheese-making in Factories.

The first requisite at a cheese-factory is a constant supply of pure cold water; without it no factory manager can be uniformly successful. It must be cold for cooling the milk in hot weather, when cooling is indispensable, and it must be pure for washing the utensils. During the heat of summer its temperature should not be above 55°, and this secured, the rest of the year will take care of itself. Enough running water to fill a pipe whose diameter is 1½ inches will be ample to supply a factory of 500 cows.

One of the most important parts of a manager's duty is to closely watch the milk he receives into the factory. He is perfectly justified in rejecting any of it that is sour, dirty, skimmed, diluted, or otherwise impure and out of condition. His success, in fact, will in a great measure depend on his vigilance in these matters, providing all his milk-suppliers are not strictly careful and conscientious, for no one can make good cheese from milk that is not what it ought to be. He cannot, it is true, detect skim-milk as easily as he can sour or dirty milk; nor can he, even with a lactometer, decide absolutely whether or not the milk has been diluted with water; but carefully-acquired experience will enable him to detect, by his faculties of sight and smell, and without the aid of scientific instruments, the more flagrant cases of carelessness or adulteration.

The lactometer is simply a hydrometer applied to milk, and it indicates only specific gravities. The more casein, milk-sugar, and mineral matters—the more solids, that is—there are in milk, the
greater will be its specific gravity or density, other things being equal, and the higher will be the indication on the lactometer; and it is on account of these constituents—not on account of its cream—that milk is heavier than water. Pure milk has a specific gravity of about 1.032, that of water being 1.000; milk is therefore about 3 per cent. heavier than water. Now the fats of milk, of which cream is chiefly composed, are lighter than water, the specific gravity of milk-fat being 0.9, and of water 1.0; cream, however, is not to this extent lighter than water, because it contains a certain amount of milk-solids. But in any case, cream and water are each 3 per cent., or upwards, lighter than milk. Skimmed milk is heavier than pure milk, because the lighter fats have been taken out of it. But if this skimmed milk be again charged with cream, to an extent beyond its natural quantity, its specific gravity will be brought nearer that of water than it was before the milk was skimmed, and sufficient cream may be put into it to reduce the specific gravity even below that of water, because cream is lighter than water.

That portion of milk called "strippings," which is the small quantity of milk that a cow usually lets down a short time after she has been milked, is known to be richer than ordinary milk in fats, and its specific gravity is lower than that of ordinary milk. The specific gravity of strippings is sometimes found to be as low as 1.020, when the proportion of cream is unusually large, and 1.025 is not by any means uncommon. If ordinary milk is found to have a specific gravity of 1.025, instead of its normal 1.032, it is reasonable to suppose one of two things: either that it is exceptionally rich in cream, or that it has been diluted with 15 or 20 per cent. of water. Hence it follows that specific gravity is not by any means an absolute or even a fair test of the purity of milk, for while it can be raised by abstracting the cream, it can be lowered again by putting in some water; and as cream is lighter than water, a smaller quantity of water put in than of cream taken out will suffice to restore to the milk the specific gravity it had before it was skimmed. Hence it is one of the simplest things in the world to tamper with the purity of his milk. In making a test to ascertain with how much water the milk may have been diluted, a very fair conclusion may be arrived at by using two cream-gauges, as shown in a, b, Fig. 129; a per cent. glass, c; and a lactometer, Fig. 130.

Fill one of the cream-gauges to gauge-mark 10 with milk which is known to be pure, and drawn from several cows. This will be the standard of pure milk for that day. Fill the other to the same number with milk to be tested, and fill the per cent. glass with water to gauge-mark 0. To avoid any mistake, mark first jar by pasting letters v.m. on the side or bottom. Set the jars away, side by side, a sufficient length of time for the cream to rise, and all to become of the same temperature. Now note the quantity of cream in each jar of milk. If a less quantity is found on the milk which is being tested than on the other, it indicates diluted or skimmed milk.

Now remove the cream from each jar; introduce the lactometer into the jar marked v.m., and note on the scale-mark where it floats. Then remove it to the other jar, and note also where it floats. If it sinks lower than in the first, it is positive evidence of dilution with water. Replace the lactometer in jar marked v.m., and from the per cent. glass, filled with water exactly to 0, or zero, pour into v.m. jar until the lactometer sinks exactly to the same point as in the other jar. Now count or number on per cent. glass from zero down (each mark represents one-half of 1 per cent.), and we have precisely the percentage of water with which the milk we are testing has been diluted.
We do not say that this is an absolutely correct test, for the milk of different cows, or of the same cow at different times, varies very much as to the proportion of cream it contains. And the cream of the milk of some breeds of cows, or of individual cows that differ from the generality of the breed, rises so much more slowly than that of others, that to make the cream-gauge test at all a fair one the milk must stand for a very long time to cream. And, again, some milk will not throw up more than a portion of its cream, however long it may stand, while other milk will throw up nearly the whole of it in a comparatively short time. But if mixed milk from ten or fifteen cows, all of which is known to be genuine, is taken as a standard, all other milk produced under similar conditions, on the same day, in the same district, on similar land, and from cows of the same breed, ought when tested to approach pretty near to it in quality. So the test is not by any means an unfair one, its results are tolerably trustworthy, and it is the quickest and cheapest test that an ordinary person can employ, providing it is used intelligently and with care.

A lactometer, however, requires to be used with the greatest nicety, if its record is to be of any value, for a comparatively small change in the density of a fluid frequently represents a considerable change in its composition. If we take milk as an instance of this, we find—leaving cream out of consideration—that 9·2 per cent. of milk-solids raise the density of milk only 3·0 to 3·5 per cent. above that of water. Mineral substances dissolved in water raise the density more rapidly than organic substances, and the mineral matters in milk amount only to about 0·75 per cent., while the milk-sugar and casein amount to about 9·0 per cent., the latter being twelve times as great as the former in quantity.

In simply testing the relative percentages of cream in various samples of milk, a set of simple glass cream-gauges, as seen in Fig. 131, with graduated marks upon them similar to those on the cream-gauges in Fig. 129, will be found sufficient for all practical purposes. A quicker determination of cream may be made by the centrifugal cream extractor, illustrated in the next chapter.

The percentage of cream is, however, no infallible sign that milk has or has not been skimmed, because the proportion of cream in pure milk varies greatly and depends on many causes. The food the cow eats, the kind of land she grazes on, the weather, the period of the year, the breed of the cow, the state of health she is in, and her general treatment are all causes which affect the quantity of cream in milk. And there are other causes which are not at present understood, because the proportion of cream in a cow's milk will be found to vary greatly on successive days, though she may be kept on the same food, and the weather and her health may, for anything we can tell, remain unchanged.

Different kinds of land, equally valuable perhaps from an agricultural point of view, will produce milks that differ greatly in richness; one kind of land will produce a large quantity of milk somewhat inferior in quality, and another kind a smaller quantity of milk of a superior quality; while yet another kind of land, that is richer and stronger than either of the others, will produce a large quantity of milk of very good quality. One sample of milk, therefore, that contains a smaller proportion of cream than another sample against which it has been tested, must not be hastily condemned as having been denuded of a portion of its cream; for, if they were tested together a week later, it is quite possible their positions in the cream-gauge might be reversed. Still, as the table on next page will show, the variations in cream in different samples of milk, tested on the same days and produced in the same district, though on different sorts of land, are found to bear some kind of relationship, and for the most part to rise and fall together in somewhat irregular unison. The tests were made by a painstaking and accurate friend of ours, in the year 1877, at one of the Derbyshire cheese-factories, and they may be accepted as presenting a trustworthy picture of the true state of things. The leading feature in the picture is, however, the continual fluctuation that is going on. The samples in each case were taken from milk that was believed to be perfectly genuine, and from the mixed milk of the number of cows mentioned in the margin.

The least percentage of cream is found in July, and this is probably owing to the heat of the weather preventing the milk from cooling as
much as it ought to do if the cream is to rise perfectly. Cream rises best, though not quickest, in a slowly-falling temperature, and the longer the temperature continues falling, the more completely the cream will rise; so that the smaller quantity of cream indicated in the hottest month may be owing in part to the cause we have stated, and in part to the milk being actually poorer in fats, on account of the cows drinking more and eating less when the weather is cooler.

Notwithstanding these fluctuations in quality, it is the duty of the manager to repeatedly test various samples of milk against each other in the manner illustrated by this specimen table, and it is no less the duty of milk-suppliers not of standing whilst the cream was rising, but the taking off a portion of the cream is a direct act of petty larceny committed against the Association.

We have referred at length to the questions of purity and quality of milk, because they are the first considerations in factory cheese-making; and we have spoken plainly as to the duties of milk-suppliers and factory managers, because success is impossible if these preliminary duties are neglected. Cleanliness is a prime consideration in cheese-making—cleanliness in everything to which the word can be applied. We also consider it to be an important thing that the milk, before being sent off to the factory, especially in hot weather, should be aerated—well stirred about, to let the gases and odours escape out of it—and at all events partially cooled. In cold weather there is less need for these precautions, though aeration is at all times a good thing, wherever it can be done in a pure atmosphere. But if the milk is neither cooled nor aerated, and the weather is hot, it arrives at the factory in a condition very unfit for cheese-making, and seeds of destruction that cannot be afterwards removed in the factory are already sown in it. Yet there are milk-suppliers who take no precautions as to cooling or aerating, no matter how hot the weather is or how great the distance to the factory may be; their chief aim is to get the milk to the factory as soon as possible, and then wash their hands of it. They seem to think it a matter of no consequence whether their milk be quite fresh or not; if

Variations in the Quality of Milk.

<table>
<thead>
<tr>
<th>No. of Cows</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>Oct.</th>
<th>November</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E.</td>
<td>E.</td>
<td>E.</td>
<td>M.</td>
<td>E.</td>
<td>M.</td>
</tr>
<tr>
<td>6</td>
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<tr>
<td>1</td>
<td>16</td>
<td>10</td>
<td>8</td>
<td>8</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>8</td>
<td>9</td>
<td>9</td>
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<tr>
<td>3</td>
<td>24</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>9</td>
<td>9</td>
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<tr>
<td>4</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>11</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>24</td>
<td>7</td>
<td>8</td>
<td>8</td>
<td>9</td>
<td>7%</td>
</tr>
<tr>
<td>6</td>
<td>30</td>
<td>10</td>
<td>9</td>
<td>9</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

M., Morning; E., Evening.
it is wrong the factory will set it right, they imagine, and the result is that they are more careless with it than they would be if they made their cheese at home.

Fig. 132 represents the kind of can that is generally used for carrying milk to a factory. The sides are perpendicular, and the lid slips down inside until it rests on the surface of the milk, thus preventing a too violent agitation en route. In the middle of the lid is a hole through which the gases of the milk can escape. As many farmers send their milk to the factory in ordinary farm carts that are innocent of springs, the milk would be almost churned on its way if the space in the can were large enough to allow the milk to wash about; the sliding lid of the can obviates this. Arrived at the factory, the milk is poured into a can that stands on a weighing-machine, both of which are raised high enough to admit of the milk running down tin pipes direct into the milk-vats, and so obviating all lifting of the milk after it is weighed; and in order to this the carts are stood upon raised ground outside whilst they are being unloaded.

Fig. 133 represents the can in which the milk is weighed and the tap by which the milk empties itself into the pipes. In many cases the weighing-can has a plug-tap in the bottom instead, and when each lot of milk is weighed it is let out by raising the plug with a chain that is attached to it. In the case of the can shown in the woodcut the bottom of the can inclines toward the sluice, so that all the milk easily runs out; and this can admits of being placed on a lower platform than the other, because the pipe does not pass under it to abstract the milk.

The cheese is made once a day, except in very hot and bad-keeping weather, when a zealous manager will make it twice a day if he has reason to think the evening's milk will hardly keep sweet till morning. This, however, does not occur very often, and need be no more than mentioned. The normal routine is to receive the evening's milk into the milk-vats, dividing it pretty equally amongst them; keep it cool and in motion, so that it may remain sweet and the cream may not rise; and when the morning's milk arrives make up the two together. There are two objects kept in view in dividing the evening's milk equally among the vats; that souring is more surely prevented by having the milk distributed over as large a vat-surface as possible, and that it is advisable to have the evening's and morning's milk mixed together as evenly as may be convenient.

The vats (Fig. 134) are not always the same size, but they are usually capable of holding about 500 gallons each, being 14 feet long, by 48 inches wide, and 20 inches deep. They are made of stout tin of the best quality, and are enclosed in and supported by a stout outer case of deal or pine, between which and the tin is a space under the bottom and around the sides and ends. During the night a stream of cold water runs through the vats, in at one end and out at the other, filling the space between the tin and the wood, and thus cooling the milk which the vats contain. And the water is made to perform a second duty, for as it issues from the other end of the vat it is conducted by an india-rubber tube to a small water-wheel that is sunk in the floor close by. To the wheel the agitators are attached, and the water, gradually filling the buckets that are on the periphery of the wheel, at length causes half a revolution, which, by crank and lever overhead, stirs the agitators that float on the surface.
of the milk. The agitators are simply wooden rakes, and these, pushed to and fro by the intermittent action of the water-wheel, move the milk every half-minute or so, and thus prevent the rising of the cream.

In this manner the milk is soon cooled down to about 65°, providing the water is cool enough for the purpose; below 60° it is not considered advisable to cool milk for cheese-making purposes, and if it has been delivered in good condition at the factory it may be safely allowed to remain at a temperature of 65° to 70°, even in very warm weather. But if it is cooled below 60° it seems to be deprived of some property that it does not regain; the curd from it is dull and lifeless as it might be, and the cheese appears to ripen after the manner of fruit on the wrong side of a wall.

Whilst the milk is being cooled another important process is going on, for the agitators, whose chief office is supposed to be that of preventing the rising of the cream, perform the equally important though less obvious duty of aerating and deodorising the milk, thus enabling it to throw off the heat and odour and cowy smell peculiar to new milk. This aeration ought, however, to be performed before the milk leaves the farmstead, for the longer the odour and warmth are retained in the milk, the quicker will it decay. Milk obtained from heated cows that have been tormented by the attacks of flies, or have been hurriedly driven on a hot summer's day, is already in a state of heat and ferment which are the fore-runners of decomposition; it is therefore by far the best that milk should be at all events partially aerated and cooled immediately after it is drawn from the cow throughout the hot weather of summer and autumn, or it will acquire a taint that cannot afterwards be entirely got rid of; and milk very quickly becomes tainted if it is put into closely-lidded cans and jolted in a farm-cart over a mile or two of rough roads, on its way to the factory. It is, of course, less necessary to take these precautions with the morning's milk than with the evening's: the former is made while the cows are cool and tranquil in the night and when the flies are at rest, the latter is made in the heat of the day; the former is made up into cheese soon after it arrives at the factory, the latter has to wait twelve or fourteen hours in the milk-vats.

When the morning's milk arrives at the factory it is weighed and run into the vats, where the evening's milk is waiting to receive it; and when sufficient of it has gone into the vat that is farthest away from the weighing-can, the tin pipe is shortened to adapt it to the next vat. Steam is then turned under vat No. 1, occupying the space that has been filled with a stream of cold water through the night, and the milk in the vat is raised to a temperature of 78° to 82°, according to the weather, and the rennet is mixed with it. The heating of the milk at this stage and the cooling of it during the previous night are modified to suit the state of the weather and the time of the year; in cool weather it is heated up to 81° or 82° at "setting" time, and in warm weather to 78° or 79°; in cool weather the space between the outer and inner shells of the vat is merely filled or partly filled with cold water, the stream of it being then conducted to the water-wheel without running through the vat on its way; in warm weather it is not easy to over-cool the milk, and the water runs through the vat all night. These modifications, if carried out with thought, not only save trouble, but improve the quality of the cheese.

The exact quantity of rennet to be added to the milk will depend on its strength and purity, but it ought to be so that half a pint of it will coagulate 100 gallons of milk in about an hour; and it should always be as pure and sweet as such an unlovely element will admit of, or the cheese will taste of it. A test of the strength of rennet is that the milk shall have perceptibly thickened in a quarter of an hour, and that it shall be sufficiently coagulated in an hour, the vats meantime being covered, if the weather is cool, to preserve uniformity of temperature.

The test of coagulation having advanced far enough is that the curd shall break cleanly over the finger in trying to lift a bit of it; and at this point the curd-knife (Fig. 135)—a many-bladed cutter, the blades of steel, turned to preserve them against the effects of acid in the curd, sharp on the edges, fixed parallel to each other about half an inch apart, and perpendicular in position—is now passed slowly through the mass of curd backwards and forwards, from one end of the vat to the other,
until all is cut. Later on the curd-knife (Fig. 136), the blades of which are horizontal in position, is also passed to and fro through the mass of curd, cutting it into cubes and strips about half an inch square; or, in default of this second knife, the curd, having rested a short time since the first cutting, is turned over gently by hand, and the first knife passed repeatedly about in it until it is all cut into small pieces. The cutting and turning of the curd at this period are performed in a very gentle manner, because the newly-formed coagulum is for the time being very tender, and it is desirable not to crush or bruise it by hasty manipulation.

Again the curd rests for a time, during which the whey is rapidly separating from it. After a short time a little steam is turned into the space between the shells, and the curd is kept in stirring—a little faster than before. The whey now exudes from the curd very rapidly, and the latter shrinks in bulk, becoming firmer and tougher as it shrinks. More steam is now turned on, and the curd will bear without injury a little rougher usage. It must be kept constantly moving, or the bottom of the vat will scorch it, the result of which would be that a thin hard shell would form round the scorched particles of curd and would keep the whey inside them. The bottom of the vat is made very hot by the steam, the whey is rapidly leaving the curd, and the curd is kept in rapid motion to prevent scorching. This is a very busy period of the process. Meantime the whey has almost completely left the curd, the particles of which have shrunk from half an inch to about the size of grains of wheat, and they are no longer tender and delicate.

This steaming of the mass of curd and whey is called the cooking process, and it is advisable not to hurry it too much—not to raise the temperature too rapidly, that is. When the thermometer marks 90°, the steam is turned off and the curd kept stirring for some little time longer, until the bottom of the vat has cooled down somewhat; at this stage the vat and its contents remain at rest for fifteen or twenty minutes, during which time the other vats are being attended to. Presently the steam is again turned on, the curd and whey are kept in motion by a curd-agitator, or stirring-rake, two kinds of which are seen in Figs. 137 and 138, and the temperature of the contents of the vat is raised to 98° or 100°. Throughout the steaming part of the process the manager uses his thermometer frequently, as it is advisable not to heat up the mass too high or too quickly, and when 100° is indicated the steam is turned finally off. Again the steaming is modified to suit the weather—to 90° or 98° in very hot weather, and to 100° or 102° in very cold.

The direct effect of the steaming is to expel the bulk of the whey from the curd, and to develop lactic acid, which expels the remainder. After the steam has been finally turned off, and the curd has been kept in stirring a short time longer to prevent scorching, the curd settles to the bottom of the vat, and it is left at rest for the longer or shorter time which is required to develop a perceptible quantity of acidity; this will depend on two things chiefly—whether the milk was or was not perfectly sweet and fresh, to begin with, and whether the atmosphere is hot or cold. If the milk is quite fresh and the weather cold, acidity is sometimes several hours in developing.

It is a common practice to use sour whey in the milk at the time of setting it for coagulation, in order to hasten the development of lactic acid. The quantity of whey to be used will depend to a very great extent on the temperature the evening’s milk is found to be at on the following morning, for the higher the temperature of the
milk, the smaller the quantity of whey that will be required to bring about the desired result. By remaining through the night at a temperature of upwards of 65°, the milk has been going through the incipient stages of acidity, and when warmed up to 100° the acid soon becomes perceptible; but when the milk has been kept at a lower temperature, it is free enough from acid when morning comes. It will seldom, if ever, be found necessary to use any sour whey in warm weather, or when the milk is over 63° in the morning; and even in cold weather it must be used with caution. We assume that the whey to be used is distinctly acid, though not extremely so, and in this case the quantity to be used will be about as follows:

<table>
<thead>
<tr>
<th>Quantity of Milk</th>
<th>Temp. of Milk in the morning</th>
<th>Sour Whey to be used</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 gallons</td>
<td>63° Fahr.</td>
<td>3° quarts.</td>
</tr>
<tr>
<td>200</td>
<td>62°</td>
<td>6</td>
</tr>
<tr>
<td>200</td>
<td>61°</td>
<td>8</td>
</tr>
<tr>
<td>200</td>
<td>60°</td>
<td>11</td>
</tr>
<tr>
<td>200</td>
<td>59°</td>
<td>14</td>
</tr>
<tr>
<td>200</td>
<td>58°</td>
<td>18</td>
</tr>
<tr>
<td>200</td>
<td>57°</td>
<td>22</td>
</tr>
<tr>
<td>200</td>
<td>56°</td>
<td>27</td>
</tr>
</tbody>
</table>

This borrowed acidity assists the rennet in its work, and the milk coagulates in less time; hence it must be cautiously employed. If, however, in this case all the whey be removed soon after it has left the curd, the cheese will be firm to the touch, sweet and mild in flavour, rich in quality, and of the finest texture. But if the whey is left for some time resting on the curd, it is a matter of the first importance that the development of acidity be closely watched, for if it is allowed to go too far, the cheese will never ripen as it ought to do. And, indeed, whether acidity is generated by using sour whey, or whether by steaming up to 100°, it is equally necessary to watch it very carefully, and to draw off the whey as soon as the acid is perceptible to the taste or smell. The formation of acid may be easily seen by a careful watcher in the changed appearance of the whey—not a change of colour, but a sort of glimmer or brightness on the surface. But the ordinary test is to take a piece of curd in the hand, squeeze the whey well out of it, and touch hot—not red-hot—iron with it; if sufficiently acid, or if the "cheesing process," as it is termed, has advanced far enough, the curd will adhere to the hot iron, and draw out in fine threads an inch or so long. Whether these threads indicate acidity, or a given stage in what we may term the digestion of the curd, is a matter not yet determined.

The Cheddar system of cheese-making is, perhaps, the most celebrated of all systems, and the most universally useful; and in that system acidity is, perhaps, the most prominent feature. It is brought about by what is termed slip-saucing—not by heating up the whey and curd by steam. But in the Cheddar system acidity is developed in the curd alone rather than in the curd and whey together; and this, we believe, is the soundest and safest way of employing acidity. The method employed in the factories is what we may term the American-Cheddar method, which is a modification, though not necessarily an improvement, of the old Cheddar system. The chief disparity between the two lies in developing acid in the whey on the factory system, and in developing it in the curd on the Cheddar system. The only reasons that can justify the former are—first, that in factory cheese-making the milk is much more likely to be tainted than it is in farm-houses, and acid checks taint; and, second, that when the milk is very fresh to begin with, it is very tedious to develop acid in the curd if the whey is dipped sweet. These reasons may seem paradoxical, because they are founded on two opposite states of the milk—perfectly fresh and tainted milk; they are, however, not by any means as paradoxical as they seem, and milk that is neither very fresh nor perceptibly tainted will produce a curd in which acidity will develop even if the whey is removed as soon as possible; tainted milk would also do this, but in this case a stronger acid than would develop in the curd alone is required to check the taint, while in the case of perfectly fresh milk it is difficult in the curd alone to develop the amount of acidity that is desirable.

It is open to doubt whether on the factory system the cooking process is not carried too far—whether the curd aimed at, acidity, could not be better attained by the use of a small quantity of sour whey and less steaming. But, however this may be, there is no doubt whatever that the practice of developing the required acidity in the whey and curd together is a dangerous one in the hands of a careless person. We believe a better plan is to dip the whey sweet—that is, before any acidity is perceptible—and
afterwards packing the curd in the bottom of the vat, and keeping it warm until the whey is out of it and the acid is developed. This may be the more easily done by piling the curd on racks in the bottom of the vat, after the Cheshire manner, and covering it up with a thick cloth to keep it warm. The object of piling the curd on racks is to enable it to avoid being scorched if it is found advisable to turn on a little steam now and then to keep up the temperature.

We are not advocating drawing off the whey while the curd is still soft, but drawing it off before any acid that can be easily detected has formed in it. This is coming very near to the pure Cheddar system, and the system now employed in the factories is midway between that and the first modification of the Cheddar plan that was adopted in America. That first modification consists in developing all the acid in the whey, and then vatting and salting the curd at once when the whey is dipped off; the midway system consists in developing part of the acidity in the whey, and the remainder in the curd; while the pure Cheddar consists in developing all the acid in the curd. But to return to the modus operandi that is followed out in the factories.

When the whey is considered ready for dipping—that is, when the acid is sufficiently developed—the perforated strainer (Fig. 139) is placed close to the lower end of the vat and sunk to the bottom of it, and the syphon, also seen in Fig. 139, is filled with whey, and one end of it placed inside the strainer, the other end being outside the vat. The syphon has, or ought to have, a faucet at the long end and a valve at the other, thus preventing the whey from escaping when filled; by placing the valve end in the strainer, which is made of perforated tin, the whey can be drawn off from any of the vats, as it will immediately commence running on opening the faucet. When the bulk of the whey has run off, the blocks of wood are removed from underneath the two legs of the vat at its lower end, and the vat tips on the two legs in the middle, causing the whey to incline to the spot where the syphon is at work. As the whey runs off through the syphon it is conducted away either to the whey-vats, where it is allowed to remain until it has thrown up its cream, or it passes directly away to the tank. Meanwhile the curd adheres together and is drawn to each side of the vat, leaving a space down the middle, by which, as the vat is now tilted, the remaining whey can drain off as it leaves the curd. The curd is then cut into lumps, which are piled on edge in the upper end of the vat; the lumps are turned over occasionally, as well to expose them to the action of the oxygen of the air as to facilitate the escape of the whey.

After the curd has thus lain some time and the whey has nearly all left it, it is ground to the size of raisins and currants mixed, and salted at the rate of 2 per cent.—that is, 2 lbs. of salt to 100 lbs. of curd, or per 1,000 lbs. of milk, which comes to about the same thing. The mill used is similar to Fig. 93, page 207, except that there are studs in it instead of blades; it is placed across the milk-vat when in use. The salt and the curd are well mixed up together by hand, so that the former may be equally distributed through the latter. The curd is next measured into the press-vats which are in use, and for a while at first is put under a light pressure, so that the remaining whey may leave the cheese without carrying away with it too much of the solids. The grinding crushes the curd to a degree that would, if possible, be gladly avoided, and if a heavy pressure is put upon it immediately afterwards the whey that comes from it is quite white, with minute particles of curd. In the course of an hour, the pressure having in the meantime been increased, the newly-formed cheeses are taken out of press, bandaged, and put in again; but they do not require "dry-clothing," like farm-house cheese. The best press for factory use is the compound press seen in Fig. 119, page 235. A heavy pressure is now put on them for the night, and next morning they are finally taken out of press and taken to the cheese-room, weighed—the weight booked—and put on the shelves to ripen. Before being placed on the shelves, however, they have strong tissue-paper hot-ironed on the flat sides of them; this is done to pre-
vent cracking and to exclude the air, but we do not consider it necessary for either of these purposes, though it is, no doubt, useful in assisting to "coat" the cheese—the hot-ironing, that is, is useful.

The shelves used for cheese in factories are self-turning. In each frame are three or more "sets" of shelves, each containing three rows of cheese. Each of these sets is turned separately, quickly, and easily in about the time it would take to turn a single cheese by hand; and they have the advantage of allowing each cheese to rest on a dry place every time the turning is done. The sets are held in position by a catch and carry-latch in the end, and the strips of wood at the back prevent the cheese from slipping off. These self-turners are great labour-saving contrivances, and they offer no obstacle to a due examination of the cheese. Fig. 140 sufficiently explains their general construction.

In several factories that we know, the cheeses are first placed in a damp room on the ground floor; this, we think, is a mistake. We have frequently seen the young cheeses with a film of mould covering them, owing to the dampness of the room, and it is scarcely possible that the ripening, checked in this way in the earliest stages, should ever be properly completed. It is not by any means an uncommon thing, strange as it may seem, that well-made cheese is spoilt in the ripening. But where the curing or ripening rooms are well adapted to the purpose, dry, well ventilated, and maintained at a temperature whose limits do not exceed 75° on the one hand and 65° on the other; where the milk from which the cheese is made is brought to the factory in good condition, and where the cheese has been carefully made on the system we have described, the results will be in all respects satisfactory. Carefully made from good sound milk, and as carefully ripened, such cheese will, at two months old, be covered with the dark green coat that so much improves the appearance of cheese, and which may be generally taken to indicate ripeness; the flavour and aroma will be rich, delicate, and nutty, and the texture flaky and compact—not waxy or soapy,
but mellow and salut between the thumb and finger.

In Fig. 141 we give a ground-plan of the Brailsford cheese-factory, near Derby, which is one of the best in the country, so far as convenience of arrangement and excellence of construction are concerned. It is large enough to make cheese from the milk of 700 to 800 cows. In Fig. 142 is given a view of the interior of this

circle by training farmers to stricter commercial ideas with regard to the business in which they are engaged. The average yield which dairy-cows return, or ought to return, to their owners, in order to ensure a profit in cheese-making, is no longer arrived at by hazy conjecture among those who send their milk to a factory; the fiscal-equivalent of a gallon of milk has ceased to be a nebulous entity; the quantity of milk required to make a

![Fig 142.—Brailsford Factory (Interior).](image)

factory, showing the weighing-can and the pipe from it which conveys the milk to the milk-vats, three of which are plainly and the fourth partly seen; on the left are seen two of the lever-presses, which are now in general use in English factories and farm-houses alike.

Though it is improbable, owing to the rapid expansion of the milk-trade in this country, and to the facility with which cheese can be produced in enormous quantities in America, that cheese-factories will become numerous in Great Britain, their introduction has done much good in dairying

... pound of cheese in the different months of the season is understood with tolerable accuracy; and this educational process has brought in its train a great deal of practical inquiry into the most economical methods of feeding dairy-cows and of producing at a minimum cost a maximum quantity of milk. The commercial principle, in fact, is being developed in dairy-farming, slowly and fitfully, perhaps, but none the less surely.

We are decidedly of opinion that dairy-farmers would do well to keep a record of the milk their cows produce per day, and of the cheese and butter made from it. In any case such a record would
be a means of education, and would be valuable for reference, and for comparison with succeeding years. We do not advocate an elaborate system of book-keeping, because we know that such a system would soon be thrown aside, but a simple account showing at a glance the daily items and

This form of book-keeping, it is hardly needful to say, would, with few alterations, do equally well for farm-house and for factory, for the landlord on the home farm, and for the large and small tenant-farmer as well.

The sound commercial principles and methods

<table>
<thead>
<tr>
<th>Statement of Dairy Produce</th>
<th>Farm, for the Month of</th>
<th>18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Daily Quantity of Milk</td>
<td>Made into Butter</td>
</tr>
<tr>
<td>-----</td>
<td>------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td></td>
<td>qts. gals.</td>
<td>lbs.</td>
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<tr>
<td>1</td>
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<td>2</td>
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<td>30</td>
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<tr>
<td>31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
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</tbody>
</table>

the monthly totals. In the annexed form Mr. Jemmatt, the well-known agricultural accountant, has given us a system which admits either of minute details, or of general results only, being recorded. An account-book, prepared somewhat after this manner, would cost very few shillings, and might save a great many pounds; while, if faithfully kept, it would be a graphic picture of dairy operations one year after another, a picture very instructive and well deserving of study. just spoken of as so desirable are, perhaps, less apparent in the selling of cheese than in any other branch. The haphazard way still exists of selling cheese at home, the seller being commonly taken at a disadvantage when a sudden advance in the price of cheese takes place; and the unwieldy cheese-fairs at the county towns appear as yet to have a long lease of life to run. We think exchange rooms and commission warehouses provide safer, quicker, and more equitable
means than the present cumbersome methods do for the disposal of cheese, and we should be glad to see them established in numbers. Yet it is probable that the need for them will grow smaller as the years pass on, for it is clear that the quantity of cheese produced annually in Great Britain is diminishing, and in all probability will continue to diminish. Farmers do not watch the markets very closely, as a rule; nor, indeed, have they facilities for doing so at all times. They but seldom have cheese to dispose of, say five or six times in the year, so that they are not often enough in the markets to master the fluctuations, and to save themselves the loss of selling too early in a rising or too late in a falling state of the trade. The dealers, on the contrary, are always en rapport with each other and au fait with the tendency of the trade and with the relationship between the probable supply and the prospective demand; they have access to information from all parts of the country, and of the world in fact, from which the supplies of cheese are obtained, and they have equal facilities for gauging the probable requirements of the public. Hence it follows that they are constantly in a position to do a favourable stroke of business, with the farmer for the victim. We know that the general lines on which the business interests of a district or country are conducted, however inconvenient or faulty they may be, are difficult to alter; of slow growth, framed from time to time to meet the growing wants of the people, they do not easily give place to something totally different. We are, however, glad to welcome the gradual rise of the commission system in the sale of cheese, even among dealers; and at Derby there already exists a warehouse to which farmers' and factory cheeses are sent to be sold on commission. Thus the commercial heaven is permeating our dairying districts, which may fairly be said to have been the last to yield to its influence, and it is doing the good which was to be expected. It is not our object to set farmer against dealer, but we wish to see dairy products disposed of in a manner more in keeping with modern practices in other departments of human industry, and so we venture to advocate changes which seem to us to promise certain advantages.

Proportion of Solids in Milk.

The quantity of milk required to make 1 lb. of cheese varies in different districts, in different years, and at different times of the year. As will have been noticed in the balance-sheets of the Longford, Holmes, and Windley factories, the average for the season was a little over 10 lbs. of milk for each 1 lb. of green cheese, and there is every reason to believe that more curd is produced from a given quantity of milk in factories than in farm-houses. A neighbouring farmer, who was opposed to cheese-factories, made a careful test on the 7th and 8th of July, and from 715 lbs. of milk he produced 61.5 lbs. of green cheese; this was at the rate of 11 lbs. 10 ozs. of milk per 1 lb. of cheese. At an adjoining factory the average weight of milk per 1 lb. of green cheese for the same month was 10 lbs. 9.11 ozs., which was more than 16.5 ozs. of milk per lb. of cheese less at the factory than at the farm-house. There was nothing except difference of system to account for the disparity of result in this comparative test.

Much depends on the quality of the land and on the breed of the cows. The year, also, has a good deal to do with the result, for the milk "yields" better in some years than in others. It will generally be found, however, that the longer the cows have been calved, the richer in curd is the milk. Still, this is not an invariable, but only a general rule, as the following table will show. A wet month, for instance, succeeding a dry one will diminish the proportion of solids in the milk; it will, however, greatly increase the total quantity of milk, and in some measure the total quantity of curd, and the result is more favourable, though the milk shows a less percentage of solids and a greater of liquid. For the table we are indebted to Mr. John Nadin, the able and painstaking secretary of the Hartington Cheese Factory Association. The figures in the table represent the average weight of green cheese—that is, cheese as it leaves the press—that was produced, in each month respectively, from 1,000 lbs. of milk:

<table>
<thead>
<tr>
<th>Month</th>
<th>1876. *</th>
<th>1877. +</th>
</tr>
</thead>
<tbody>
<tr>
<td>April</td>
<td>90.69</td>
<td>95.46</td>
</tr>
<tr>
<td>May</td>
<td>91.16</td>
<td>91.69</td>
</tr>
<tr>
<td>June</td>
<td>96.52</td>
<td>100.55</td>
</tr>
<tr>
<td>July</td>
<td>99.09</td>
<td>101.27</td>
</tr>
<tr>
<td>August</td>
<td>102.28</td>
<td>100.11</td>
</tr>
<tr>
<td>September</td>
<td>100.11</td>
<td>107.95</td>
</tr>
<tr>
<td>October</td>
<td>112.75</td>
<td>112.75</td>
</tr>
</tbody>
</table>

* Opened April 3rd.  + Opened April 9th.
Professor Boelcker, with a view to arrive at certain results, has analysed the milk of a healthy cow at different periods of the day. The professor found that the solids of the evening’s milk (13 per cent.) exceeded those of the morning’s milk (10 per cent.), while the water contained in the fluid was diminished from 9 per cent. to 8 per cent. The fatty matter gradually increases as the day progresses. In the morning it amounts to 2½ per cent., at noon 3½ per cent., and in the evening 5½ per cent. The practical importance of this discovery is at once apparent; it develops the fact that while 16 ozs. of morning’s milk will yield but ¾ oz. of butter, about double the quantity can be obtained from the evening’s milk. The casein is also increased in the evening’s milk from 2½ to 4½ per cent., but the albumen is diminished from 8½ per cent. to 6½ per cent. Sugar is least abundant at midnight (¼ per cent.) and most plentiful at noon (1½ per cent.). The percentage of the salt undergoes almost no change at any time of the day.

Judging Cheese.

This is a matter which, when well done, involves great nicety, patience, and system, particularly where the samples are numerous. The following formula may be found useful:

Scale of Points for Judging Cheese on a Basis of a Total of 100 as Perfection.

<table>
<thead>
<tr>
<th>Definition of Positive Qualities.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flavour 25.—Agreeably, nutty, buttery, fine and full.</td>
</tr>
<tr>
<td>Keeping 15.—Preservation, inclination to slow changing, retention of good qualities.</td>
</tr>
<tr>
<td>Quality 20.—Mellow, salky, pasty, flaky, stoky, rich, soluble, melting on the tongue.</td>
</tr>
<tr>
<td>Texture 15.—Solid, close, firm, compact.</td>
</tr>
<tr>
<td>Colour 10.—Pleasing, natural; not appearing artificial, even.</td>
</tr>
<tr>
<td>Make 15.—Includes all not included under other points, as 100 use of rennet, proper manipulations, ripening curd, salting, pressing, curing, perfect rind, cleanliness, &amp;c.</td>
</tr>
</tbody>
</table>

Definition of Negative Qualities.

Off flavour, strong, tainted, sour, bitter, rancid, rapid.
Rapid decay, early loss of good qualities, soon taking on bad ones, inclined to rapid changing.
Tough, leathery, curdy, sticky, dry, crumbly, insoluble, not melting on the tongue.
Porous, spongy, loose, weak.
Excessively deep or pale, unnatural, uneven.
Improper use of rennet, uneven heating, handling and ripening curd, bad salting, curing, imperfect rind, cracks, skippers, uncleanness, &c.
Chapter XIX.
Butter-making.


The production of milk in the system of an animal is at once one of the most necessary as it is one of the most curious processes in the economy of Nature. That the milk from which we make butter comes from the cow we all know, and we are equally familiar with the fact that it is primarily derived from the food which the cow eats. These two facts taken together place the cow in the position of a machine—a living one it is true, but still a machine, which, receiving the raw material of grass or hay or corn, transforms it into a product which is indispensable to the welfare of mankind. Or we may liken the cow’s body to a laboratory in which crude materials, some of which would not be of any service in themselves in sustaining human life, are reduced to a form in which they are of the greatest possible service. It is worth while to inquire a little how this is done.

The most advanced investigations into the structure of the mammal-gland reveal to us that the interior of a cow’s udder is composed first of all of a wonderful ramifications of ligaments and tissue which, interlaceing each other, support the udder in position; about in this structure blood-veins pass to and fro, and milk-duets, cavities, glands, lobules, and vesicles are distributed. In Fig. 143 we have an illustration of the network which is interwoven in the milk-glands of the udder, and which sustains them in situ. If we pass a pliable probe up the inside of the teat it traverses a duct, or tube, which opens into a reservoir communicating with other reservoirs or with ducts; following one or other of these ducts, the probe finally comes to a small saucer cavity, and it goes no farther. Within this cavity and its vesicles and cells the fats of milk are produced, and there are numbers of similar cavities.

In Fig. 144 we have a portion of the udder showing the main ducts and the lobules which are interplaced. A microscopical examination reveals that these cavities, or lobules, themselves irregular in size and shape, are composed of vesicles which also vary in the same particulars.

In Fig. 145 is shown one of the lobules, which consists of sixteen vesicles, and it also shows the cells which the vesicles contain; these cells are wonderfully minute and delicate.

Now the fat of the animal is constantly supplied to these cells, and they, by a process which may be likened to budding, throw it off in the form of cream-globules. These globules or buds, or fatty-pollen as we may term them, when perfected, drop off into the cavities, in which they come in contact with and are taken charge of by the water therein, which also contains casein, albumen, and milk-sugar that have transuded from the tissues; and they are carried along through duct after duct into the acini, or milk-cisterns, and finally they are extracted through the teats. The product is an emulsion named milk.
When milk is placed under a powerful microscope the cream-globules in it, like the lobules and vesicles in which they were formed, appear irregular in size; their form, however, is always rounded, having a rotund and not an angular exterior. This evenness of exterior is due to the semi-liquid character of the contents of the globules. It follows, then, that these cream-globules have actually been part and parcel of the system of the animal; they will, consequently, always partake in a measure of the nature, character, and condition of the animal by which they are produced; and as cows differ greatly in the nature of their organisation, so must there be differences in the quality of the milk they give.

The subtle process of animal chemistry by means of which the ordinary fat of the animal is changed into the peculiar form of fat which we are familiar with as butter, and the means by which is obtained the no less singular odour and flavour of butter, both of which differ so much from anything else we know, are—and we assume must remain—among the occult mysteries of Nature. But it is evident that the milk-glands are the seat of a wondrous activity to supply the countless myriads of infinitesimal globules of fat which are found in milk; and they are the no less wonderful theatre of mysterious chemical processes which produce the singular and delicate flavour, aroma, and colour of butter.

It will now be understood that milk is a compound fluid, made up in a beautiful way of several distinct elements, and as such is subject to physical as well as chemical changes. We all know that when milk is left at rest in a vessel for a time the lighter portion of it rises to the surface; this lighter portion is called "cream," and is easily distinguished and separated from the "skim-milk" beneath. These cream-globules were first found by Leeuwenhoek in the year 1697; and Fleischmann in our own day has calculated that the largest of them weigh about 00,000,004 milligrams, and that a pound of milk, containing 4 per cent. of butter, contains about 40,000 millions of them. Yet for all this they are not so crowded as we might think, and it has been discovered that between each two of them in fresh milk there is space enough for a third to pass without touching either; this, as it affects the rising of the cream, is an important matter. These globules never all rise to the surface, no matter how long the milk may remain at rest, because some of them are so very minute in size that they have not buoyancy enough to rise through the superincumbent mass of milk, and we never find skim-milk which does not contain a vast number of them. Skim-milk, indeed, is distinguished under the microscope by the absence of the larger globules, and by the lessened number of globules in a given space. Cream-globules contain or are composed of fatty matter, and fat is lighter than milk, hence they may be regarded as tiny.
balloons which seek the position to which their specific gravity entitles them. Some of them, however, are so tiny that the amount of fat they have is not enough to float them to the surface, not even enough to sustain them in situ, so that it has been noticed that instead of rising or remaining in position, a few of them, being mere granules, slowly sink toward the bottom.

The larger globules rise quickest and first, the medium ones next, and so on. Three drops were taken from a vessel containing milk which had been at rest for fourteen hours: the first from the surface of the cream, the second from the lower layer of the cream, and the third from six inches below the surface. The difference in the average size of the globules was found to be as follows:

<table>
<thead>
<tr>
<th>Layer</th>
<th>Average size of globule</th>
<th>Time of churning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface drop</td>
<td>( \frac{3}{4} ) inch</td>
<td>13 minutes</td>
</tr>
<tr>
<td>Second drop</td>
<td>( \frac{1}{2} ) inch</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Third drop</td>
<td>( \frac{1}{2} ) inch</td>
<td>34 minutes</td>
</tr>
</tbody>
</table>

If these different qualities of cream were churned separately, the first would be churned sooner and easier than the second, and the second much sooner and easier than the third, while the quality of the butter would be found to vary with the size of the globules. The average size of the globules is largest when the cow has recently calved, and the longer she remains in milk the smaller it becomes. After a time the larger globules are no longer produced in numbers, and so it follows that the cream of old milk is slow to rise and tedious to churn. It may be borne in mind that cream-globules vary in size from mere granules whose diameter is less than \( \frac{3}{8000} \) of an inch, to the comparatively large one of \( \frac{3}{16} \) of an inch.

As the results of some experiments in churning different qualities of cream, Dr. E. L. Sturtevant gives the following:

<table>
<thead>
<tr>
<th>Quality</th>
<th>Average size of globule</th>
<th>Time of churning</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>( \frac{3}{4} ) inch</td>
<td>13 minutes</td>
</tr>
<tr>
<td>Second</td>
<td>( \frac{1}{2} ) inch</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Third</td>
<td>( \frac{1}{2} ) inch</td>
<td>34 minutes</td>
</tr>
</tbody>
</table>

And corresponding results have been met with in churning milk fresh from the cows, in which the average size of the globules showed still greater variations of quality; the milk was cooled to 60° Fahr., and churned in a Florence cask. "These relations," it is said, "are too constant to be accidental, and are useful as explaining some of the actions of milk in the hands of the dairy-maid. When churning takes place the larger globules are broken first, and, by being over-churned, apparently hinder the breaking of the smaller globules." When the smaller globules are not broken in the churning, many of them pass away in the buttermilk; the rest are either retained in the butter, or are removed by washing it. Assuming that the globules have actual shells, and that the shells consist of casein or of albumen, it is a disadvantage to retain them in the butter, for they decompose earlier than the butter-fats, and so cause the butter to go rancid.

It is, however, as yet undetermined whether or not the globules have shells at all, properly so called, though a great many experiments have been made with the object of deciding the question. It is probable, still, that the enclosed fats have a covering or protection of some kind, for they are not dissolved when other or other agents which dissolve fat easily are added to the milk, and they certainly would be dissolved in this manner were it not that they have a covering of some sort. In any case the globules, and the shells which encase them, if shells there be, are elastic in nature, for the fats will expand and contract in varying temperatures without rupturing the round form, and it is only extreme heat or cold that will cause them to burst. They soon burst, however, by violent agitation of the cream in a churn.

**The Raising of Cream.**

Every one is more or less acquainted with the natural process by which cream rises to the surface of milk which is at rest for a few hours, yet there are comparatively few who understand the delicate and interesting theories which the process embodies and the influences by which it is affected. Among the more advanced dairymen of Europe and America different practices in the setting of milk prevail, and some of these are so diametrically opposed to each other in their theoretical as well as their practical aspects, that it is as difficult to reconcile them as it is to ascertain which is really the best. It is therefore expedient that we appeal to the natural laws which operate in the raising of cream, in order to gain a clear view of what is right and what is wrong in the matter. Professor L. B. Arnold, one of the leading authorities on dairy matters in America, writes as follows:

"The first prominent fact in the separation of
The temperature and cream-raising.

Cream from milk is that it rises by reason of having a less specific gravity than the milk with which it is mingled.

"The average specific gravity of milk is about 1.036. The difference between this and 0.855 brings the cream to the surface; it is so little that the cream makes haste very slowly. The globules never all come to the surface. Other circumstances being the same, the largest ones rise soonest, as they are specifically lighter, and in rising meet with less resistance in proportion to bulk than the smaller ones. Many of these never make a start towards the surface at all. Neither do the large ones always rise; some of them settle instead of rising. In placing in a glass tube 16 inches long milk on which the cream appeared to rise perfectly, leaving a blue skim-milk, and letting it stand twenty-four hours, and then drawing milk from the bottom of the tube, globules of good size (1/10 of an inch in diameter) appeared mingled with the smaller ones. As globules of unequal size remained at the bottom, it is evident they did so because of a difference in their composition which made them specifically heavier. Those remaining at the bottom of a deep vessel appear less opaque than those which rise to the surface, those rising first being the most opaque. Analyses of skim-milk show that about one-eighth of the fatty matter never gets to the surface.

"The smaller the globules, the slower they rise; and some of them dwindle down to such minuteness that they would not rise through 3 inches in a week, if the milk could be kept sweet that length of time. Cream will continue to rise till the milk gets thick, be that time short or long. The best part rises first. If milk is skimmed every twelve hours, and the cream of each period churned separately, the product of the first period will be the highest flavoured and the highest coloured, and the colour, quantity, and flavour of each successive skimming will diminish to the last, but the keeping qualities will grow better. The fourth and fifth skimmings will be quite pale and insipid. Where a high-coloured article is desired it is not advisable to continue the process of creaming too long. What will rise in forty-eight hours at 60°, on milk 4 inches deep, is all that is generally profitable to separate. What comes up after that is so white and tasteless as to do more injury, by depressing the flavour and colour, than it can do good by increasing quantity.

"The second essential point is the fact that fats expand and contract more than water with heat and cold, and more than the other elements of the milk. The difference of specific gravity between milk and cream is varied by the circumstance of temperature. It is greatest when hot and least when cold, and this fact materially affects the rising of the cream.

"As fat, of which cream is chiefly composed, swells more with heat and shrinks more with cold than water, of which milk is chiefly composed, it is evident that, if other circumstances are alike, cream will rise better in a high temperature than in a low one, since the fat in cream, by swelling more with heat, will be relatively lighter when both milk and cream are warm than when both are cold—the temperature in both cases neither rising nor falling, but standing without change. Most people seem to have the opinion that milk must be cooled to make the cream rise fast, and that the colder they get it, the faster the cream will rise. The fact is exactly the reverse when the temperature is stationary. The colder the milk, the slower the cream rises, because there is less difference between the specific gravity of the cream and milk, and because the milk is more dense and offers more obstruction to the motion of the cream-globules. It does not rise so fast at 60° as at 160°. In butter-making the waste of butyrous material is confined almost wholly to the minutest particles of cream. These rise with great difficulty and very slowly. Those who make butter from whey often heat the whey to 170°, when the difference in specific gravity between the fat in the cream and the water in the whey becomes so great that the cream all rises to the top in a short time. By cooling to 60°, five or six times as much time is required to effect the same result.

"In noting the difference of expansion in water and fat by varying the temperature, the fat in rising from 60° to 130° swelled, as near as I could determine by graduated tubes, twice as much as water by the same increase of temperature. Water expands unequally by an equal increase of heat, according as the increase is made at a high temperature or at a low one. Water rising from 40° to 50° swells only one-tenth as much as when rising from 50° to 90°, and in cooling, of course, the same law is followed in the shrinkage. In falling from a high temperature to a low one, the
water in the milk shrinking little and the fat much, the specific gravities come nearer alike, and hence the fat rises more slowly at low temperatures than at high ones when the temperature is unvarying. Water is a better conductor of heat than fat; hence, when the temperature of milk varies either up or down, the water in the milk feels the effect of heat or cold a little sooner than the fat in the cream does, therefore the cream is always a little behind the water in swelling with heat or shrinking with cold—thus diminishing the difference between the specific gravity of the milk and cream when the temperature is rising, and increasing it when the temperature is falling. The difference between the specific gravities of milk and cream when both have the same temperature is but little; it is barely enough to give a sluggish motion to the cream. Where the difference in gravities is so very small a slight increase or decrease is sensitively felt, and the careful observer will have no difficulty in noting the retarded ascent of cream in a rising temperature, or its hurried ascent in a falling one. The fact of a hurried rising of cream in a falling temperature of milk has great significance in butter-dairying; but though always open for recognition in every butter-making establishment, whether corporate or private, it has failed of being recognised both by dairymen and dairy-writers—perhaps because they have had their minds bent on some ideal temperature or depth as the \textit{sine qua non}.

"A further consideration is depth; other circumstances being equal, it must be evident that it will take cream less time to rise through a thin structure than a thick one—less time to rise through 3 inches than 12. But depth involves temperature, which makes the question of depth a complicated one. It cannot be consistently considered alone, for there is no particular depth at which, under all circumstances, cream rises better than at every other depth; and of temperature it may also be said that there is no particular temperature at which, under all circumstances, cream rises better than at every other temperature. Depth and temperature are somewhat correlative; in practice they affect each other, and they should be considered in connection. Further experiments are necessary to note all the facts which result from the combined influence of these two circumstances, but a little explanation may help to show how these general statements are connected with deep and shallow setting.

"If two vessels of milk at \textit{80°}, and of the same depth and quality, are set in a room which has an even temperature of \textit{50°}—one being cooled to \textit{50°} before setting, and the other not—the vessel which is cooled will not throw up cream so rapidly nor so perfectly as the one which is not cooled before setting, because the former will receive no benefit from an increased difference between the specific gravities of the milk and cream by reason of a falling temperature. If, after the cooled milk has stood at \textit{50°} until the cream ceases to rise, it is warmed, and then set again in a room at \textit{50°}, or if, without warming, it is set in a colder room, more cream will rise, because of the falling temperature that will in either case follow. The same results would be obtained, but in a feebleer degree, if the milk which was not cooled before setting were treated in the same way, provided it was set shallow, say 2 inches deep, in the first place. Bearing in mind that the warmer milk is kept, up to a certain point, the sooner it spoils, \textit{65°} is a high temperature to set milk in; yet milk set 2 inches deep at \textit{65°} will throw up its cream quickly and perfectly when it would not do so if set at \textit{50°}, because in the latter case it would too soon fall to the standard of the room and cease to derive any advantage from a falling temperature. If we should set warm milk in vessels 6 inches deep in a room at \textit{65°}, it would take the cream so much longer to come up through that increased depth, and it would remain warm so much longer, that the milk would spoil before it had all risen. But let the deep vessels be placed in a cold room, say \textit{50°}, and the result will be altogether different. Unlike the shallow milk in the cool room, the increase of depth and bulk will so much prolong the time of cooling that the cream will all, or very nearly all, rise before the milk has dropped to the temperature of the room.

"We can now see how the arguments of the advocates of deep and shallow setting are derived. An experimenter having observed a fact like the last, in which the cream is perfectly raised in a deep vessel, declares in favour of deep setting as the best and only sure way to get all the cream; and another one, having set milk 2 inches deep at \textit{65°}, and accomplished the same result, takes position on the other side, and becomes an advocate of shallow setting under all
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circumstances. Each having weighed but half the facts, his arguments cover but half the ground. Had both investigated more thoroughly, they might have agreed in the position that all the cream can be obtained by either deep or shallow setting, if there is a proper adaptation of conditions; and they might go farther, and lay it down as a rule that the warmer the room in which milk is set, the less should be the depth of the milk, and the cooler the room, the greater may be the depth of the milk. By having the foregoing statements well grounded in the mind, and keeping in distinct remembrance the relation between temperature and depth, especially the important effect of a falling temperature, any one can, with a little experience, be successful in raising cream perfectly at any temperature from 40° to 70°.

"It will become clear that, though certain temperatures are desirable, they are not absolutely necessary to obtaining all the cream. There is a great deal of talk about an even temperature for raising cream, and, so far as the dairy-room is concerned, it is desirable that it should be uniform, because it gives regularity to all the operations of the dairy, and aids in securing uniform results; but so far as the single fact of raising cream is concerned, it is better that the milk should not be kept at any one particular degree, but at a temperature steadily falling as long as possible. It is an important item in heating milk before setting it that it gives a wider range of temperature for it to fall through. Low cooling contributes to the same result at the other end of the scale; but it is necessary to observe that in using low temperatures the depth and bulk of milk should be graduated to the warmth, so that the rising of the cream shall not be arrested by too soon bringing the temperature of the milk to a standstill. If the cooling is sufficiently rapid to prevent the milk from souring before the cream is all up, the slower the cooling the better, as the benefit of a falling temperature will be more fully availed of. This is one reason why cooling milk in cold air is better than cooling in cold water; the water, being a better conductor than the air, brings the temperature to a standstill too soon. But at the beginning the rapid cooling will throw up cream faster than slow cooling, but the slow cooling produces the best results in the end.

"The greater the number of degrees of temperature through which milk falls while the cream is rising, the more perfectly does it come up, other circumstances being equal. Milk cooled from 80° to 60° in twelve hours will not throw up its cream so rapidly nor so perfectly as when falling from 50° to 40° in the same time. Facts like this have been noticed, and a wrong inference drawn from them. It is supposed, because cooling at 40° instead of 60° makes the most butter, that cream rises better the lower the temperature. But this inference is unwarranted and untrue, for if a mess of milk is divided, and one-half cooled to 60° and the other to 40° before the cream is allowed to rise, and kept at those temperatures respectively, the cream will rise more rapidly and perfectly on the portion that is cooled only to 60°. This fact may be easily verified by experiment, and the general principle confirmed that cream rises better at high temperatures than at low ones when the temperature is unvarying. The other experiment will prove to be a very satisfactory demonstration of the fact in regard to the influence of raising cream while the temperature is depressing. Particular attention is called to these general facts, because some experimenters who are regarded as authorities have fallen into the error just alluded to. In effecting a separation between milk and cream, the influence of a falling temperature has been long and entirely overlooked.

"Another important fact that affects the separation of cream is the growth of minute organic germs in the milk, which up to a certain point is greater the higher the temperature. In all milk exposed to the air there are thousands of germs that are ready to start up and grow whenever the milk is warm enough for them to do so, and by their presence hinder the upward passage of the cream-globules. The sour-milk spores are the principal obstructions in the way of raising the cream; they begin to form long before the milk begins to appear thick. The growth of other germs does injury by altering the flavour. Organic germs are prevented from interfering with the rising of the cream, either by retarding their growth by cooling the milk, or by killing them by heating it."

The theory of cream-raising, based on facts supplied by experiment, is clearly enough set forth in Professor Arnold's close reasoning, as given in the preceding paragraphs. As he remarks, the
question of temperature has been wholly disregarded, or at all events very imperfectly understood, by butter-makers in the past. It is, however, true that the practical facts connected with temperature in a milk-room have, consciously or unconsciously, been worked out long ago in some cases; yet, not being clearly understood, and therefore not publicly announced, they have not been widely made use of until the present generation. Some may think that Professor Arnold's theory of a temperature falling through a considerable period being the best for cream-raising is disproved by the Swartz system of setting milk in ice-water whose temperature is not many degrees above freezing-point, because by this method the milk in a short time is cooled down to some 40° or 42° Fahr., and therefore has not the benefit of a slowly-falling temperature. It would appear, however, that a rapidly-falling temperature does, though somewhat differently and with a varying result, the work of a slowly-falling one, for the cream under the ice-water system rises very quickly. The difference is this: the cream in the ice-water system does not separate so perfectly from the milk as it does in ordinary shallow-pan setting—probably, in part, on account of the diminished surface of the milk—but it all rises into the upper portion or layer of milk and remains there intermixed with more or less of the milk—is softer, more liquid, and thinner than cream that has risen in the ordinary way. This appears to be the usual result of deep-setting, whether the milk be cooled in ice-water or not; and there would seem to be little or no advantage in cooling milk in ice-water in the cold weather of winter. The advantage of such cooling lies in keeping the milk quite free from sourness in the hottest weather. The thinness of the cream in the deep-setting systems is by some regarded as a disadvantage, and by others not; these say that it churns the better for being thin, those that it does not. For ourselves, we are in favour of not having very much milk churned along with the cream; and yet, where milk is churned, instead of cream only, the supposed disadvantage of churning the milk with the cream does not appear to operate seriously.

The reason of the cream rising so much quicker when the milk is set in ice-water arises from the fact that the cooling operates on the sides and from below rather than on the surface of the milk; the surface, in fact, being covered over with a lid, is in a measure protected from the cooling influence which is operating elsewhere, because there is a space between the surface of the milk and the lid which is occupied by air, and the air is kept warm for a time while the process of cooling is going on around the sides and at the bottom of the can which holds the milk.

This, however, scarcely holds good in the deep-setting of the Cooley system of cream-raising, which resembles the Swartz system closely in principle. In both the milk is set in deep cans and in cold water, which, if not cool enough of itself, is made so by the addition of ice or of snow; the only difference of importance between them is this: in the Cooley system the cold water not only surrounds the can outside as high, at all events, as the milk rises inside, which is the practice observed in the Swartz system, but it flows over the lid as well, and so the can is completely submerged. The water, in fact, is an inch or two over the lid of the can which contains the milk, and so it follows that the surface of the milk is cooled in a measure simultaneously with the rest of it, for the air-space between the milk and the lid is cooled by the water which flows over the lid. And yet the cream rises quite as quickly in the Cooley as in the Swartz system, which goes to prove that cooling the surface of the milk does not retard the rising of the cream, so long as the sides and bottom are cooled as well.

For many generations, so far as we have means of finding out, no change or improvement worth speaking about took place in the method or methods of treating milk in butter-making. It is only in our own day that many and great novelties have been introduced, that improved utensils have been invented, and that the rule-of-thumb practice of the olden times has been reduced to an intelligent and intelligible system. The last twenty or thirty years have brought about a thorough transformation in matters relating to the dairy—a transformation, in fact, which is still in progress, and not at present established everywhere. So far the improvements in dairy practices have made headway in America and in several countries on the continent of Europe rather than in England; and it is to those countries that we have to go in search of the most
advanced practices, and, in most respects, for improved appliances. We shall try to verify this statement later on.

From time immemorial butter-making in England has been a primitive, simple sort of business, the principles of which have not been understood, and until the second half of the present century the utensils and appliances used in it were of a simple and almost rude character. The vessels in which the milk was set to cream were usually of wood, and the milk-rooms were generally used for a variety of purposes, and not kept specially for the milk. Later on, milk-pans were made of brown earthenware, which was glazed inside. These earthenware pans were a great improvement on the old wooden ones, because they were so much easier kept sweet and clean; but they were cumbersome and brittle. They were of different sizes, but generally of one shape; the commonest size was about 12 to 18 inches in diameter at the top and 8 or 10 at the bottom; their sides were sloping, and they were some 6 to 8 inches deep. In recent years these pans have been to a great extent superseded by others made of tin or of galvanised iron pressed into shape, and last of all glass ones have in some places come into use. But for its extreme brittleness, glass is about the best possible material that can be used in the manufacture of small vessels to contain milk, and when the art of making malleable glass shall have been perfected there can be little doubt of this material coming into general use in butter-dairies. The chief merits of glass are that vessels made of it do not become impregnated with taints from sour milk, that they are cleaned with the greatest ease, and that they have no seams in which impurities can lodge. In Fig. 146 is shown a milk-pan of modern shape for shallow setting of milk. As a rule, these vessels are made of wrought-iron, pressed into form so as to obviate seams, and then tinned over.

But they may be made of glass or any suitable material; made, however, of the material indicated, they are very durable, and are kept clean without great difficulty. The common practice in England is to have them, when filled with milk for creaming, arranged on shelves running round the milk-room. Some persons object to tin milk-pans, on the ground that they impart a flavour to the milk, particularly when the tinned surface is worn off, and the iron beneath is laid bare. This objection, no doubt, has some foundation in fact; but if the pans are well cleaned with hot water and soda each time before milk is put into them, the objection may be dismissed. It is worth while, however, to remember that no such objection can be raised against glass or glazed earthenware; and these materials, except for their weight and brittleness, may be declared better than any others for milk-pans.

In Fig. 147 we give a cut of an ingenious set of milk-shelves, copied from the American Agriculturist of March, 1876, which will be found very useful where space is limited and it is necessary to make the most economical use of it. The whole arrangement of the revolving shelves is so well shown in the illustration that but little description is needed. It consists of an eight-sided central shaft, provided with an iron pin at the bottom, which works in a socket in the floor beneath; the upper part is carried through the ventilator in the upper floor. Eight arms are mortised into the shaft to support the shelves, of which there are six. Strips are carried from the upper part of the shaft over the edges of the shelves, as a further support to them. The shelves, which are about 15 inches apart, are made of lattice-work, thus furnishing ventilation to the bottoms of the pans. The lowest shelf is 6 feet in diameter, and about 2 feet above the floor. The whole framework...
revolves upon the pin at the bottom, and is readily moved around as the pans of milk are placed upon the shelves. This arrangement makes a great economy of space. The pans are not shown upon the shelves, so that the structure may be seen. The whole of the shelves should be well painted in pure white. The two sets of shelves, one of which is seen on either side of the room, are of the ordinary kind, yet with the ends so formed that more or fewer shelves can be put in them at will, and the revolving shelves are designed as a supplement to them where space is limited and it is desirable to make the most of it. The revolving shelves, in fact, may be placed in a corner anywhere, and simply need to be turned in order that every pan of milk may be skinned with ease and celerity.

It is necessary to remember that milk-rooms should always be kept scrupulously clean, well ventilated with pure air, free from impure odours of any kind, whether from within or without, and as dry as is convenient. Almost everything is capable of throwing off and absorbing effluvia or vaporous compounds, some of which are beyond the scope of chemical estimation; and it may sound strange to some when we say it would be next to impossible to devise a compound liquid more susceptible than fresh milk is to effluvia influences. Nature never intended that milk should be exposed to the air, but to be taken direct from the body of the parent to that of the offspring. This is clear enough; and the uses to which the requirements of civilised life consign the great bulk of it are just as clearly outside its natural functions. It is what chemists call a transition compound, and as such is fickle and transitory, and requires the most intelligent and careful treatment. Being a quick and powerful absorbent, it is expedient to keep it far enough away from any kind of odour that would taint it. An odour of any kind, be it pleasing or nauseous, will surely taint the butter, through having first been absorbed by the milk. The odour of oil, for instance, of onions, of decaying vegetable or animal substances—any odour whatever, in fact, especially if it be of a pungent character—will be absorbed by the milk which comes in contact with it, and will be reproduced in the butter. The milk-room, therefore, must be kept perfectly clean; floor and walls and ceiling, windows and doors—all must be free from impurities of any kind. If milk is spilt on the floor it must be carefully cleaned away, and not allowed to decompose in the crevices between the tiles or pavement. So with anything else that is at all likely to emit an offensive odour. Ventilation is no less useful than cleanliness, providing it can be done with pure air. But if the air from the outside is likely to be tainted with impurities from cesspools, farm-yards, or what not, it is better to exclude it. And, lastly, it is well to keep the milk-room dry, so that the gases from the milk may pass off into the atmosphere, and so away, rather than that the moisture in the atmosphere should condense on the surface of the milk—a thing it is apt to do while the milk is warm. It must also be borne in mind that all vessels with which the milk comes in contact must be well scalded with boiling—not merely warm—water, and well scrubbed with a hard brush after each time of using, and especially so if they are made of metal or wood. Glass and glazed earthenware will easily be kept clean with heated water without the scrubbing. Sour milk has a great faculty for tainting any vessels in whose pores or crevices it can find a lodgment; it decomposes there, and if not removed will turn fresh milk sour in a short time, so each time a vessel is emptied of its milk it must be thoroughly cleaned before other milk is put into it. If these matters are faithfully attended to, the milk will throw up pure, sweet cream, and the cream will produce butter whose flavour and aroma will gratify the palate of an epicure.

A good deal of importance is attached by many people to the practice of heating the milk soon after it is drawn from the cow, and before it is set for creaming, up to 130° or 140°, and there can be no reasonable doubt that this practice, if intelligently carried out, is a sound one. In the first place, it will expel the animal odour, the "cowy" smell, from the milk; it will, for the time being, checkmate all germs leading to decay that the milk may naturally contain or that it may have absorbed from the air; and it will dissipate the peculiar flavour which some kinds of food—turnips, for instance—impart to milk that is produced by their aid. But it must be borne in mind that milk at a high temperature will quickly go sour, so that, especially in warm weather, and unless it can at once be placed in a very cold room, it should without delay be cooled down again to about 70° by means of cold water, after which the cooling may be allowed to proceed more slowly during the time when the cream is rising. Whilst
it is being cooled from the high temperature it should be kept in motion, or an albuminous skin will form on the surface, and this will interfere with the rising of the cream. This system of heating, and then cooling, will enable the milk to remain sweet a longer time than cooling without heating; and after the cooling has been done it is a good plan to place a cover over the milk, the more nearly air-tight the better, in order to keep the milk from contact with the atmosphere. Only a particularly pure atmosphere could do the milk any good at this period, therefore it is safest to exclude it altogether. This system of scalding produces perfect butter; it prevents alike the hasty souring of the milk in summer before the cream has risen and the bitterness so commonly developed by long standing in winter, but it is a perilous system when left in the hands of a careless or otherwise incompetent person; for, if carried too far, the delicate flavour of the butter is liable to be dissipated, and if the after-cooling is not carefully finished the milk is apt to turn sour. The effect of scalding milk is described by Dr. Hoskins in the following manner:—

The Swartz System of Creaming.

In recent years a new system of raising cream has spread throughout Scandinavia and Northern Europe generally. It is known as the ice-water system, and was discovered by Mr. Swartz, of Hofgarden, near Wadstena, Sweden, whose name is now associated with it wherever the system is known. It has completely changed the character of butter-dairying in many northern countries, and the high reputation which Danish and Swedish butters have won is owing to it. The system is simple enough from beginning to end, and though it may not have introduced any previously unknown element, it has certainly reduced to a system the best features of the various old practices. The salient idea embodied in the system is that the milk is set in ice-water to cream. This is really the foundation and the essence of the system, and if there is anything new at all in it, this it is that is new.

For cooling or "setting" the milk, tanks or cisterns are used, whose dimensions are governed
by the requirements of each dairy. They are not, however, as a rule, more than 9 feet long by 3 feet wide, inside measurement, and their depth is 24 inches. They are made of 2-inch planks, and are, of course, water-tight. In Fig. 148 is given a top view of one of these tanks, showing the arrangement of the milk-cans in it; and in Fig. 149 is given a section, which gives an idea of the depth, and also shows the inlet and the outlet water-pipes. It may here be explained that wherever there is a constant supply of spring-water which is cold enough for the purpose, there is no need to use ice at all to cool the water, and by it the milk. If the temperature can be brought low enough, say to 42° Fahr., it is no matter whether ice or spring-water be the agent employed; but as it happens in so few cases that water alone can be depended on for the purpose, it is much more common to use water in which a large number of small pieces of ice are placed, and in this case there is not a stream of water coming into and passing out of the tank, but the tank is filled to a proper depth with water and ice, and so left. In some cases the only fresh supply of water which these tanks receive is that provided by the melting of the ice daily, and the overplus of water simply passes away by the outlet-pipe, which can be raised or lowered to regulate the depth of the water in the tank. The water is not, and has no need to be, frozen at any time. Such a temperature would be too low, and would do more harm than good. From 40° to 45° is found to be, as a rule, quite low enough, even in summer; in winter this is easily reached with a small employment of ice, and snow is not uncommonly used instead of ice. In Fig. 150 is given one of the milk-cans, which, when nearly full of milk, are placed in the tank, side by side and about 3 inches apart, as seen in Fig. 148. Immediately after milking, the milk is strained into the cans, and the cans are placed in the tank at once, so that the milk has no time to become in any degree tainted, even in the hottest weather, because of its own warmth, and there is no time lost in raising the cream. In Fig. 151 is seen a milk-strainer which fits on one of the cans; and in Fig. 152 is a lid which in hot weather, or at any time when it is desirable to keep the milk from contact with the air, is used to cover the cans. Two little funnels will be noticed, one at each end of the lid: these permit the escape of the gases and odours from the milk in the early period of the cooling.

The milk-cans are made of iron or steel-plate, and thoroughly tinned both inside and out; their form is oblong, because this shape has been found to be the most effective in cooling, and it admits of the cream being easily skimmed off the milk; their depth is usually that of the tank, viz., 24 inches, and they are filled with milk up to within some 2 or 3 inches of the top.

In summer, ice-water is used for cooling; in winter, snow-water, or water alone if it is cold enough; in winter a stock of ice is stored away for summer use. In the hot weather the water in the tank is regulated so as to reach the same height outside as the milk does inside the milk-cans, so that the cream as well as the milk is kept perfectly cool and sweet; in the cold weather the surface of the milk is usually allowed to be a few inches above that of the water. Each can contains from 2 to 3 gallons.

The temperature of the cooling-room is kept as low as possible in summer, and the milk in the cisterns is reduced to 40° or 42°. In winter the temperature of the room is not intentionally allowed to fall below 50°. The time required for the cream to rise depends on the temperature of the water in the tank and of the atmosphere of the room, especially on the former. If the temperature of the ice-water does not exceed 38° at the time of setting the milk in it, and does not rise much above that point during the cooling, the cream may be skimmed twelve to eighteen hours afterwards, for it rises quickly at this low temperature. It must be borne in mind that 35° is a much lower temperature than is either necessary or
advisable. If milk is set to cream at or a little above freezing-point, the yield of butter will be less than if it were set five degrees higher, and 40° is low enough. In the old-fashioned way of setting milk in pans, as shown in Figs. 146 and 147, the cream has not all risen in forty-eight hours, and this is a dangerously long period to allow milk to stand, unless in cold weather.

The great merit of the Swartz system lies in the perfectly sweet and fresh cream which it produces, and it is only from cream in this condition that the finest-flavoured butter can be obtained—"gilt-edged" butter the American dairymen term it. It is by some laid down as a rule from which there is little deviation, that the fresher and sweeter the cream is, the more nearly perfect will the butter be. Yet even in Sweden, where the system was invented for the very purpose of producing such sweet and fresh cream, the Swartz system is in some cases robbed of the very benefits it is designed to confer; in these cases, as Mr. H. M. Jenkins informs us,* though the milk-house has been altered to enable the ice-water method to be pursued, yet the cream is still kept to go sour, and the butter made on the old system. Where the system is followed out in its integrity the cream is not kept more than two days during the warmer season, and three days during winter, before it is churned. There is, it must be admitted, much diversity of opinion on the subject of sweet versus sour cream for churning. A proper degree of souring, developed as it ought to be, is probably a useful thing in butter-making in some cases; the danger lies in having too much of it in the cream too early. We shall return to this topic later on.

**American Systems of Creaming.**

Great and intelligent attention has for some time been paid to butter-making in the United States; in farm-houses the utensils and appliances have undergone great improvement, and more recently large "creameries" have been established, after the pattern of cheese-factories. Of the creameries we shall speak in a separate section. In Fig. 153 is seen an arrangement of improved milk-pan for raising cream, suitable to a considerable farm-dairy. It will be noticed that two of the coolers have each two pans, making in themselves a complete set, of half the capacity of the full set, which may be used as such in spring and autumn, when milk is not plentiful. The two double pans, as will be noticed in Fig. 154, are connected by a tube, so that in summer each double pan may act as a single one, while in winter it may, by stopping up the tube, be made to act as two distinct pans. The four full pans, made to order according to the number of cows whose milk they are designed to hold, are intended for a creaming process of forty-eight hours' duration, if necessary; or they may be made to answer for a thirty-six hours' process, having in this case one pan empty and ready to receive the next "meal" of milk; or they may answer as a double

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*Journal of the Royal Agricultural Society, 1875, p. 224.
set for a twenty-four hours' process. These different periods will be governed by the rapidity with which the cream can be made to rise by the cooling process. In Fig. 155 is seen the arrangement of the interior of the cooler. Tranverse bars of wood support the milk-pan, and direct the course of the stream of water which is constantly running through, in at one end and out at the other. The water inlet is seen at A, the outlet at B; at C is a brass tube, passing through the stuffing-box, and this can be raised or lowered, so as to increase or decrease the depth of the volume of water inside. At D is seen an opening, through which, by means of a tube from the bottom of the milk-pan, the milk can be drawn off from beneath the cream, leaving the latter in a position which admits of its being easily gathered, without the ordinary process of skimming; and without any of the "skim-milk" being intermixed with it. The prices in America of complete sets of these coolers are as follows:—10 cows, £12; 20 cows, £16; 30 cows, £20; 40 cows, £24; 50 cows, £27. The Orange County milk-pan (Fig. 156) is a good arrangement where room is an object.

Another American system is the "Cooley system," so named after Mr. Cooley, of Vermont, who invented, or rather adapted it in 1876. There is not much—if, indeed, there is anything at all—that is new in principle in this system; it is based on the Swedish ice-water system, which was discovered by Mr. Swartz many years ago, and which is now almost universal throughout a great portion of Northern Europe. The Cooley system we say is based on the Swartz system, but it has one or two features that are not commonly, if ever, found in the latter; and yet these features are not, if we except one of them, wholly original—if, indeed, that one is. The two features are: first, setting the milk-cans in a lidded box or tank; and second, in completely submerging them, that is, allowing the ice-water or cold spring-water to flow over the tops of the cans; this last is the original feature.

The milk-cans, as seen in the one in Fig. 157, are round and deep, and have a lid fitting loosely over the top; they have also a tap in the bottom, by means of which the milk can be drawn away from beneath the cream, thereby obviating the necessity of skimming the latter off the former. To the tap in the bottom it will be noticed a tube is attached; the tube is of india-rubber, and of course flexible; at the other end of it is attached a metal outlet, and this slides in a groove which is graduated to correspond with the narrow pane of glass which is inserted in the upper portion of the can, and which is designed to show how many degrees of cream have collected on the milk. By raising the outlet pipe in the groove to correspond with the depth of the layer of cream, the whole of the skim-milk can be drawn off by the tap and tube, leaving the cream only in the bottom of the can, and so skimming is obviated. In Fig. 158 is given a representation of the box or tank, and inside it are seen two milk-cans fastened down by means of bars of wood placed across the top. The patentee speaks as follows:—
"These engravings illustrate the new system of setting milk in submerged cans. The cans are 20 inches deep and \( \frac{8}{1} \) inches in diameter, the covers are fastened down, and the air under the rims of the covers prevents the passage of any water into the cans. The cans are set in the water-coolers, which are lined with metal, and fitted with inlet and overflow pipes for using flowing spring-water. These coolers are thoroughly built, with tight-fitting covers, to exclude warm air, and retard the melting of ice when used to maintain a uniform temperature. A thermometer is inserted in the front of each cooler, in order that the temperature can be ascertained without raising the cover. This apparatus is very simple, dispensing with costly milk-rooms, as but little room is required, and is the only system that will produce uniform results; and until some uniform system is adopted there will be as many grades of butter in the market as there are makers.

If the temperature of the water in the coolers is kept at 40° to 50° in spring and summer, and at 40° in winter, the cream will rise in twelve hours, in which case only cans enough to hold a single milking are required, or one-fourth of the capacity needed with any of the patent open-pan systems of setting. By the submerged system of setting milk we have sweet cream from sweet milk raised in the shortest possible space of time, a uniform quality and quantity of butter through hot weather, which retains all the rich flavour of new milk, possesses superior keeping qualities, is firm in texture and uniform in colour, free from casein or sour-milk specks, and possessing a peculiarly rich flavour, which imparts much pleasure in eating. Gilt-edged butter can only be made from cream taken from sweet milk."

Fig. 159 illustrates a convenient arrangement for running off the milk from the cans. It can be made of pine boards, the bench about a foot wide, the sides about 3 inches high. If desired, a pipe can be arranged for conducting away the skim-milk. This is an inexpensive thing, and a great convenience—it saves lots of "slop."

Mr. Cooley's experiments were of an interesting and practical kind. He commenced setting milk at 100°, maintaining it at that temperature until the milk soured, noting carefully the quantity of cream and the time it was rising; he then set other samples at 90°, following the same course as above, then at 80°, then at 70°, then at 60°, then at 55°, then at 50°, then at 45°, then at 40°, and finally at 35°, this being as low as he could carry the temperature by the use of ice.

By these experiments he found that the lower he carried the temperature the faster cream would rise, until he arrived at 40°, or the greatest density of water, the best results being attained at between 40° and 45°, if the milk were cooled immediately after being drawn from the cow. And he sums up his conclusions as follows:—"If we want cream to rise quickly, and in the best possible condition for making a first-class article of butter, we must cool the milk thoroughly, immediately after milking, down to at least 45°, and the nearer we approach to this the better will be the results."
In Fig. 160 we give a section of one of Cooley's milk-setting cans as it is in the box, with the water flowing over it, and the cream gathering on the top of the milk. It will be noticed that the can is completely submerged, the water flowing over the top of it. The covers are held in position, as will be seen in the cut, by bars of wood placed across them. They are neither airtight nor water-tight, yet the water does not get into the cans, because the air under the rims of the covers, acting on the principle of a diving-bell, prevents it. If the milk were first of all aerated by forcing through it a volume of air which had been filtered through cotton-wool, or in some other effectual manner, we think this system of milk-setting would be as nearly as possible perfect; but if the milk, directly it is taken from the cow, is put into these cans, and hermetically sealed in the manner described, it would almost seem that the gases of the milk, being confined on the surface, can hardly fail, particularly in hot weather, to injure, however slightly, the quality of the cream. Aerating the milk before submerging it would remove all possible danger on this score.

It is at the same time true that the rapid cooling of the milk fills the office of a safeguard against any danger which may arise from the action of the gases and odours peculiar to milk fresh from the cow. That such sources of danger exist no one who knows his subject will, we think, deny; and, especially in hot weather, when cows are gadding about the fields, is this danger the more apparent to one's sense of smell when his face is over a pail of newly-drawn milk. These remarks, it must be understood, being applicable to milk from healthy cows, are more decidedly so to milk from cows who have foot-and-mouth or any kindred disease. But in any case the cooling at once checks the activity of the gases, and we may reasonably assume that the greater part of them become dormant, and remain in situ in the skim-milk, the risen cream being comparatively free from them. Notwithstanding these things, the best safeguard is aeration—an expedient so simple and cheap that to neglect it is without excuse.

We are able to speak practically as to the simplicity and usefulness of the Cooley creamer; it is, in fact, a great economiser of labour. The cream rises perfectly in twelve hours, providing the conditions laid down are complied with, and so a minimum number of utensils are required for raising the cream; the cans, in fact, on being emptied, are at once re-filled with fresh milk, which, in its turn, is emptied when the cows are again milked; and so the system goes on, the morning's milk taking the place of the evening's, and the evening's of the morning's, and so on the season through. The milk being kept always sweet, by reason of the low temperature, it is not often that the cans require even washing out, and much seldomsealring and scrubbing. At the same time we would advise that they be carefully cleaned two or three times a week in the hot weather; in the cold this is a matter of less consequence.

The Cooley system, indeed, of all the various modifications of the Swartz system, appears to us the most likely to meet the wants of British dairy-farmers. Ice is not necessary to it, providing enough cold water is at hand of a temperature from 40° to 50°. The complete exclusion of the air, by submerging the milk in water, is no doubt a most valuable feature, no matter whether or not there really is any objection to it on the ground we have suggested; and it is owing to this perfect exclusion of the air that the system answers perfectly, so far as raising the cream is concerned, at a higher temperature than appears to be allowable in the Swartz system. In the average of winters ice is not easily procurable in many parts of the British Islands, and so the ice-water systems are not applicable to our wants; but in most dairying districts springs of water are available; and where there are no springs on the surface, there is water to be got in wells below it, of a temperature which will answer well for the Cooley system. In any case we may say that if this system will not meet our insular wants, none of its rivals will meet them. The system is introduced into this country, and to the notice of British farmers, by Messrs.
Neel, Son, and Anderson, of London, from whom the apparatus may be obtained.

The Hardin System.

This system, like the foregoing one—which is, by the way, its junior in point of age—is based on the Swedish system; but ice only, not ice-water, is used as the cooling agent, and the cans, except 4 inches at the bottom, are under the influence of cold air rather than cold water. In Fig. 161 we give a view of the apparatus known as the Hardin system of creaming, which was invented by Mr. L. S. Hardin, who is regarded as an authority on American dairying. The cans which contain the milk may well be identical with the Cooley cans; and as in the Hardin system they are not submerged in water, the gases of the milk have free egress from the cans. This may or may not be regarded as an advantage.

The inventor says of the system:—"About four years ago I started a butter-dairy near the city of Louisville, Kentucky, in a climate hot and humid, where animal substances decayed rapidly, and where insect and parasitic life developed spontaneously and without limit. To spread the milk out in the usual manner was to invite the enemy I was most anxious to avoid. To overcome my difficulties I began a series of experiments, beginning with shallow pans in the open air, and step by step I lowered the temperature and increased the depth of my milk, until I reached what is called the Swedish plan of setting milk, in water at 40°, with cans 20 inches deep. I found I had passed the profitable point, and had to retrace my steps, until I decided upon 49° as the best temperature for raising the cream perfectly, and made my cans 8 inches in diameter and 12 and 20 inches deep. My butter was now all I desired, but the use of ice in cooling water that was in immediate contact with the hot air was too expensive. I soon discovered that it took less ice to cool a given cube of air than it did to cool the same cube of water. It was equally evident that it was a useless waste of ice to cool off a whole roomful of air; and reasoning from these premises, I concluded to confine my milk and air to the smallest possible space, in order to economise the use of ice. I then built me a box with double sides and close-fitting double door, putting a hood or trap over the waste-water pipe, so as to entirely exclude the surrounding atmosphere. As it is the nature of heated air to ascend, I placed the ice-shelf in the top of the box to secure a uniform temperature. A space of 1 inch is left open on each side of the shelf, to allow the air to pass around the ice. The drippings from the ice are utilised to the extent of 4 inches in the bottom of the box. The cans are made with a perforated rim on the bottom, to allow the water to pass under them. The covers of the cans fit outside, so as to shed the water and prevent any of the drippings from the ice getting into the milk."

Mr. Hardin does not attach, nor does Mr. Cooley, any importance to permitting the gases of the milk to escape; and he thinks that not only is there no disadvantage on this score, but that if there were it would be more than balanced by the exclusion from contact with the milk of any foul odours, or of parasitical germs or fungi which the atmosphere may contain. Mr. Cooley argues the point in the following manner:—"This objection to the submerged system may be raised—viz., that there is no way for the 'animal odours' to escape, or no ventilation; to which we reply that while new milk is deemed by everybody pure enough to feed to infants, by some it is supposed to be an impure thing, full of rank taints, when they come to setting it for butter, and we hear volumes of nonsense about 'animal heat' and 'animal odours.' We do not care to set the milk from sick cows, or from cows which consume impure water or food; such milk is unfit for butter. In making butter, the light gases contained in milk, called animal odours, are condensed, as they will be if the milk is rapidly cooled to the proper temperature, and remaining in the watery part of the milk, are thus effectually disposed of. On the other hand, when milk is set in open pans every odour about the premises is absorbed by it, every breeze which blows through the well 'ventilated' milk-room, laden with the perfume of the barn-yard, imparts to the cream flavours neither
pleasant to the smell nor delightful to the taste." And Mr. Hardin says:—"If the milk is set in water, in open pans, and thus kept cooler than the air, it of course condenses the moisture of the air into the surface of the cream, thus drawing down into the cream all the impurities of the air." Mr. Hardin claims that the cream raised by his method is firmer and solider than in other deep-setting systems, because it is cooled mainly from the top, the lumps of ice being on a shelf just above the milk. If this claim be substantiated it is no doubt a point in favour of his system, for in the ice-water systems, whether the cans be submerged or merely set in it to a depth equal to that of the milk, there can hardly be two opinions as to the cream being too thin—that is, having too much of the skim-milk with it.

It appears to us that these two prominent advocates of setting milk to cream in closed cans are going just a little too far. If all dairy-cows were kept in a healthy and tranquil state, and if all the food they ate and the water they drank were quite pure and good in all respects, then, perhaps, the question of animal odours in milk might be dismissed as a myth; but as things are, and ever will be, they cannot with impunity be ignored. It is a fact, too, that perfectly sound milk has, when it is taken from the cow, a sickly and nauseating flavour and odour which many people object to, and that this flavour and odour are to a great extent dispersed by simply aërating the milk, without cooling it at all; and if the milk is cooled as well, and again heated up to blood-heat, the animal odour is not in it. By cooling the milk without aërating it the odour is converted into a flavour. Either aërating or heating to 110° will expel the odour. Now, this being the case, it follows that the cow's odour and taste of new milk cannot be any advantage to the butter, and it cannot but be true that to facilitate the escape of these offenders before the milk is set to cream, wherever such can be done in a pure atmosphere, will tend to the improvement of the flavour of the butter, though it may not affect its quality in other respects. It may be here remarked that aëration is the more effectively done if a gentle wind blows away the gases as they escape from the milk.

The essence of all these statements by the advocates of deep-setting in closed cans is, first, that pure, sweet, fresh cream can with greater certainty be obtained on the ice-water method, be it the Swartz, the Cooley, or the Hardin method, or any other, than can be obtained on the old system of setting the milk in open pans, and without any cooling agency; and, second, that from pure, sweet, fresh cream only can the best qualities of butter be obtained. These data are strictly true; still, it does not by any means necessarily follow that fine butter cannot be obtained on the open-pan system, for we know it can; but to attain this result it is needful to use more care, system, patience, scalding water, scrubbing-brushes, and soda than are used in 90 per cent. of the butter-dairies of the kingdom. It is justly claimed for the ice-water or cold spring-water system that nothing is left to the accident of chance, and that, being a correct system, the results are in the highest degree satisfactory, if the system is faithfully carried out. But in England it is not always possible to lay up a store of ice in winter, and in many places a spring of cold water is not always at hand to use instead of ice. Where neither ice nor cold water is obtainable, the scalding system is no doubt the best, coupled with the always indispensable care and cleanliness. At a temperature about 60°, deep cans will not do; the milk will usually sour before all the cream reaches the surface. When this temperature is unavoidable, shallow and broad pans will give the best results. When cold water is abundant, and the means of keeping it at 50° or lower are at hand, it will be found that cans 20 inches deep and 8 or 9 inches in diameter will save much labour, and at the same time make quite as much and better butter. It must, however, be borne in mind that butter made from cream that has been raised in refrigerators will not keep so well as if the cream had been raised at a temperature near to that in which the butter will be afterwards placed. If, for instance, the cream is raised at 45°, and the butter is kept at 55°, decay will sooner set in than if the cream had been raised at 50° to 55°.

The inventor of the cream-raising apparatus shown in Fig. 162 has endeavoured to produce a creamer which should possess all of the good features of more expensive apparatus, with the advantage of cheapness. The tank in which are placed the milk-cans is made of plank, and has at one end, near the top, a water inlet-pipe, and at the other end an opening partly closed by a gate (a) which regulates the height of the water. The
milk-cans (b) which stand in the water have perforated foot-rims, which admit of a free circulation of water under the cans, and weighted covers (c) are provided which fit loosely and extend downward sufficiently to dip in the water and thus hermetically seal the cans. A conical skimmer (b) is used to remove the cream from the milk. It is carefully dipped, apex downward, into the milk until the cream flows over its edges; it is then removed and emptied, and the operation is repeated until all the cream is removed. This apparatus is designed principally for dairy use, and is particularly applicable where natural flowing springs are available. We cannot, however, see in what respects it is superior to the Cooley creamer, while in some it is in our opinion decidedly inferior. The skimming, for instance, is done with the “dipper,” while in the Cooley system the skim-milk runs out through a tap, so that no skimming is needed, and much trouble and time are saved.

Yet another creamer commands our attention. It is called the Bureau Creamery and Refrigerator, and we give a cut of it in Fig. 163. It differs from the Hardin creamer chiefly in having shallow instead of deep setting of the milk. The inventor contends that the best keeping butter is made from cream that is more perfectly separated from the milk than is the case in the deep-setting system, and which has “ripened” by remaining a longer time on the milk; and he provides against air-contamination by having his shallow pans accessible to only a limited supply of air which has been cooled by contact with ice that is stored above the milk. In the upper part of the bureau is a rack for holding a supply of ice, and a metallic pan with rubber tube attached, for conducting off the waste water from the ice. Immediately below the ice are four large pans, each pan having a capacity for one whole milking of a dairy. Around each pan is sufficient space to admit of the free circulation of cold air from the ice above. The pans stand on suitable rests, and are each provided with metallic castors, so that they may be easily drawn out of the bureau, on two movable rests, for skimming or drawing off; these rests are very strong, and are easily attached. An independent door is provided for closing the bureau while either pan is drawn out.

Below the pans is a closet or refrigerator for cream and butter (d d), with a capacity for several tubs; the doors to this closet are large enough to admit a 50-lb. tub of butter. A cream-can (c) is furnished with each bureau (two with the larger sizes); this is used for warming the bureau in cold weather, by filling it with hot water and setting it in the closet at the bottom. Each end of the bureau is supplied with four ventilators (a A) closing with wooden slides and covered with wire screens, for the exclusion of flies and other insects, dust and dirt. These ventilators are for controlling the temperature and the circulation of air in the bureau. The bureau is furnished with glass doors, permitting a full inspection of its contents without opening it, and also for the proper admission of light, which experience has proved to be necessary for the full development of the natural colour of the cream. A thermometer (a) is provided for regulating the temperature. None but the best material is used in their manufacture, and great care is taken to have them made in the most substantial manner, and perfect in every particular. There are several features in this creamer, but the
need of ice is fatal to its employment in the British Islands, except in isolated cases. Such, at least, is our opinion.

Snow and Ice for Cooling Milk.

Professor Fjord, of Copenhagen, has made many experiments in the storing of snow and ice for butter-making, and finds that if snow is collected at the time when thawing has commenced it can easily be trodden into a compact mass, having all the advantages of ice. Dry, newly-fallen snow, thrown loosely together, was found to weigh 13.6 lbs. per cubic foot; by hard treading the weight was increased to 26.3 lbs. Thawed snow thrown together without treading gave a mean of 32.7 lbs. of dry snow per cubic foot, and when well trodden a mean of 43.6 lbs. per cubic foot. Ice thrown without special care into the ice-house weighed 36 to 38 lbs. per cubic foot. With extreme care in packing, so as to fill all crevices, the weight may be raised to 53 lbs., but with a moderate expenditure of labour the weight will not exceed 15 lbs. the cubic foot.

The cooling of 100 lbs. of milk from 83° to 36° will require 32½ lbs. of thawing ice, and as the milk has not only to be cooled, but kept cool from twelve to twenty-four hours, a further expenditure of ice will be required. With a properly-constructed cooler, in a room whose atmospheric temperature is 50°, 39 lbs. of ice will be required for 100 lbs. of milk skimmed at the end of twelve hours, and 45½ lbs. of ice if the milk is to remain twenty-four hours in the vessel. If the cooling vessel has no double casing, and is not provided with a lid, the quantity of ice will be increased to 44½ lbs. for twelve hours, and to 57 lbs. for twenty-four hours.

In the case of dairies dealing with an average quantity of milk amounting to 50 gallons a day, in districts whose mean temperature for the year is 50°, the quantity of ice required for the year's work will be about 220 × 365 = 80,300 lbs.—about 36 tons. This would be the quantity required for use, but as there is always waste in the ice-house, a larger quantity than this must be stored, say 50 tons. If we allow each cubic foot of ice or snow to weigh 43 lbs., the space required for storing 50 tons will be 2,600 cubic feet. Snow is best stored when it has begun to thaw a little, because it can then be trodden into a smaller space and a more solid mass; and, so far as England is concerned, in the bulk of winters, snow would be easier than ice to store away.

An ice-house may be constructed at a very moderate cost and in a very simple manner. The cheapest kind are those built partly underground, in situations and subsoils that admit of thorough drainage, not only of rain or spring water, but also the waste water of the ice. Between the outer and inner walls must be a space which must be filled with dry sawdust, or other non-conducting material; the space should be at least a foot wide. The space within the inner walls may then be compactly filled with ice, closely packed together, and the whole should be surmounted by a shed whose walls and roof are made non-conducting in the same manner. It is not absolutely necessary that there should be an inner wall, for the sawdust may come into direct contact with the ice, but they are much better kept apart, or the sawdust will become wet and so lose its non-conducting property. The inner walls should if possible be impervious to water, so that the sawdust may be kept dry. The drain-pipe should be bent in one place, the bent portion always remaining full of water, and so forming a sort of trap by means of which the outer air is excluded. Fig. 164 gives a general idea of the construction of an ice-house, and on this plan it may be built either above or below ground. The entrance to the ice-house should always be above the level of the ice, so that the stratum of cold air above the ice is disturbed as little as possible.

It is a matter of little moment what the materials are of which the ice-house is constructed—
wood, brick, stone, concrete, or iron—so long as the following requisites are secured: first, perfect drainage, with complete exclusion of air below; second, good ventilation above; third, ample non-conducting material around and above the ice; fourth, total exclusion from the ice of all outside water and air; and fifth, solid, compact packing of the ice in the house when the weather is dry and cold.

**Centrifugal Cream-extractors.**

The most recent and striking methods of separating cream from milk come to us from Germany. At the International Dairy Show, held in Hamburg in March, 1877, we saw at work the instrument of which we give an illustration in Fig. 165. As will be noticed, it consists of two wheels in a stand, one of which actuates the other by means of a belt. In the upper wheel four glass tubes, containing milk, are securely placed; the lower wheel is then turned by hand, giving the upper one upwards of 1,000 revolutions per minute. Whirling round at this great speed brings centrifugal force to bear on the milk in the tubes, and the cream, being lightest, collects at one end and the creamless milk at the other; the separation is complete and clearly defined, as in an ordinary cream-gauge. The time required by the centrifugal machine to complete the separation of cream from milk is from ten to thirty minutes, according to circumstances. Larger machines are now made, capable of dealing with as much as 200 quarts of milk, and though they are not at present quite perfected, there can be no doubt of their ultimate success. By a later improvement the cream is drawn off while the machine is still in rapid motion, instead of stopping it and waiting for the milk to settle down; while still in motion a quantity of skim-milk is caused to flow in, and, as the vessel was full before, the cream is crowded out, and escapes through an opening provided for that purpose. By means of this new invention 80 to 90 per cent. of the cream may be obtained in less than half an hour.

A more recent machine, which is known as De Laval's Centrifugal Cream-separator, is wholly different from the preceding one in construction, but acting like it by means of centrifugal force. This new cream-separator was introduced to the notice of the British public at the Kilburn Show of the Royal Agricultural Society in 1879, and since then it has become a tolerably familiar object to those who visit the leading shows of the country in which dairy interests form a special feature. At the Kilburn Show, Dr. Voelcker inspected the machine at work, testing the quality of the milk used in it, and the cream and skim-milk produced by it. Subjoined is his report on these tests, as given in the *Journal of the Royal Agricultural Society*:

"The following is the composition of the milk used in the Kilburn trials on the 4th of July, 1879, and of a sample of the skim-milk produced by Laval's cream-separator:

<table>
<thead>
<tr>
<th>New Milk.</th>
<th>Skim-milk from Laval's Cream-separator.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>87.72</td>
</tr>
<tr>
<td>Butter-fat</td>
<td>3.45</td>
</tr>
<tr>
<td>Casein</td>
<td>3.12</td>
</tr>
<tr>
<td>Milk-sugar</td>
<td>5.11</td>
</tr>
<tr>
<td>Mineral matter (ash)</td>
<td>.60</td>
</tr>
<tr>
<td></td>
<td>100.00</td>
</tr>
</tbody>
</table>

*Containing Nitrogen.* 

"Milk well skimmed in the ordinary manner contains on an average about $\frac{3}{4}$ per cent. of butter-fat, whereas the skim-milk obtained in Laval's cream-separator did not retain quite $\frac{1}{4}$ per cent.

"Thus of the $3\frac{1}{2}$ per cent. of butter-fat (in round numbers), $3\frac{1}{4}$ per cent. were obtained in the cream, and only $\frac{1}{4}$ per cent. of fat passed into the skim-milk, affording a striking proof of the perfect manner in which the butter-forming constituents are separated from milk in passing through Laval's rotatory machine.

"Had the milk been set in pans and skimmed thoroughly in the usual manner, instead of $3\frac{1}{4}$ per cent. of pure butter-fat only $2\frac{3}{4}$ per cent. would have been obtained from the new milk; or, in other words, by Laval's separator 93 per cent. of
the butter-fat were obtained in the cream and 7 per cent. only left in the skim-milk, whilst by the usual plan of skimming only 78½ per cent. of the butter-fat of milk passes into the cream, and 21½ per cent. remain in the skim-milk.

"In another trial at Kilburn on the 8th of July the separation of butter-fat from the milk was not so perfect as in the first trial, as will be seen by the following results, showing the composition of the skim-milk produced:

<table>
<thead>
<tr>
<th></th>
<th>Water</th>
<th>...</th>
<th>...</th>
<th>90-49</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butter-fat</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>0-46</td>
</tr>
<tr>
<td>*Casein</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>3-01</td>
</tr>
<tr>
<td>Milk-sugar</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>5-31</td>
</tr>
<tr>
<td>Mineral matter (ash)</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>0-73</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100-00</td>
</tr>
</tbody>
</table>

"In the second trial it will be seen nearly ½ per cent. of fat was contained in the skim-milk.

The cream obtained by means of the separator had the following composition:

<table>
<thead>
<tr>
<th></th>
<th>Water</th>
<th>...</th>
<th>...</th>
<th>66-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butter-fat</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>27-69</td>
</tr>
<tr>
<td>†Casein</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>2-69</td>
</tr>
<tr>
<td>Milk-sugar</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>3-03</td>
</tr>
<tr>
<td>Mineral matter (ash)</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>0-47</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100-00</td>
</tr>
</tbody>
</table>

"Good cream obtained in the ordinary way of skimming milk seldom contains as much as 25 per cent., and generally rather less, butter-fat; and quite as much casein as was contained in the cream from Laval's machine.

The Kilburn trials thus show that cream from milk which has been passed through Laval's separator is richer in butter-fat than that obtained in the usual manner.

"On the occasion of the dairy show held last October at Islington, I had another opportunity of examining the skim-milk obtained by Laval's cream-separator. This sample had the following composition:

<table>
<thead>
<tr>
<th></th>
<th>Water</th>
<th>...</th>
<th>...</th>
<th>90-82</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butter-fat</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>0-31</td>
</tr>
<tr>
<td>‡Casein</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>3-31</td>
</tr>
<tr>
<td>Milk-sugar</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>4-77</td>
</tr>
<tr>
<td>Mineral matter (ash)</td>
<td>...</td>
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"Another portion of the same milk, after

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"According to these trials nearly four times as much butter-fat was left in ordinary skim-milk as in the skim-milk obtained in Laval's cream-separator.

"I may state that in these experiments the percentage of pure butter-fat was determined with great care, and the results were verified by appropriate checks."

The Laval separator is shown in Fig. 166, and in Fig. 167 is seen a section of it which shows the arrangement of the interior. The action of the machine is to cause the separation of the cream from the milk by means of centrifugal motion; this causes the heavier portion of the milk to be thrown to the outside of the circle, whilst the cream, being the lightest, gathers close round the axis of rotation. The milk, while still warm from the cow, is, if desirable, placed in the milk-can shown in Fig. 167, and runs through an ordinary tap into the hollow tube A, which terminates in a T outlet near the bottom of a spherical vessel of about 10 inches in diameter, which, enclosed in a cast-iron casing (E), rotates at the extraordinary velocity of 6,000 to 7,000 revolutions per minute. The heavier portion, which is known as skim-milk, is thrown to the outside of the space in the vessel, and is forced up a bent perforated pipe which communicates with the open space C, and from thence is delivered to the lower of two block-tin trays or covers, which is provided with an outlet-pipe. The cream gathers in a wall around the inlet tube, and rises to the upper tin tray D, whence it is delivered by an outlet-pipe. The rotating vessel and shaft are of forged steel, in one piece, which, for safety's sake, is tested by a pressure of 250 atmospheres. The rate at which the milk enters the machine must be regulated according to the velocity at which it is driven; the greater the speed the more rapid the separation of the cream from the milk. The advantages claimed for the machine are: perfectly

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<td>† Containing nitrogen, 0-48.</td>
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fresh cream can be obtained from milk warm from the cow; the butter is free from the taints which commonly develop in milk as it stands to cream; the machine occupies but a small space in the dairy; and a great saving in pans and dishes for milk-setting is secured. But whether or not the machine, exceedingly clever and valuable as it undoubtedly is, will supersede all the old systems of cream-raising, is a problem whose solution we leave to time. We think, however, that it will bring about something akin to a revolution in methods of preservation are made unnecessary, and the danger of loss from souring is reduced to a minimum. In the various cold-water and ice or ice-water systems this advantage is, however, more or less perfectly secured, but in these there is need of a number of utensils which are not required where the mechanical butter-making in most, if not all, large dairies and creameries. The saving of time, and of the large number of vessels that are required for cream-raising in such establishments, will, in all probability, provide in itself enough inducement to employ the centrifugal cream-separator. But there are other features of merit in the invention. In cases where the skim-milk is sold, or where it is made into cheese, it is a matter of the first importance to have it available for those purposes while it is still quite fresh and sweet. In the hot months this advantage cannot be easily over-

Fig. 166.—Laval’s Cream-separator.

Fig. 167.—Section of Separator.

cream-separator is employed; they require also an elaborate supply of cold water or of ice, to secure which is costly, and which again is obviated by the separator. Motive power, however, is needed to drive the separator, and for this reason it is not well adapted to small dairies, where the cost of such power would be out of proportion with the work it had to do.

Skimming.

When milk is set in shallow vessels the cream is usually skimmed after standing twenty-four hours, and again twelve hours later. It is in some cases
allowed to stand the whole thirty-six hours before skimming; but this is not considered a good practice. If fine butter only is required, the cream skimmed after standing twenty-four hours is used, that rising later being of inferior quality. The test of cream being ready to skim is when, after passing the finger through it, it does not flow back behind the finger and re-unite. In hot weather the cream will need skimming earlier than in cold, because the milk is much more apt to turn sour. In the depth of winter it is sometimes left for forty-eight hours before skimming. In the case of deep-setting of milk in water whose temperature is about 40°, the cream remains softer and contains more milk, is less perfectly separated from the milk, and is in a very much deeper layer, than on the shallow-pan system, and the finger-test as to time of skimming is not applicable to it; this softer cream is not "skimmed," but "dipped" instead with an instrument of which we give an illustration in Fig. 168, or with a deep skimmer, as in Fig. 169; the cream is too liquid for a shallow skimmer, as in Fig. 170 or 171. The skimmer, Fig. 169, is the one commonly used in the Swartz system of creaming.

It is by some considered advisable, when skimming, to take more or less of the milk along with the cream; the reason for this is, that if cream only is churned, the grain of the butter is injured by having too large a proportion of butter for the quantity of liquid; the butter-globules meet with too much friction, and are apt to be over-churned if there is a deficiency of liquid. This, however, will depend on the kind of churn used. And we may be allowed to doubt whether the supposed advantage of having the cream in a decidedly diluted condition in the churn rests on more than a fanciful basis. At the same time we freely admit that cream may easily, when raised in the open-pan system, be too thick and clotted to churn at all satisfactorily. In this as in many other things it may be said that a medium state is the best. In some large dairies it is the practice to churn the milk as it is without allowing the cream to rise, and it is quite true that excellent butter is made on this plan; but it is believed not only that there is no real advantage in the system, but that the butter made on it is somewhat less firm than that made from cream. The milk will churn the more easily if it is just beginning to thicken with souring, and the butter will be the firmer; yet the fine flavour will be more or less injured, according to the degree of sourness in the milk. The butter comes out the sooner, because acidity acts on the shells of the cream-globules, making them more easily fractured by agitation in the churn. The rule, in fact, is: the sourer the milk, within limits, the easier it churns. There would, of course, be a difficulty in preventing the rising of the cream while the milk was souring, unless the souring was accelerated purposely or accidentally; and we only mention the question to dismiss it again, because it is not in the least likely to become a system to be recommended in butter-making.

Different kinds of cream, from the milk of different cows or of different breeds of cows, vary greatly in butter-yielding capacity. Some kinds will yield twice as much as other kinds, and the best yielding cream is generally churned the easiest. Fastidious butter-makers—and we confess we have admiration for these—in some cases go so far as to make two qualities of butter from the same milk. That is, they take the first skimming of cream for the best butter, and that which rises afterwards is kept by itself and produces a butter somewhat inferior in colour and flavour as well as in quality. This first skimming contains the largest of the cream-globules—the more highly-developed ones, that is; the smaller ones, which rise later because of inferior buoyancy, would seem to be inferior structures, having less of colour, of flavour, of intrinsic quality, and being of a lower order of merit in all respects. They add, it is true, to the volume of the butter, but
they diminish its quality. They delay the churning because they are the longer in being fractured themselves, and interfere with that process in its application to the others. Hence it follows that we have finer butter, though less of it, and quicker churning without them.

TREATMENT OF CREAM.

There is nothing better than glass or glazed earthenware jars to store cream in directly it is skimmed from the milk, providing it is not wanted for churning at once. It is by many people considered an advantage that cream should not be churned until it has been skimmed at all events twelve hours; by standing this or a longer time, according as the weather is hot or cold, it obtains a sort of ripeness which is conducive to a larger yield of butter. But it must not be kept until it is bitter, or the flavour of the butter will be injured; and if it is kept till it is more or less sour, the delicacy of flavour will be gone. By adding a small tea-spoonful of powdered saltpetre to each 3-gallon jar of cream, the usual bitter taste will be prevented. The question of sourness is an important one in butter-making; for if old cream that is sour be churned along with fresh cream that is sweet, the inequality in their condition will cause more or less of the butter to be left in the buttermilk. Sour and fresh cream that are intended to be churned together should be well mixed and allowed to stand for some hours before churning, so that it may be all alike in condition; and the colder the weather the longer should it stand, because the souring of the fresh cream will proceed slower than if the weather were warm. The temperature, however, may be artificially regulated.

While the cream waits for churning it should be occasionally stirred, especially if it is exposed to the air, or a thick crust of hardened cream will form on the surface, and this makes churning more tedious and uncertain; it is the influence of dry air which causes this crust to form, therefore it is better to keep the cream covered up from the air. Yet it is not advisable, even in cold weather, to keep the cream more than half a week before churning, though it will then keep sweet a much longer time than it will when the weather is hot and no artificial means of cooling it and keeping it cool are employed. Good butter is of course produced by churning once a week, or even once a fortnight, in cold weather, yet it would be better if churned oftener. And it may, indeed, be laid down as a sound proposition that cream is fit to churn as soon as milk is fit to skim.

Sometimes white flecks appear in the cream, and are conveyed to the butter. They are usually a result of a faulty condition of the milk, and are often developed by the influence of light and air playing on the milk. The surface of cream that is dried and hardened by absorption into the air of the moisture that is in that portion of the cream will sometimes cause these flecks, but not often. The general cause of them lies in the coagulation of drops of milk by the action of germs in them, and these germs will be developed sometimes by a strong light falling on the milk, as in the case of pans set near to a window; sometimes again by a current of air playing on the surface of the milk; the germs may be in the air, or they may be latent in the milk; in either case the air will tend to develop them. Hence it is better to cover up the pans, or set them in a darkened room through which no current of air passes beyond what is necessary for ventilation; but the safer plan is to cover up the milk: this keeps it alike from air and light, neither of which it requires if it has been properly treated beforehand. Flecks will not easily occur in milk that has been scalded and cooled, and afterwards covered up; the scalding kills the germs which are the cause of the flecks, and the cooling and covering prevent their re-introduction. Sometimes they will appear in one cow’s milk and not in another’s, and they are commonest in the autumn when the cows are being let dry and the milk remains longer in the udders; but judicious treatment of the milk and cream will checkmate them at all times. When these white flecks are in the cream they may be separated from it by running the cream through a fine wire sieve, pouring on warm water at the conclusion, which washes all the cream through, leaving the white specks in the sieve.

In winter, especially, butter is commonly so pale in colour that its value is lowered if the colour is not restored by artificial means. This is done in various ways, but the colouring matter must always be mixed with the cream just before churning—not with the butter after it. No kind of colouring matter can be incorporated with the butter after churning, without so much working in that the grain of the butter would be injured; and none is yet known that will not injure the
butter by coming into direct contact with it. Some people use the juice of carrots, and this is harmless enough except that, being a vegetable matter, it soon decays, and so injures the keeping property of the butter. Others use a preparation of annatto made specially for the purpose, and, so long as the public demand high-coloured butter, this is on the whole the best colouring material to use—in moderation. In recent times, various people have produced artificial colouring matters for butter which are quite as satisfactory as anything artificial can well be expected to be. So clever, indeed, are some of these colours that they give to winter-butter a rich, warm, golden tint, which can hardly be surpassed by the natural tint of summer. And so long as the public prefer a coloured to a pale butter, we assume that these artificial aids will continue to be employed.

CHURNING.

The temperature of cream is a matter not to be overlooked at churning-time. It must needs vary according to the state of the weather and the time of the year. In the hottest weather it has no need to be below 55°, or the labour of churning will be increased without any advantage to balance it; in winter it may without detriment be raised from 60° to 65°, or even 70° in very cold weather, and when the cows are eating dry fodder, in order to reduce the labour of churning; but in summer to have it above 60° will cause the butter to be soft and spongy; 60° in fact may be regarded as the normal temperature, to be varied from as circumstances may require. In raising or lowering the temperature of cream, the process should be gradual; the best way is not to pour hot or cold water into it, but to place the cream in a tin vessel and surround it with either hot or cold water as the case may be. It is seldom, however, that the temperature will need reducing at any time, and never in winter. By having the cream below 65° in cold weather, the labour of churning will often be great; and if it is below 60° it can hardly be churned at all until the temperature is raised. It is in winter, when the cows are on dry food, that difficulty in churning is experienced; in summer, when they are on grass, the butter forms readily in the churn. Cream that has soured a little will churn easier and at a lower temperature than sweet cream; but care must be taken that it is not very sour, or the labour of churning will be increased, the quantity of butter diminished, and its flavour ruined; and in extreme cases of souring, the cream may be so far injured that the butter will not come at all in the churn. A very good system of introducing the desirable acidity is to pour a little sour buttermilk into the cream, say a quart to 4 or 5 gallons, when the latter is put in the churn. This system takes away the bitter taste which butter commonly has in winter-time, and it has the great advantage of introducing the acidity at the right moment. Or it may give to cream some of that ripeness which is thought by some to be essential, by being added to it a few hours before churning.

The question of sour versus sweet cream for churning has been much discussed, and it is, perhaps, quite as unsettled now as it ever was, except in the minds of those who are definitely committed to the one side or to the other. We incline to the opinion that a little sourness in butter-making, as in cheese-making, is really beneficial when judiciously employed. The danger in both lies in developing it too early and too far. Sourness, in fact, may be regarded as an incipient stage of ripening, but it is a stage which should be held in check. Both cheese and butter will be the firmer for a little employed acidity, and have more of "character" about them, but it should in both cases be employed at the right time. We do not hold with cream being allowed to go sour as it likes before churning, and we think it would be far better kept sweet until churning-time, or nearly so. The finest butter we remember seeing—the firmest, having the most "body," the clearest and richest in colour, with a mild and pure flavour, and having a perfect "grain"—was produced from sweet cream into which a little sour buttermilk was mixed at churning time. This butter was exhibited at the International Dairy Show in Dublin, in December, 1879, by Mr. Patton, of Glasslough, who has on several occasions carried off the highest prize for butter in the leading shows of Ireland. He milks only some fifteen or sixteen cows, and his daughters make the butter. This is a fine example of the success which may be attained by care, system, and scrupulous cleanliness on a medium-sized farm in Ireland.

When cream churns reluctantly—that is, when the butter is slow in coming—it is customary to use one or other of the various sorts of "butter-
CHURNING AND WASHING THE BUTTER.

powder” that are in the market, some of which are very useful. We have known refractory cream, that refused to yield up more than a small portion of its butter, quickly reduced to submission by the use of butter-powder, and the second yield of butter has been larger than the first. In winter, especially, cream is apt to swell out very much in the churn; at such times it is well to put a little dissolved carbonate of soda in the cream just before churning begins. A little salt, too, prevents the swelling, and helps the churning.

It may be laid down as a rule that the longer it is since the cows calved, the longer time will the churning occupy. This is owing to the average size of the cream-globules being smaller than when the milk is from cows that have been calved a shorter time. Thus it is that the cream of the milk of Jersey cows churns easier than most other kinds—the cream-globules in it are, on the average, larger; and this is one of the chief reasons why Jerseys are better “butter-cows” than most others. Scalding the cream—that is, bringing it nearly to boiling-heat—will diminish the time and labour required in churning it; and the higher the scalding the easier it will churn. Scalding the milk while still fresh has a similar effect in abridging the time used in churning the cream from it. In this case, however, the milk must be cooled to 70° or 75° before setting it to cream; and scalded cream must be cooled to 60° or 62° before churning it.

The object of churning is to denude the cream-globules of their delicate membranes without interfering with the structure of the tiny granules of fat inside them. If these granules are broken up too much by over-churning or over-working, the “grain” of the butter will be destroyed. But if the structure of the granules is left intact, a piece of butter at 60°, if fractured, will show a clear and distinct fracture like unto that of cast-iron, and if seen through a magnifying-glass will show a granular appearance; whereas, if the grain is destroyed the fatty elements are mixed up together, and the fracture will have little or none of the granular appearance seen in the other case. If the grain of butter is destroyed, the flavour is more easily lost, and the butter will not remain sweet so long. In all the processes through which butter passes, the grain should be specially considered and preserved; too much friction either in or out of the churn will injure it; therefore in churning the process should be agitation, and in working the butter pressure, not friction in either case. At the commencement of the churning the motion should be slow, but when the cream is well mixed together the speed may be gradually increased until it has reached the rate for which the churn is adapted, and when the cream begins to break into butter the speed must be reduced again so as not to “over-churn” or injure the grain of the butter. It is not advisable in any case to subject the cream to very violent agitation; a moderate, steady, and uniform rate of churning will make the best and most butter; and in summer the rate of speed must be slower than it need be in winter.

Washing and Working.

It is advisable to stop the churn before the butter is fully gathered; that is, while it is in grains like wheat, and before it is compactly massed together in a lump by the continued action of the dashers. The reason for this is: that as butter immediately after churning always contains more or less buttermilk that must be removed by washing and working, the separation is more easily done before the butter is massed together than afterwards. By pouring cold water into the churn just at the time when the butter is about to gather, and lowering the contents to 51° or 55°, the butter does not mass together but remains in small pieces like small peas, and the lower the temperature the smaller will be these pieces, while at a temperature of 60° to 70° they mass together. The cold water may be put into the churn at two or three different times, and the churning slowly finished. The advantage derived from this method lies in enabling the buttermilk to be washed out without any of the ordinary working; and this can be done by draining the buttermilk out of the churn, putting water in its place, stirring the butter carefully, and repeating the water part of the operation until it runs out clear and free from buttermilk.

Some object to the washing of butter, on the ground that both the flavour and keeping properties are injured by it. This depends entirely on the way in which the washing is done, and on the kind of water used. If perfectly pure, clear, spring-water is used, and if the washing is done with care, the butter is improved, not injured, by the process. In the absence of suitable water it is of course better to get the buttermilk out by
working instead of washing, but where good water is at hand it may be used to advantage. Some think washing the butter washes out the flavour; but this is not the case, for the flavour of butter consists in fatty matters that do not combine with water at all, and therefore cannot be washed away by it. But washing butter may be made to remove the flavour—if impurities are introduced to destroy it; and this is not uncommonly the result of using improper water, so that instead of the water purifying the butter, the butter purifies the water. The keeping properties, again, are not injured but improved by carefully washing the butter in pure water; the washing, in fact, removes the casein, which, being a nitrogenous substance, decomposes earlier than the fats of butter. Imperfectly washed butter, indeed, turns rancid early, chiefly because of the casein which is left in it.

Under the old system the butter is first of all removed from the churn and placed in a tub containing clear, cold water, and is washed there in the tub; or it is placed on a sloping bench or table, and water poured over it to wash out the buttermilk. An improved plan is to use a small watering-can which distributes the water in a shower by means of a "rose," and, while the spray is falling on it, to keep the butter stirring about, not by hand, but by a flat wooden ladle made for the purpose (Fig. 173). In this operation the butter is, or should be, used gently and turned over lightly, and the water after falling on the butter passes freely away, carrying with it more or less of the buttermilk, milk-sugar, and milk-

acids. In hot weather, and in the case of using water that is not quite what it ought to be, it is better to use brine for washing out the buttermilk; by dissolving a portion of salt in it the water is less liable to do harm to the butter, and it will take up the buttermilk better than water alone will.

For the making of butter, and without always knowing the why and wherefore of the matter, a dairymaid with cold hands has been for generations past, and still is, preferred to one who does not possess that peculiarity; a warm hand, especially in hot weather, is considered unfit to manipulate butter, and some dairymaids have a pail of cold water close by into which they frequently dip their hands to cool them during the time they are making the butter. These simple facts in connection with butter-making have, in some of the more advanced dairying countries, led to the invention of mechanical butter-workers, by means of which the butter can be thoroughly washed, worked, and salted without being touched by the hand at all.

It is well known, to come to the scientific aspect of the question, that carbonic acid is constantly being thrown off from the pores of the skin of the human body; and it is no doubt true that this physiological process is less active in the skin of a cold hand than in that of a warm one, and so the cold hand will do less harm than the warm one to the flavour as well as to the consistency of the butter. In the more advanced butter-making establishments of the Continent of Europe and of America, the human hand, be it
cold or warm, is allowed to come as seldom and as little as possible in contact with the butter. Dr. Fleischmann, who is regarded as the first scientific authority of the day on dairy matters on the Continent, considers that the varying states of health to which the human frame is liable are among the chief causes why butter varies so much in flavour and quality, and so he advocates that such a delicate product should never be touched by hand, but that butter-workers should be used, and spatulæ for turning it over.

In Figs. 172, 174, 175, we give illustrations of three different kinds of butter-workers suitable for small dairies. These may be used by one hand, while the other is employed in pouring water over the butter, or in turning it over with the wooden pat or ladle, of which a cut is given in Fig. 173.

There really can be no two opinions, in the minds of thinking people, as to the advantage of using wood instead of the human hand for immediate contact with butter in the working of it. Apart from the important fact that the warmth of a hand does more or less harm to the grain of the butter, while emanations from the skin are not calculated to improve the flavour of it, it is more comely, as well as more profitable, that wood should be used instead of the hands in the making and mixing of butter. We do not for a moment wish to insinuate that the finest butter cannot be made without these modern wooden devices. By observing the strictest cleanliness of person, of utensils, and of dairy, and when the dairy-maid's hand happens to be a cold one, it is no doubt true that butter will be produced whose condition is such as to leave nothing to be desired; but this strictest cleanliness is too commonly neglected in some point or other, and oftener, we may say, in respect of the person than of the utensils and of the dairy, while the cold hand is a mere accident of nature. Consequently we prefer that the butter should be touched by the hand as seldom and as little as possible, that these handy tools need only to be tried to be appreciated; there is no difficulty whatever in using them, and while they work the butter thoroughly they do the least possible harm to the grain of it.

The most recent, and perhaps the most useful, butter-worker for large dairies is seen in Figs. 177 and 178; and though machines of this pattern have for years been in common use in the United States and on the Continent of Europe, they have only recently been introduced into this country, and are not yet in any sense general amongst us. This machine, of which the illustrations give an excellent idea, consists of a round table with an inner and an outer rim to it, which circulates underneath the fluted roller that is seen in the woodcut. The wheel by which motive power is communicated to the machine is attached to the axle of the roller, and they go round together. To the same axle is also attached a cog-wheel,

**Fig. 176.—Butter-worker.**
which operates on projecting cogs, and gives a circular motion to the table; but the projecting cogs, though shown in the engraving, are so protected as not to catch the dress of the attendant. The butter is thus carried round repeatedly on the table, passing under the roller each time, and the attendant turns it over with a small wooden pat as it leaves the roller. It is prevented going near or adhering to the inner and outer portions of the table, as well as from getting under either end of the roller, by two fixed scrapers—one near the inner and the other near the outer rim of the table—and these, as it comes within their scope, continually incline the butter in the direction of passing under the central part of the fluted roller. It will be noticed that the table is highest in the centre, so that the buttermilk, or the water containing it, runs toward the outer edge of the table, whence it is conveyed away, by means of a small gutter and a pipe, to a pail or a tub underneath. Fig. 179 shows the manner of working.

This excellent butter-machine may be used effectually for three purposes: first, for getting the buttermilk out of the butter by means of water—and this is called "washing the butter;" second, for getting out the buttermilk by means of working only, and without the aid of water; and, third, for thoroughly incorporating the salt with the butter. It performs these various offices by pressure, and without friction, so that the grain of the butter is not injured; and it is highly recommended, by those who have it in use, as a most useful and convenient addition to any butter-dairy which has it not. It is made in different sizes to suit the requirements of either large or small establishments; for the latter, however, the implements shown in Fig. 174 and 176 are perhaps better than any other kind, being simpler and cheaper, and more easily kept in order.

A large machine of the same kind suitable for butter-factories, or for large establishments where different farmers' butter is worked up into one uniform quality—a practice followed in France—is seen in Fig. 180. This machine, it will be noticed, is intended to be driven by power or by hand, and is capable of dealing with a large quantity of butter. It is made by Mr. Edward Ahlborn, of Hildesheim, who is well known in this country as an exhibitor of improved utensils and implements for the dairy. It is not probable that these larger machines will be required in England, though they may in Ireland, but the smaller ones of the same type would be found very useful in our larger dairies.

**Salting.**

The object of working butter is threefold; to get out the buttermilk, to get in the salt, and to make the butter as compact as may be; and the less labour required to attain these results, the better it is for the butter. Some butter-makers put a little salt in the cream at the time of churning, and this not only helps the churning, but afterwards assists the buttermilk to leave the butter. Others get out all, or very nearly all, the buttermilk by drawing off nearly all of it when the butter has formed into grains like wheat, and then pouring in a quantity of cold water, and going on with the churning a little time longer at a reduced speed; the pouring in of water in this way, previously drawing out the other, is repeated two or three times, and butter washed
in this manner is found to require very little subsequent working to get out the water and with it the remaining buttermilk. This done, the butter should be spread out thin on a table, its weight having been first ascertained, and the requisite quantity of the purest, whitest, and finest salt obtainable scattered over it at several times, and gently worked in by pressure, repeatedly folding the butter up in a lump and pressing it out flat again. It should be worked at this stage as little as possible beyond what is necessary to get the salt tolerably well distributed throughout the mass. It should then rest awhile, until the salt-crystals are dissolved, after which it may again be worked a little to expel the residue of the buttermilk that the salt may have set at liberty, and all surplus moisture. The quantity of salt used varies greatly, and is too commonly applied by guess-work; but where system prevails the quantity used will vary, according to taste and requirement, from ¼ oz. to nearly or quite 1 oz. of salt per lb. of butter. The best makers seldom if ever exceed ½ oz., while some use only ¼ oz. to the lb. of butter. The following is found to be a good summer mixture:—Salt, 16 ozs.; saltpetre, one teaspoonful; best powdered white sugar, one tablespoonful. This is used to 22 lbs. of butter.

Recently a new agent for preserving butter has been invented which will do away with common salt, if need be. It is an antiseptic known as "Glacialine," and while it is tasteless, odourless, and perfectly harmless, it will preserve butter quite sweet for a much longer period than common salt will. We have tested this chemical salt in milk and in butter, and in both with the most satisfactory results. Used in winter-butter it entirely removed the bitter taste, while common salt entirely failed to do so. This in itself is no
light merit, for winter-made butter commonly has a bitterness of flavour which is given to it by the nature of the food which the cows are eating. Not only, therefore, is Glacialine an excellent preservative, but it has the property of neutralising taints and odours to which butter is sometimes addicted. Used in milk it has the effect of preventing the faintest approach of souring, for at least a week, in the hottest of weather, so that the cream has ample time to rise, or the milk may be conveyed long distances, no harm befalling it on the way. Being tasteless and odourless, this new preserving agent is not in the least objectionable, nor can it in any sense be regarded as an adulteration. With eggs and with flesh-meat Glacialine is equally effective as a preservative. Eggs dipped for an hour in a solution of it remain perfectly fresh for months, and when used cannot easily be distinguished from new-laid eggs. This most useful article may now be obtained almost anywhere, or of the manufacturers, the Antitropic Company, of Renfield Street, Glasgow.

Other butter-preservers are also being brought out; among these we may mention “Butyrosoter” and “Ozonia,” which are respectively introduced to the notice of the public by the Aylesbury Dairy Company of London, and by McDonald and Co., of Dublin.

The Aroma of Butter.

I. R. Segelcke, Professor at the Royal Agricultural College of Denmark, writes:—“Is the aroma of butter due to aromatic principles pre-existing in the milk, or not? According to the generally-received opinion, the aromatic principles of butter already exist in the milk as given by the cow, and pass from the milk into the cream, and from the cream into the butter, unless they be destroyed by chemical decomposition during the process of cream-raising or of churning.

“My experience does not confirm this opinion. On the contrary, it puts it beyond a doubt that the aromatic principles of butter do not exist in natural milk, and that it is the decomposition of the principles of this latter—probably of even utterly inodorous principles—that gives rise to the aroma of butter. If the temperature of the milk when set for cream be from 10° to 12° Centigrade (50° to 53° Fahrenheit) or more, it decomposes, forming lactic acid and several other new principles, among them aromatic principles; and it needs but to churn the cream to obtain an aromatic butter. If, on the other hand, the temperature of the milk at such time be near freezing-point, the decomposition necessary for the production of aromatic principles is held in check, and, consequently, the aroma of butter obtained from fresh cream is so feeble that it is not perceptible to persons accustomed to butters prepared as above indicated, in the same way as French butters are made at present. But if it be desired to obtain a more aromatic butter, all that is required is to place the cream in circumstances favourable for lactic fermentation, and a few hours will produce the required result.

“In either case, the aroma formed may be more or less agreeable; that all depends on the fundamental principles of the milk, on the quantity of the principles necessary for the formation of aromatic principles that is present, and on the method of manipulation employed.

“In either case, again, the appearance of aromatic principles is accompanied by that of lactic acid. Whether the aromatic principles sought for in butter are produced by lactic fermentation, by a simultaneous general fermentation, or by several fermentations combined, I do not know.

“In practice it will often be noticed that lactic fermentation is accompanied by alcoholic fermentation, and even by butyric fermentation. What, then, is the chemical composition of the aromatic principle so much admired in butter? Is it an alcohol, a compound ether, or perhaps even a fatty acid, nauseous in a state of concentration, but agreeable in a more moderate form? I know not. The fact that the valued aroma soon becomes rancid, and that it is always met with in conjunction with fatty matters, leads one to suppose that there is some relation between the fatty acids and the aroma. To solve this interesting question, elaborate experiments would be required; but meanwhile this is certain, that without decomposition there is no aroma—at least no aroma in the ordinary sense of the word.”

This is obviously a scientific problem which is not yet solved, nor, perhaps, does it admit of complete solution. That the aroma of butter exists already in freshly-drawn milk, in a greater or lesser degree, is, however, a fact which does not admit of dispute, for butter made from such milk, by churning the milk, has the aroma in it, though, we admit, in a feeble measure than is found in
butter that has been made from cream of several
days' age. At the same time it is no doubt true
that a more pronounced aroma is
obtained if the cream is allowed to
"ripen" before it is churned; and
unpleasant flavours are produced
in the same way, if the cream re-
ains too long without churning.
As in butter, so in cheese—par-
icularly in cheese—it is obvious
that incipient decomposition, which
is but another term for ripening,
develops the flavours which we so
much admire; and it is equally
obvious that these pleasant flavours
become unpleasant after a time, as
decomposition proceeds. Thus it
follows that a given degree of acidity
is useful in both cheese and butter
making, developing as it does the
flavour and aroma; but if it is allowed to go too
far it destroys both of them, or, rather, carries
them into a stage in
which they are no
longer attractive to
the palate. The in-
troduction of extran-
eous matter, also,
may easily induce a
sort of fermentation
or decomposition
which will develop
an aroma which is
foreign, or may pre-
vent the development of that which we
should naturally ex-
pect to find in a
well-ordered article;
and hence it is that
cleanliness and care of
the minutest kind are
necessary in handling
so delicate and vola-
tile a thing as milk.

CHURNS.

A great variety
of churns are in use, most butter-making countries
having several very good and favourite kinds. In
Northern Europe, where the Swartz system of
creaming prevails, the Holstein vertical churn
is the most popular. In Fig. 181 we give an
illustration of one of these churns,
of a size suitable for use by hand;
and in Fig. 182 a larger one, suit-
able for horse, steam, or water
power, and for use in large estab-
ishments. Fig. 183 shows the
method of attaching this churn
to an ordinary horse-gear. In
the inside of these churns three
round-edged pieces of wood are
fastened in a perpendicular position
and equi-distant from each other;
the revolving beater-frame dashes
the cream against them, and they
cause the cream to return to the
centre of the churn, so that a
continuous and somewhat violent
agitation is maintained. In Fig.
184 is given a section of the churn showing
this interior construction. The fixed dashes are
marked a, and the
revolving ones b,
while a thermometer
is seen at c. The
churns, being simply
constructed, are
easily cleaned when
the revolving beater
is taken out. The
larger ones are bal-
anced on axles, so
that they are easily
emptied when the
churning is com-
pleted, and as easily
cleaned, without re-
moving them from
their bearings. It
will be noticed in
the smaller one that
a fly-wheel assists in
the turning. These
justly celebrated
churns are manu-
factured by Mr. E.
Ahlborn, as also are

The old-fashioned plunge-dash churn (Fig. 185)
is still in use in many farm-houses, but it has not much to recommend it except hoary antiquity. Fig. 186. To the hole in the centre of the "dash" the upright handle is firmly attached, and the motion is an up-and-down one which is very wearying to the person employed in churning. That this churn should still remain in use seems very strange, and it is stranger still that any new ones of the same kind should be made in this age of progress.

An excellent churn, superior in all respects to the old plunge-churn, is seen in Fig. 187. Churns of this build, made now-a-days, are excellent implements; there are no loose dashers inside them, they run on anti-friction wheels and are easy to work, and they are cleaned in the simplest manner possible—by putting boiling water into them and turning the handle for a minute or two, as when churning. The bung of the churn under review is fastened on the inside, and cannot blow out in churning, and the joint is secured by an india-rubber washer, so that there is no waste of cream; the gases evolved during the churning are easily let out on touching the small valve seen on the right of the bung. This churn is made by Mr. Waide, of Leeds, and we can testify to its simplicity, its efficacy, and its value. It is equally well
adapted for churning milk or cream. In Fig. 188 we give a representation of a churn which the same maker has recently brought out. It is called the Victoria churn. It will be noticed that it is likewise a barrel-churn, but that the motion is an end-over-end movement. The lid occupies the whole of one end of the barrel, and is attached firmly by four thumb-screws, while all leakage is prevented by an india-rubber ring which fits in between the end of the barrel and the lid. There are no dashers inside the churn, as it is claimed that the end-over-end motion produces enough agitation without them, the cream being dashed alternately against the lid and the bottom of the churn; we think, however, that a couple of dashers would add to its efficiency. When the lid is off, the churn, poised as seen in the engraving, admits of the butter being removed with great ease and facility, and equally so does it admit of cleaning the inside. The buttermilk is let out by the plug seen in the lower part of the barrel, while the butter itself may be easily poured, if need be, out at the end when the lid is removed, as there are no dashers in the way of it. This churn is very easy to turn.

In Fig. 189 is represented a very old kind of churn, revived in a somewhat new form. The principle, we are led to understand, has long been applied to churns in Ireland, with a different arrangement of dash. Oblong in shape, this churn is divided longitudinally by a partition (a), which rises from the bottom to the lid; in this partition are two holes, in the bottom of it, one at each end, as indicated by the letters B B, and the milk or cream can freely pass from one division of the churn to the other. In one of these compartments the "dash" revolves, and it causes the cream to rush round, like water down a mill-race, through one hole in the partition into the other division of the churn, and backward through the other hole in the partition, and so under the "dash" again. In the other compartment is a transverse partition or midfeather (c), which slides up and down in grooves; this midfeather is not allowed to go to the bottom of the churn, but dips down an inch or two into the cream. When the butter begins to form, the particles of it floating on the surface naturally collect in a drift against the midfeather, and they remain, as it were, in still water inside the breakwater. It is, no doubt, an advantage when the butter has begun to form that its particles should not come again under the "dash," and in this case they adhere together in the other division of the churn, so that the butter cannot possibly be over-churned. This churn is easier to work than any other we are acquainted with, and a child of ten would turn it for a considerable time without being necessarily fatigued; we cannot, however, affirm that it possesses any other advantage. It is made by Messrs. Eastwood, of Preston.

**Mechanical Power.**

In Fig. 100 we give an illustration of a small but very convenient portable engine and boiler.
combined, suitable for use in large dairies. This one is made by Messrs. Nicholson, of Newark, and employed in large dairies. But where a horse or pony is kept for general purposes, and can always be had for churning when required, it may be desirable to set up a small, handy, and cheap horse-gear, as shown in Fig. 191. Such a gear may be bought at £5 to £7; it is easily put in position, and as easily attached to a churn. No power, however, is so cheap as water, and a very small stream may be utilised for such a purpose as churning at a small expense; and where such a stream is available near to a dairy it is always advisable to make use of it.

In some countries large dogs are trained to do the churning, by means of such an arrangement as that shown in Fig. 192. Still, as it will hardly do to keep a large dog for only such a purpose as churning, and as he could not actuate a large churn, a water-wheel, a horse-gear, or even a small steam-engine will be found to be cheaper in the end, and, all things considered, more satisfactory. The dog-power is on the endless-chain principle; it is so arranged that the dog, once started, must keep going until some one stops the machine, and so he may be left to mind his work. Where a dog is kept for other purposes, he may be made useful in churning also.

**Marketing.**

In England it is customary to prepare butter for market by weighing it into lbs. or half-lbs., and for the weighing no machine is better adapted than one similar to that seen in Fig. 193. The square slab on which the butter is placed should be either marble, or glazed earthenware, or enameled metal. After weighing, the butter is made up into rolls, or is moulded in a circular form with a device stamped on the top. It is generally taken
to market in ordinary baskets, packed in them in layers with cloths between. On this plan the butter is often much crushed and disfigured, and as it is thus less inviting in appearance it has to be sold for less money. In such a product as butter appearance counts for much. There is still a good deal of crudity in the way English farmers sell their butter, as well as in the way they prepare it for sale. It is not uncommon, in some parts of the country, to make it up into "½-lb." prints, weighing 9 or 10 ozs., and into "lb." ones, weighing 15 or 20 ozs. Most farmers’ wives give 1 oz. in the lb. over-weight, with a pennyweight added—this seems to be a common practice at all events in the Midland counties—and others we have known to give 2 or 3 ozs. more for the sole and only reason of being able to sell for a penny a lb. more than their neighbours.

In the City of New York fancy butter, sent out in a neat and orderly manner, commonly commands from half-a-crown to four shillings a lb. Sent out carelessly, crushed and bruised by the way, the same butter would not fetch much more than half the money. In Fig. 194 we give an illustration of an American return butter-package, for carrying “prints” of the best butter to market; the prints are wrapped in muslin cloths and placed in the tins on the shelves, and the shelves are fastened down in such a manner that no jolting of the butter takes place, and it is delivered at its journey’s end in perfect condition.

For sending butter in bulk to the retail dealers, who sell it out in small quantities, various kinds of tubs, casks, or jars are used. In Fig. 195 we give an illustration of a newly-invented tub that is used for this purpose in the United States. It is made of white ash, white oak, or spruce; the upper hoop is adjustable, operated on by a malleable iron cam, and, when closed, the head of the tub is as tight as the bottom. In hot weather it is common to fill the space between the tub and the butter with a solution of salt and water, and, being free from the air as well, the butter is well preserved during long journeys. In Fig. 196 we give an illustration of a return package consisting of a stone pot or jar, around the top of which are projections that serve as the threads of a bolt or screw, while the tinned iron hooks on the wooden cover answer the purpose of the threads of a nut. The cover is grooved so as to shut down over and clasp both the inside and outside of the top of the jar. Thus adjusted, the jar is air-tight; a strong bail attached to the cover greatly facilitates the handling of this jar. This, together with the projecting wooden cover, ensures it against all ordinary breakages. In Fig. 197 we give a cut of a crate which holds twelve of these butter-pails, or it may be made to hold any other number as desired. The wooden butter-packages are prepared for use by soaking them first in cold, then in scalding, and again in cold water. They are then either filled with brine and left so for twenty-four hours, or the inside is thoroughly rubbed with dry salt and left for a short time. The butter is pressed
together in them as solidly as possible, so as to exclude the air from the inside, while the outside of the butter is protected from it by the brine, which fills all the intervening spaces inside the cask.

If it is desirable to send the butter to market in rolls, a simple and useful mould for making them is seen in Fig. 198. It may be made of any kind of hard wood, such as box, yew, lignum-vitae, &c.; and whilst in use it must be kept wetted inside to prevent the roll sticking to it. Each half of the mould being filled with butter, the handles are brought together, and the butter is firmly compressed into a solid roll. The rolls are best wrapped in muslin and packed in a box, as in Fig. 200. When the box is full the lid shuts down and is locked, and, resting lightly on them, keeps the rolls in position. These appliances are simple, efficient, and inexpensive.

**Dorset Butter.**

In Dorset dairies the milk stands for twenty-four or thirty-six hours, according to the season of the year, and in some cases is skimmed a second time after having stood a second period; the cream is considered ready for churning immediately after it is skimmed, and during the hot weather is commonly churned every day, while in cold weather the churning is done only on alternate days. To this practice of churning the cream while it is quite sweet and fresh is owing, in a great measure, the reputation which Dorset butter has long possessed; the practice, indeed, presupposes the strictest cleanliness with respect to milk-pans and other vessels used in the dairy, for without this primary condition the daily churning would be practically valueless. The old-fashioned barrel-churn, with improved beaters, is commonly used in Dorset dairies, and after the butter is taken out of the churn the greatest care is taken to wash out all traces of buttermilk, so as to avoid the light-coloured streaks that commonly appear in ill-made butter. The coldest and clearest water that can be obtained is used for this purpose, and the butter is repeatedly turned and pressed by the hand on a slab of wood; a dairymaid whose hand is naturally cold always succeeds best in butter-making, all other things being equal. It is seldom that the butter is salted in a systematic manner; the dairymaid generally guesses the quantity of salt to be used, and an experienced and careful person can guess it with surprising accuracy; it is, however, generally understood that the butter intended for market is more sparingly salted than that for home consumption. It is clear, however, that the Dorset dairymaids have got into a better system of butter-making than most of their sisterhood in other parts of the country, for Dorset butter has a popularity greater than the butter of any other county; and much butter, made far enough away, is sold in London under the adventitious title of "Dorset butter." The name is pirated, and the name sells the butter. This sort of thing is at once an honour and an injustice to Dorsetshire.

**Devonshire Cream.**

When the milk is brought into the dairy it is at once strained into rather large and deep pans, in which it is allowed to stand from eight to twelve hours. At the expiration of that period the pans are placed in a vessel containing boiling water, and over a fire. In other cases the milk is placed on the stove immediately after milking, where it stands the prescribed time, and the stove is then lit; this method obviates the carrying of the pans containing the milk, and re-
moves the danger of disturbing the cream that has formed on the surface. When the time for heating comes, the milk and cream together are gradually warmed up to about 200° Fahr., at which time there is a wrinkled circle of cream towards the edge of the pan; a sort of film overspreads the cream, and little blisters rise in it, but the cream is not allowed to boil, and when the first bubble appears the pan is immediately and carefully removed to the dairy, or the fire is at once removed from the stove. After the scalding the cream remains undisturbed for twelve hours longer, at the end of which time it will be found of considerable thickness; this second period of waiting will vary from twelve to twenty-four hours, according to the weather. The cream is then removed in squares, or oblong rectangular pans, an inch or more in thickness, and in this state is neatly packed in the cleanest straw and sent to market. In Devonshire this thickened cream is not uncommonly churned into butter, by simply beating it with the hand in a bowl, and by virtue of the process it has previously gone through butter is quickly produced in this manner. Devonshire cream is too well known to need further description; its reputation rests on a basis at once so ancient and so sound that it is not in any danger of becoming inconspicuous. A name such as this does not easily die.

### Judging Butter.

The judging of butter is a subject on which very hazy opinions prevail in many places. The necessary merits and obnoxious demerits are not, as a rule, definitely understood. Most people know when they taste good or bad butter, and most judges decide correctly between various samples, but very few of these have so far reduced the matter to a system as to be able to give definite reasons for their judgment. The following formula may be found useful:

#### Scale of Points for Judging Butter on a Basis of a Total of 100 as Perfection.

**Definition of Positive Qualities.**

**Flavour 25.**—Agreeable, clean, nutty, aromatic, sweet, pure, distinct and full.

**Keeping 20.**—Inclined to slow changing, indicative of stability in retaining good qualities.

**Solidity 10.**—Stiffness of body, firmness, not easily melting or becoming soft.

**Texture 15.**—Compactness, closeness of grain, breaking with a distinct fracture like cast-iron, fat globules unbroken and perfect, sticking little to trier.

**Colour 15.**—Pleasing, natural, not appearing artificial, bright, even.

**Make 15.**—Includes all not included under other points, as cleanliness, perfect separation of buttermilk, proper handling of milk and butter, as churning, working, salting, skillful packing, &c.

As a general rule it must be confessed that the English do not excel as butter-makers. We fail to attach to the subject the importance it merits, and we consequently do not take the pains we ought. On the question of scrupulous cleanliness we are often at fault, and we simply leave that of temperature to take care of itself. The old practice of heavy and indiscriminate salting is still in vogue, and we entirely lose the advantages which come of using neatness and attractiveness in regard to the way in which the butter is placed before the public.

One thing is abundantly clear, that while the marvellous improvements in facility of transit have introduced a great variety of foreign butters to the notice of British consumers, thereby educating our taste and fancy after foreign models, English butter-makers have been at no special pains to keep pace with the change of conditions. Very large quantities of butter, much of which is excellent in quality and delicately pure in flavour, are annually imported into this country from various countries on the Continent; and it is simply impossible that, wherever this butter is consumed, the taste of our people should fail to be more or less influenced, modified, educated, and,
we will even add, improved; for these foreign butters are, as a rule, purer and more delicate in flavour than our own. For a long period certain French butters, to wit the Brittany, have enjoyed the leading reputation among the foreign butters sent to us, as they no doubt were superior in quality; but of late years Danish and Dutch butters have greatly improved in quality, so that they are now equal to any others; and while the former is largely sold in this country for Brittany butter, which it equals in every respect, the latter commands as high a price as our own Dorset, which is commonly regarded as the finest butter produced in the British islands.

We have given a short account of Dorset butter-making only, because no other county or district has gained a distinctive reputation for its butter. The leading faults in our butter-making are: want of system, of strict cleanliness of utensils, of regularity in attending to times and temperatures, of knowledge, and of pride in work. The milk is kept in all sorts of unsuitable rooms, and is skimmed at all sorts of irregular hours; the cream is kept—or is allowed to keep itself in the best way it can—in vessels which are less unsuitable than the rooms they stand in, and it is churned many days after skimming, when it has had time to become thoroughly sour, and without reference to temperature or speed of motion; the butter is more or less imperfectly liberated from the buttermilk, and is salted in a haphazard manner. How then, we would ask, is it possible to secure first-rate butter in this way?

The simple fact of the matter is this: excellent butter can be made anywhere, providing that proper pains are taken with it; yet both flavour and quality will vary more or less with change of district, of cows, of herbage, and of climate. Some of the worst butter on earth is made in Ireland, which is capable of producing the finest. In our own dairying districts the bulk of the butter produced is of second and third rate quality; and we are informed* that the manager of the Midland Hotel, Derby, imports all his fresh butter from Normandy, because he cannot get the same quality in his own district, which is one of the best in England. The superiority of Continental butter over English arises from the greater care which is taken in the management of it, and its popularity rests in no small degree on the neat and cleanly garb in which it is presented to the British public. France, Holland, Denmark, Sweden, all send us more or less of fine butter, which is increasing in popularity amongst us. This is not because their butter is really better than ours in inherent quality; much less that they have a better raw material to work with than we have; but in their manipulation of it the various excellences of the butter are perfectly preserved, while in our own country, as a rule, they are not. In no part of England has any general improvement, based on a recognised system, taken place in butter-making, though there are many individual cases in which the desired reforms have taken place; and in these instances as fine butter as any in the world is produced. We wish to see these cases lose their individuality in a common and general adoption of the principles on which they are conducted, or on others equally efficacious; and in order to this we place before our readers the best systems that are in vogue in this and in other countries. The old days of heavy salting to keep the butter fresh until it reached the consumer have passed away with the old coach and waggon era, and what the public now demand is fresh butter, with little or no salt, delivered to them scores of miles away from the place where and within a few hours of the time when it was made. In hot weather it must be kept fresh by ice, or by the exclusion of the air, and not by salt; and the greatest care must be taken, not only in the making of it, but also with the garb in which it is presented to the public.

CHAPTER XX.

ARTIFICIAL BUTTER.


The history of artificial, or, as it is strangely termed, "oleomargarine" butter, unlike that of real butter, belongs wholly to modern times. Its discovery dates back only about a dozen years, and as it is not regarded as a very respectable compound it has met with more enemies than friends among those who have discussed it in public. It is an imitation—professedly so—of butter, and it has met with the hard words generally accorded to such productions; but as it is already a very extensive article of commerce, and likely to become more so as time rolls on, and has really a purpose to serve in the world, it is expedient that we should give some account of it.

The discovery of a product which should form a not unsuccessful substitute for butter belongs to M. Hippolite Mége, of Paris. Aware of the growing scarcity and dearth of butter, this gentleman conducted a number of elaborate experiments on animal fat, and on the 17th of July, 1869, petitioned for a patent at the office of the Commissioner of Patents in London, for the invention of "The Preparation and Production of Certain New Animal Fatty Bodies," and it was granted to him on the 1st of January, 1870.

The object of the invention, as stated by Mége, "is to make neutral products new by their nature and superior in quality. The invention is based on the deduction of modern science, which proves, first, that odoriferous colouring matters, volatile and becoming rancid (acres et rancissantes), do not pre-exist in the natural fats called suets (graisses en branches); second, that they are developed by the action of the organised tissues under the influence of fermentation, of heat, or of chemical agents; third, that the fats of milk, called butter, are only fatty bodies from fat modified, first, by its cellular tissue, and afterwards by the organised tissues of the udder.

"In applying these facts industrially, there is obtained from suet, first, a virgin fat, without any smell or odour of fat, and like the best fatty bodies; second, a variety of true butter taken at its source, formed as in ordinary lactation, and superior to butter from milk by the length of its preservation."

The two leading features in the manufacture of this artificial product are:—First, the separation from fat at a low temperature of a pure, sweet oil, free from disagreeable odour or taste. Second, the churning of such oil with milk or cream for the manufacture of artificial butter.

Mr. H. A. Mott, E.M., Ph.D., writes as follows on the manufacture of oleomargarine butter:—

"The first step to be attended to, when a good product is to be manufactured, is cleanliness. I start off with this most important point, to which the strictest attention must be paid. The floor of the factory, the tubs, the ears, the cloths, the tanks, the hasher, the press, the press-plates, the churns, and in fact every utensil used must be the model of cleanliness; with this understanding we proceed.

"Washing Process."

"The fat, on arriving at the factory, is first weighed, and then thrown piece by piece into large tanks containing tepid water, care being taken to throw all pieces covered with blood into a separate tank, to be washed and afterwards added to the other tanks. The fat now in the tanks should be entirely covered with tepid water,
and left at rest for about one hour, when the tepid water should be removed and the fat thoroughly washed with cold water, then covered with fresh cold water and allowed to rest for one hour longer, when the water is again removed and the fat thoroughly washed for the last time, with fresh cold water, when it is ready for the next operation.

"Disintegrating Process.

"This operation consists in disintegrating the fat by passing it through a ‘meat-hasher.’ To do this, the fat in the tank is removed by means of a wooden car to the side of the hasher, where it is cut with a knife into small pieces about 5 or 6 inches square. Piece by piece it is introduced into the hasher, which, by means of the revolving knife within, cuts the fat very fine, and forces it through a fine sieve at the opposite end, to which it is introduced, and finally forces it out of the hasher in a disintegrated state, when it is received in a tub, ready for the next operation.

"Care must be taken not to introduce the fat into the hasher too rapidly, as the sieve or knife is apt to snap, for it requires considerable force for the disintegration, which of course is accomplished by steam power.

"Melting Process.

"The fat, now in a disintegrated state, is removed to the melting tank, care being taken not to introduce into the tank any of the water which is forced out of the fat during the disintegrating process. The fat is then heated by means of the water surrounding the tank, until the temperature reaches about 116° Fahr., when the steam which heats the water is turned off. The water surrounding the tank, being much warmer than the molten fat, increases the temperature of the fat to 122—124° Fahr., when the fat completely melts. During the whole operation, from the time the steam is turned on until the melted fat is allowed to rest, the fat must be continually stirred, so that an even temperature may be maintained. The adipose tissue, or scrap, of the fat separates and settles to the bottom, on leaving the melted fat at rest, and a clean, yellow oil floats on top, covered by a film of white emulsion of oil with the water contained in the fat.

"When the scrap has completely settled, the thin layer of emulsion is baled off, and the clear, yellow oil is drawn and received into wooden cars, which, when filled to within 1½ inches of the top, are removed to allow the oil to crystallise or granulate. Care must be taken in drawing off the last of the oil not to allow any of the scrap to mix again with it. It is better to receive the last portion of oil and scrap in a small galvanised iron cylindrical can and allow it to cool by itself, and then cool to melt it over again by placing the can in one of the wash-tubs and surrounding it with water heated to about 125° Fahr., and thus separate from the scrap all the oil that is possible. The scrap may then be sold. It sometimes occurs that the scrap refuses to settle, and rises to the surface, forming a layer on top of the clear oil; if such be the case, the melted fat and scrap must be stirred up together for at least ten or fifteen minutes, and then allowed to settle by standing, which it will generally do; if not, then it should be stirred once more and allowed to stand; if it does not settle this time, which is rarely the case, a quart or two of salt must be thrown on the scrap, and the mixture stirred, when the scrap will settle to the bottom on standing. (An acid solution of the active principle of the stomach of a calf was used for some time, as proposed by Mége, in the melting process. It was thought to coagulate the ‘scrap’ and cause it to settle more rapidly. Experiments have shown it to be unnecessary, however.)

"The melting process, when conducted with success, occupies about two or three hours. The oil in the cars will require at least twelve to twenty-four or more hours to granulate, and the temperature of the room should be about 70° Fahr. This is a very important operation, and must not be hurried, otherwise the stearine in the oil will not have time to crystallise. The granulated oil is now ready for the next operation.

"Pressing Process.

"The car containing the solidified oil from the melting tank (which, for convenience, I will call refined fat hereafter) is removed to the press-room, which is kept at a temperature between 85° and 90° Fahr. The refined fat must not be so solid that it cannot be worked with the fingers with ease; if it is, it must be left in the press-room until it softens.

"When in the right condition it is packed in cloths, set in moulds to form packages about
4 inches wide, 8 inches long, 1\(\frac{1}{2}\) inches thick; these packages are then placed on galvanised plates in the press at equal distances apart. The plates with these packages are piled one above the other in the press, until the capacity of the press is thus utilised. The packages are then subjected to a slight pressure, which must be increased very gradually, and only after the oil is pressed out, or begins to flow very slowly, is it taken off again. The oil is received in a tin vessel, which, when filled with oil, is replaced by another.

"The pressing is continued until no more oil can be obtained, at the temperature of the room. The pressure is then removed, and the plates unpacked, when cakes of pure white stearine are obtained, having the dimensions of about 5 inches by 5 inches by \(\frac{1}{4}\) inch. The stearine, after the removal of the cloths, is ready for sale. The cloths are put in one of the tanks containing hot water, until all oil and stearine are melted off, when they are washed in another tank and then hung up to dry. The oil and stearine in the first tank are solidified by means of cold water, collected and sold as soap-grease.

"The oil obtained from the press is removed to a cool place, until it assumes a temperature of about 70\(^\circ\) Fahr., when it is ready for the next operation.

"Churning Process.

"The treatment of the oil from now on, is conducted by my own process, and success in the business depends on the result of this operation, which is always successful in producing a good product (provided the oil has been properly made), where the following is closely adhered to:—

"The oil, now at the proper temperature (70\(^\circ\) Fahr.), is removed to the churning-room. One hundred pounds of the oil are introduced into the churn at a time, with from 15 to 20 lbs. of sour milk (just turned). About 3 or 2\(\frac{1}{2}\) ozs. of anatho, to which has been added from \(\frac{1}{2}\) to \(\frac{3}{4}\) oz. of bicarbonate of soda, may now be added, and the whole agitated for about ten or fifteen minutes, until milk, colouring matter, and oil are thoroughly mixed together, when the whole mixture is withdrawn from the churn, through a hole at one end, and allowed to fall into a tube containing powdered ice. As the oil flows on the ice it must be kept in constant motion until the tub is filled with solidified oil, when another tub is put in its place. The grain is by this simple process completely removed. The solidified oil, which has a slight orange colour, is left for about two hours in contact with the ice in the tubs, when it is dumped on an inclined table, where it is crumbled up so that the ice may melt and leave it; it is then crumbled up fine by hand, and about 30 lbs. of it at a time introduced into churns, with about 20 to 25 lbs. of sour milk, which may have been previously churned, and the whole is agitated for about fifteen minutes. During this agitation the solidified oil takes up a certain percentage of milk, and with it the flavour and colour which the melting ice had washed out of it before. It is then removed from the churn to the working table, where, after standing and draining for a time, it is salted at the rate of \(\frac{3}{4}\) to 1 oz. of salt to the lb. of butter, and it is packed into firkins and is ready for sale."

This product is not butter, however much it may be made to resemble it in taste, colour, and smell. Butter is one of the most complicated fats known; it contains in varying proportions nine different so-called fatty acids in combination with glycerine, and it consists therefore of glyceroids. These glyceroids are butine, stearine, palmitine, myristine, caprine, capryline, caproine, butyline, and oleine. But artificial butter contains only three of these, palmitine, stearine, and oleine, with a trace of caprine. The stearine is not all removed in the process of manufacture, for artificial butter still contains 47 per cent. of it. The name oleomargarine is taken from palmitine, which is sometimes called margarine; but of this particular substance artificial butter contains much less than it does of either of the other two. By churning animal oil in milk an attempt is made to introduce into artificial butter the six missing fats which are found in real butter, yet with very indifferent success, for only a mere trace of one of them is secured. The following table shows the difference between them:

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Fats in Real Butter</th>
<th>Fats in Artificial Butter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palmitine</td>
<td>20-33</td>
<td>22-32</td>
</tr>
<tr>
<td>Stearine</td>
<td>42-77</td>
<td>46-94</td>
</tr>
<tr>
<td>Oleine</td>
<td>27-71</td>
<td>30-42</td>
</tr>
<tr>
<td>Butyline</td>
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<tr>
<td>Caproine</td>
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<td>Capryline</td>
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<tr>
<td>Batine</td>
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<tr>
<td>Myristine</td>
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<td></td>
<td>9-19</td>
<td>32</td>
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<td>100-00</td>
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</tbody>
</table>

ARTIFICIAL BUTTER. 325
The substances absent from artificial butter are limited in quantity, but on them rest the singular excellences of real butter; and it is their production in the mammal-glands that invests those organs with so much interest—that makes them one of the most wonderful of nature’s laboratories. Butter is a peculiar product, and its flavour, odour, and composition are found in nothing else in nature in the same, or nearly the same, combination. Animal fat, on the contrary, is not produced by the mammal-glands but by other tissues of the animal’s body, hence it is not invested with these peculiar properties on account of which butter is at once famous and unique. It may be, and probably is, as wholesome and nutritious as inferior natural butter, but it is not butter any more than chalk is alabaster, though in each comparison there is a good deal of similarity; yet chalk has its uses, and so has oleomargarine butter.

One thing is clear: the inferior kinds of butter will have to succumb before oleomargarine, because it can be produced so much more cheaply than they, and because it is an infinitely more reliable article. Common butter is made every shade of colour and very irregular in quality and flavour; but oleomargarine is made uniform in appearance, inequality, and in taste, and these qualities, being reliable, will carry it over the prejudice which exists against it at present. It is, in fact, a more desirable, a more marketable, and a really more valuable article than our commonest kinds of milk-butter, and very much more so than bad whey-butter; it is being used—the better brands of it, that is—for ordinary table use already to a very large extent, and in course of time its consumption in this manner will altogether supersede that of the poorer and commoner kinds of natural butter. To say the least, it is a great and dangerous rival to natural butter; and our dairy-farmers will have to bestir themselves so as to produce the best possible butter from the good raw material of milk, or the oleomargarine makers will run them very hard in the competition for public approval; for the item of cost of production is very much in favour of the artificial goods, as it is a heavy handicap on those who produce the real ones.

Artificial butter is being commonly sold under the name of “butterine,” and this is by far preferable to oleomargarine as a commercial designation of the article. Though the taste of it is not positively objectionable, it is negatively so, for there is a disappointing absence of flavour of any kind. Comparatively speaking, it is both tasteless and odourless, and while it can never find much favour with those who have been accustomed to and can still obtain good milk-butter, it is sure to be preferred by those who have been used to eating the inferior qualities of natural butter. The retail dealers have every inducement to sell it to those customers who have no particular objection to it, because they can get a very good profit out of it; then, again, they can depend on a regular supply of an article that is quite uniform in quality, colour, and flavour; and, in the commercial world, these qualities are of great importance between salesman and customer. But with all the inferior grades of natural butter the ease is quite different; the dealers cannot depend on getting uniformity of anything, and their customers are of course equally uncertain. Then, further, the keeping properties of butterine are very much superior to those of inferior butter, and this fact provides both dealer and customer with cogent reasons for preferring the former to the latter. It is only really good butter that can compete with success against butterine.

A good deal of oleomargarine is worked off in adulterating real butter. The two are simply mixed up together in a more or less thorough manner, and then sold as the real article. In this way butter is degraded. We consider that a law should be made under which such practices can be dealt with in a prompt and special manner. The sale, indeed, of oleomargarine requires a special Act of Parliament for its control. None of it ought to be allowed to be sold in any shape or form, except under a designation which shall plainly declare its real character, so that no customer be deceived in buying it. If the public will then buy it from preference, there is nothing more to say; but they have a right to protection against being supplied with a spurious when they ask for a genuine article. This artificial butter is an invention of modern times, and its development should be controlled by a law which is sufficiently elastic to cover every phase into which the article may enter. And this is the more necessary because the public cannot detect butter which has been adulterated with oleomargarine; nor can they, indeed, always distinguish between genuine butter and its counterfeit rival.
Professor G. C. Caldwell writes as follows on this topic:

"The detection of oleomargarine in butter, when the adulterating material is made, as it can be, in a careful and cleanly manner, is not easy, nor certain, except by methods which only a skilled chemist can execute. Several simple tests have been given, but my own experience with them has shown that they can be relied upon only when the oleomargarine is poorly or carelessly made, or when the butter consists entirely of oleomargarine simply flavoured by the small proportion of cream with which it is churned. Of these tests the following has given the best results within my hands:—Over a piece of good butter as large as a chestnut in a wine-glass pour about twice its bulk of ether; stir it up until the fat is all dissolved. Let it stand for a few minutes till the undissolved salt has settled to the bottom. Pour the clear solution off into a table-spoon and set it aside for an hour or two, or till all the ether has entirely evaporated. Perform the same operation with a piece of oleomargarine, and on comparing the two fatty residues the latter will be found to have a more or less distinct tallowy odour, which may become more apparent if the spoon is held for a moment in the hot steam from the boiling teakettle. The residue from good butter has no such odour; but genuine butter may be adulterated with half its weight of oleomargarine, and the adulteration cannot be detected by this test. When genuine butter is heated to a temperature of several degrees above the boiling-point of water, it foams much more than oleomargarine does when treated in a similar manner. I have found that this test enables us to distinguish genuine butter from genuine oleomargarine, but it is no more serviceable than the other for detection of adulteration of the one with the other. No one should place much dependence on either of these tests without going through with the same operation with genuine butter at the same time, or at least not until thoroughly familiar with the different results given by the two substances under the conditions of the test."
CHAPTER XXI.

Condensed Milk.

Usefulness of Condensed Milk—Its Nutritive Value—First Manufacture by Professor Horsford, of Massachusetts—Mr. Borden's Experiments—He Discovers the Necessity of Protection from Atmospheric Influences—Adopts the Vacuum-Pan—Other Minute Precautions Necessary—Cause of Ferment and Decomposition. Mr. Borden's Rules for Milk-Sellers—Description of the Borden Apparatus and Process—Growth of the Trade in Condensed Milk.

ANY of our readers are doubtless acquainted with condensed milk; travellers by sea are familiar with it, and it is carried to distant parts of the earth for use where it is impossible to obtain fresh milk. As a rule its consumption is at present for the most part confined to those who cannot procure fresh milk at all, or cannot procure it regularly, and it is not commonly used in the exclusion of fresh milk where the latter is available, unless in cases where it is difficult to obtain a pure and genuine article in the fresh state. It is probable that the Adulteration Acts, under the operation of which pure milk is now obtainable almost everywhere in our towns and cities, have checked somewhat the growing consumption of condensed milk; and it is more than probable that it would by this period have come to be very extensively used as a regular article of diet in private families, if the supply of fresh milk to our urban populations had remained in the unsatisfactory state of a dozen years ago. But as matters now stand, fresh milk of fairly good quality is almost everywhere obtainable, though not always at a moderate price, and the vacancy which condensed milk would otherwise have been called on to fill no longer exists, or exists on a much diminished scale. But outside the bounds of family use there is a very wide demand for condensed milk; for the army abroad, the navy, the merchant service, for travellers almost everywhere, for hotels and various large public institutions, it is a most valuable adjunct to the supply of food. In former times sailors, soldiers, and travellers beyond the limits of civilisation have felt severely the loss of milk, which, previous to the invention of the condensing process, they were unable to take with them except in the forms of cheese and butter, and it is only in our day that the deprivation has been removed.

Cheese is a condensed form of milk, and butter consists chiefly of the fats of milk without any of the casein; both are most excellent and valuable—nay indispensable—articles of food, and though the former may be regarded as in most respects a very tolerable substitute for milk in a dry form, while butter is extremely valuable as consisting of the carbonaceous elements of milk, neither one nor the other can by any practical process be re-invested with the properties on account of which milk is placed in the front rank of the world's food products. Condensed milk differs essentially from cheese in this: the casein in it is still soluble, as in new milk, while in cheese it is precipitated. It differs again in this: it contains the whole of the sugar of milk, the bulk of which passes off in the whey in the process of cheese-making. But the chief difference is the first mentioned, for, when once precipitated, the curd of milk cannot be restored to its former condition. In cheese-making, as in milk-condensing, the salient result is the removal of the bulk of the water which milk contains, but in this it is done without precipitation of the casein, while in that it is not; in this also all the sugar is retained in the product, while in that the bulk of it escapes in the whey. The process of cheese-making is much simpler and less expensive than that of milk-condensing, but the product in one case is totally different in character from that of the other; and while cheese cannot be re-invested with the characteristics of the milk from which it was made, condensed milk, by the
simple addition of a given quantity of water, can easily and quickly be made to re-assume all the character of, and to again become to all intents and purposes identical with, new milk as taken from the cow. Hence it follows that condensed milk, as applied to certain purposes, possesses a value which is not shared by any other product of the dairy.

America claims the first production of a satisfactory, merchantable article of condensed milk. Experiments in this direction began in that country in 1816, and were quite independent of the efforts in England and France ten and twenty years before. To Professor E. N. Horsford, of Cambridge, Massachusetts, is due the credit of the first experiments which established the two points of evaporation at a low temperature and the requisite proportion of sugar for preservation. A chemical assistant of his joined some business men and succeeded in making in Dutchess County, New York, an article of solid condensed milk, which was found practically useful in California as early as 1852, and was proved by the Subsistence Department of the United States Army upon the plains in 1853-4. It was also tried on ship-board, and orders filled from Liverpool. The same parties prepared in 1856, for the Arctic Expedition of Dr. Kane, 600 lbs. of condensed milk in solid blocks, which was very valuable during that memorable voyage. Professor Horsford has still in his possession (1880) a little block of this very lot in a condition of perfect preservation, although protected from the air only by an envelope of loose tin-foil during these four-and-twenty years. This enterprise was not, however, a commercial success, and the manufacture ceased.

In the introduction we stated that the credit of being the first to produce a thoroughly successful article under the name of condensed milk, which was, to all intents and purposes, actual milk minus the bulk of its water, is ascribed to the late Mr. Gail Borden, of the United States. It is not claimed by Mr. Borden's friends that he was the inventor of milk-condensing, nor did he make any such claim on his own account, but only that he was the first to reduce the process to a thoroughly successful and satisfactory form. Before he commenced operations at all, various kinds of condensed milk were being produced, some of which were in a solid, others in a liquid, and others again in a powdered form, each of which when re-mixed with water represented milk with more or less fidelity. Most of these require some extraneous substance or other to assist in preserving them, and sugar was, and indeed still is, extensively employed for that purpose, so that much of the condensed milk on the market was, and still is, unpleasantly sweet. It is still necessary, even under the best methods, to intermix more or less sugar in condensed milk that is required to be kept a considerable time before it is used; but plain condensed milk, intended for early consumption, is now successfully prepared without the help of any foreign preserving agent, and Mr. Borden was the first who made an article answering to this description.

Thirty years ago Mr. Borden's attention was directed to producing suitable food-supplies for the use of emigrants and travellers across the vast plains of America—food of a highly nutritive character, and at the same time easily portable, containing in a concentrated form food-elements that could not with any regularity or surety be obtained on the plains, and he produced a "meat-biscuit," which soon became popular. From this his thoughts turned toward the preserving of milk for similar uses. His aim from the onset was to accomplish the preservation of the milk by simply removing the water, and to guard carefully against any possible detriment from the time when the milk was drawn from the cow until the process of preservation was completed. He examined various preparations of solidified and otherwise preserved milk that were on the markets of England, France, and America, and found in none of them a near approach to his ideal standard of what condensed milk ought to be; the high price at which these preparations were sold, their properties and qualities, and the fact that most of them contained alkaline salts and other foreign substances, prevented them becoming popular, and Mr. Borden saw that there was a broad margin between what these products supplied and what the public required; this opening he determined to fill.

He discarded from the first all thought of condensing skim-milk, although scientific friends warned him that he aimed too high in trying to retain, uninjured, all the butter in connection with the remaining solid constituents of the milk; this, they told him, could not be attained in practice, however clear it might seem in theory, and they advised him that the removal of a portion of the
cream would be found necessary as a first step; but he "pushed on regardless of the advice, persevering with characteristic energy and determination until his object was attained."

After testing the processes employed by others, and carefully observing results, he became convinced that protection from injurious atmospheric influences during the process of evaporation was an essential requisite to success; but he soon found that serious difficulties stood in the way of grafting this principle of protection on any existing process of milk-condensing. The chief difficulty was the adhesion, in the form of a crust, of the albuminous constituents of the milk to the inner surface of the vacuum-pan (this was at length prevented by oiling the inner surface of the pan); and the foaming of the milk under the lessened atmospheric pressure was such that an experienced sugar-boiler, whose aid he sought, pronounced it sheer folly to persist in trying to employ the vacuum method in the evaporation of milk, because it was utterly impracticable. These and other difficulties were, however, at length overcome, and success was assured.

Mr. Borden's first application for a patent to cover his marked improvements in milk-condensing was made in May, 1853, but owing to technical objections he did not obtain the grant until August, 1856. In his claim he stated that evaporation in vacuo was a leading feature of his process, and in reply the Acting Commissioner said: "You allege great importance to working entirely in vacuum. This office does not have any faith in such an allegation." Yet while these learned officers could see no advantage in evaporation in vacuo over that in open pans, they did grant a patent for "conveying the steam and flavour arising from the evaporation of milk through another vessel containing sugar, the purpose being to thus distil milk and condense the same in sugar to preserve the pure flavour," as if in the water and odours of milk lay all its virtue! The importance of protecting the milk from contact with the air was a point in which Mr. Borden strongly believed, and which he asserted in his application for the patent; but though the Examiners and Commissioner admitted the superiority of his condensed milk over that of other makers, they were-for the time wedded to the belief that an equally satisfactory result might be obtained under any other method of evaporation, providing equal skill and care were employed in the manipulation, and that it was not due to any special superiority of Mr. Borden's apparatus. This objection was finally overcome by scientific evidence to the fact that by no other method could condensed milk of equal quality be obtained, and the patent was granted.

Mr. Borden was not, at all events at the outset of his experiments in the preservation of food, a scientific man, though his mind had a decided scientific tendency. He had no knowledge of the germ theory, but he had a wholesome dread of incipient decomposition of milk, and he hit upon the scientific fact that if he could prevent its beginning before and during the process of condensation, it would be easy to secure the product against its inroads. Hence the adoption of the vacuum-pan, by means of which the milk, properly taken care of previously, was completely protected from atmospheric taints whilst its water was evaporating at a comparatively low temperature. This process Mr. Borden made so completely successful that it superseded all others in effectiveness, and it is affirmed that all the brands of good or even of fair quality now sold are prepared substantially under the system originated by him.

At an early stage in his experiments he came to the conclusion, from which he never wavered, that milk could not be satisfactorily preserved in a dry form, either as deissicated, or powdered, or solidified, but must be left in a semi-liquid state. It also became evident that to secure long-keeping properties some preservative agent must be employed, and sugar was found to be the only proper thing to use for that purpose. Without taking from the milk any constituent except water, and adding to it nothing except sugar, condensed milk is now produced; it is semi-liquid, of the consistence of honey or molasses, and when re-mixed with water is actual milk once more, possessing all the characteristics and properties of fresh milk, and differing from it only in so far as it is a little sweeter. The preserved milks that are in a solid or powdered state require to be dissolved in hot water, but the condensed milk prepared under Mr. Borden's system dissolves readily in cold water, hence there is an essential difference between it and them; for domestic purposes generally this difference places the semi-liquid condensed milk far before the other forms in which milk has been preserved, so far as value and convenience are con-
cerned; while, at the same time, it is practically identical with new milk, when the proper quantity of water is restored to it, and they are not.

The successful manufacture of condensed milk demands the utmost and unceasing care during the whole of the process, scrupulous cleanliness everywhere, and minute attention to details. To use Mr. Borden’s own words:—“The making of a good article depends not so much upon the formula in the best specification, as upon the condition of the milk when brought to the factory, and the care and attention given to every part of the process, from the washing of the vessels and the thorough cleanliness which should be observed in every department. The success of the milk manufactured at our three factories is due to the attention which we give to the personal inspection of every department of the dairies on the farms, which is assigned to one person at each factory, and to the constant examination of every man’s milk, by samples taken and subjected to tests as to cream, sweetness, and the time it will keep after being brought from the dairies. In short, there is nothing manufactured that requires so much care and everlasting vigilance and attention as milk. From the time it is drawn from the cow until hermetically sealed in cans it requires that everything should be done with the utmost integrity.”

Mr. X. A. Willard, of Little Falls, New York, to whose early and long-sustained efforts after improvement American dairying owes more than to any other man, writes as follows on the subject of condensed milk:—“In Mr. Borden’s early experiments the nature and cause of a peculiarly bad behaviour of milk from time to time were imperfectly understood. Under certain circumstances and conditions the milk could be readily handled, and gave no trouble in its manipulation. When in this state, comparatively inexperienced operators —men who simply followed a set of rules, with little or no knowledge of principles—were enabled to turn out a good product, whether it was condensed milk, or butter, or cheese. Sometimes these conditions would continue for days, for weeks, or for months; but there was no reliability on their continuing for a specified time, or, indeed, in different localities during the same time. The milk might be easily worked one day, and the next would refuse to be controlled under ordinary treatment. The fault was at first supposed to originate in some want of cleanliness, either at the factory or among those who produced and delivered the milk. This was a part, but not the whole of the trouble. The importance of cleanliness, and of what seemed to many to be ‘an absurd fastidious neatness,’ became apparent to Mr. Borden at an early stage of his investigations. He therefore instituted a set of rules for the government of dairymen in the care and management of milk; and as he bought only such milk as would pass the closest scrutiny of an expert, he was able after a time to enforce an observance of his printed regulations. He adopted also the practice of cleaning and steaming at the factory his patrons’ delivery milk-cans, because he feared, and with good reason too, that this work might not be properly done at the farm. But even when farmers had become educated, and all his conditions of cleanliness had been observed and carried out to the letter, milk not unfrequently came to his factories which, though apparently perfect, or at least so perfect as to pass the rigid scrutiny of his experts, was in a condition that rendered it impossible to be converted into a good product. The reason for this was not easy of solution, and it has been the cause of heavy losses and the closing up of factories which were not under Mr. Borden’s immediate supervision.

“It may be observed here that good condensed milk is more reliably clean and healthy than most milk that goes to the city consumer. Dirty milk, foul with the drippings of the stable, cannot be condensed into a clean-flavoured product. The success of the condensing factory depends entirely upon the ability to put a fine-flavoured, perfect article upon the market. The milk must be uniformly good. An inferior condensed milk is more readily detected than an inferior article of cheese; at least, imperfections in cheese may be tolerated, and the article may find a place in the market, but a factory sending out imperfect or badly-flavoured milk must soon cease to be remunerative, and must inevitably close its doors. To obtain any success in this business there is an absolute necessity for clean healthy milk in the first instance, and it may be well to warn those who propose to enter upon condensed milk manufacture that more than ordinary difficulties lie before them.”

Microscopical investigations by various scientific men have revealed the nature of the active agents which bring about the decomposition of milk, changing it from its attractive and palatable form to one that is repulsive and unwholesome.
The processes of decomposition are various, according to the nature of the ferment applied and of the substance acted upon. The germs of decay exist in the air, sometimes in great plentitude, and are ever ready to seize on substances whose inherent life-principle does not for the time protect them. The air we breathe, which is indispensable to life, contains the germs which disintegrate organisms whose life has departed, or substances which have become detached from the organisms which produced them. Some substances are subject to much more rapid decay than others, because they are composed of ingredients on which the decay-germs feed with greater avidity. Few things are more liable than milk to early and rapid decay if it comes in contact with air that is charged with the germs of ferments—some of which are easily perceived by the offensive odour which they emit.

Professor G. C. Caldwell, of Cornell University, writes as follows on "Organised and Unorganised Ferments":—

"Within these last ten years the line of demarcation between organised and unorganised ferments has been more plainly laid down. Fermentation in general, inclusive of putrefaction, is now defined to be a chemical change, in which an organic body, some product of vegetable or animal life, is modified in a certain way under the influence of another organic substance, which is likewise some product of vegetable or animal life, and is called the ferment. The products of the chemical change produced in the first body are formed exclusively at the expense of that body; there is no union of the ferment with the fermented body, or with any product of the decomposition of that body, to form a new chemical compound. One of the most striking features of this process of fermentation is the great power of the ferment, manifested in the decomposition of many hundred or thousand times its weight of the substance attacked by it.

"Now we find that in certain classes of cases the ferment is not only organic—that is to say, some product of vegetable or animal life—but also organised, itself a living being, either vegetable or animal, and the fermentation is accomplished in some yet unexplained way in connection with the operation of the vital processes of the living being. The form and structure, and in many cases the movements, of these living beings are made out with the aid of the microscope, and often without the use of very high magnifying powers.

"An eminent writer on this subject has lucidly stated the difference between the two kinds of ferments. Both ferments, he says, are derived from living organisms; the one, the unorganised ferment, or the soluble ferment, as it is sometimes called, can act independently of the living organism which is necessary to produce it; but in the other case the living organism itself must be in the fermenting liquid in the actual performance of its vital processes, growing and multiplying there.

"In some cases these unorganised ferments will withstand quite high temperatures without the permanent loss of their fermenting power, as compared with the organised ferments. Pepsine, one of these ferments, has been heated to 230° Fahr. without destroying any of its fermenting power; the ferment found in the pancreatic juice which brings about certain changes in the albuminoids and fats of the food that it meets in the intestines has been heated to 320° without the entire destruction of its power, and to 225° for half an hour and to 205° for five hours without the loss of any power.

"In some cases we find several of these ferments in one and the same liquid, as in the pancreatic juice of the animal, where there is one ferment that alters the albuminoids, another that breaks up the fats, and still a third that converts the starch into sugar; and these ferments may be in a measure separated from one another by treating the pancreatic glands with solutions of different salts, one salt serving to extract one ferment only, and leaving the others. A solution of rochelle salt or of nitrate of ammonia will extract nothing but the ferment that acts on the albuminoids, while the one that converts the fats is taken up by bicarbonate of soda.

"There are other points of difference between unorganised and organised ferments, some of which furnish us with quick and ready means of determining whether in any given case we have to deal with the one kind or the other; a brief consideration of these reactions will serve to bring out in a still more striking manner the strong line of demarcation between the two kinds of ferments. When an organised ferment is exposed to the action of oxygen gas under pressure it is killed; an unorganised ferment is not. Certain chemicals which stop alcoholic fermentation,
or any other kind of fermentation of a similar character, have no effect at all on the action of diastase: these are prussic acid, alcohol, ether, chloroform, and oil of turpentine; on the other hand, citric and tartaric acids, which hinder alcoholic fermentation but slightly, stop the action of diastase completely; borax stops the action of the soluble but not of the organised ferment. Acids in general hinder the action of the soluble ferments; carbolic acid, which is, however, not a true acid, has but little effect upon them; no organised ferment will work in a solution containing more than 0·5 per cent. of carbolic acid, while a soluble ferment like pepsine continues its action without hindrance. Another and an important point of difference between the two kinds of ferments is found in the different kinds of chemical changes which they produce; the change produced by the organised ferment is much more complicated than that produced by the unorganised.  

Contact with impure air quickly communicates to milk the elements of decay, and it would appear that the ferments given to milk in this way are chiefly organised ferments, or fungi of one kind or another; but whatever they may be, and whether they act by souring the milk or by tainting it, their action proceeds to decomposition and decay. When deposited on substances rich in nitrogen, as milk is, and if the temperature is suitable to their propagation, these ferments usually multiply at a wonderful rate, causing a rapid destruction of the substance in which they operate. Some of them pass through a variety of forms as they develop, multiplying in number at each stage, and the course is finished in a very short time. At a temperature of only 50° to 60° the fungus Penicillium crustaceum (blue mould) runs through its course in forty-eight hours at the most. The spores of the fungus are extremely minute, and each one of them produces, in the time named, several hundred other spores, and these again multiply at the same rate, and so on. Under different conditions, at least six different kinds of spores are produced from those of Penicillium, each one representing a different kind of decomposition; these are only so many different stages in the development of the original fungoid spore, and under proper conditions these new and different spores are just as surely re-converted into Penicillium spores as they were in the first place produced from them. Thus it is that putrefactive ferments act, feeding on and destroying a previously sound and fresh substance, and converting it into the same decomposed elements as those from which they sprang themselves.

Milk will quickly absorb any kind of taint that may happen to be in the air to which it is exposed, whether it be a putrefactive taint or not. The taint may consist of germs thrown off by some adjacent animal or vegetable substances in a state of decomposition; it may arise from cesspools reeking with a hideous mixture, or from manure-heaps and liquid-manure tanks; or it may not be a decay agent at all, but simply an odour thrown off by various liquids or substances, as paraffin, asphalt, &c. &c., and the odour itself agreeable or otherwise, as the ease may be. These can only be expelled by immediately heating the milk to about 150°. There are few if any odours, however mild, with which milk will not become impregnated, if they have access to it, and in extreme cases the milk will have acquired the intensely disagreeable property of tasting like the smell of the odour it has absorbed. Once acquired, this property cannot easily be got rid of; and whatever is made from the milk, be it cheese, butter, or condensed milk, will be more or less injured accordingly; and, strange to say, the extent to which the property is acquired seems to depend less on the volume of the milk and of the infectant odour than on the quantity and quality of the cream in the milk. The foul, too, and the treatment of the cows, as we have seen in another part of this work, have a great deal to do with the condition and quality of the milk, and by these means alone, without the help of extrinsic influences, milk may be much reduced in value.

Such, then, are the enemies with which the maker of dairy products has to contend, and the condensed-milk producer is affected by them in an especial manner. Suspecting this, Mr. Borden was led to locate his factories in favourable districts for obtaining good milk, to select as milk-suppliers persons whose long experience in furnishing milk for city consumption had instilled habits of care and cleanliness to a degree which is uncommon among dairy-farmers in general, and to frame for his own security and for guidance of the suppliers of milk the following set of rules:

1. The milk shall be drawn from the cow in the most cleanly manner, and strained through wire-cloth strainers.

2. The milk must be thoroughly cooled, immediately
after it is drawn from the cow, by placing the can in which it is contained in a tub or vat of cold water, deep enough to come up to the height of the milk in the can, containing at least three times as much water as there is milk to be cooled; the milk to be occasionally stirred until the animal heat is expelled, as below.

"2. In summer or in spring or fall, when the weather is warm, the bath shall be spring water, not over 52° temperature (a day or night after a heavy rain excepted), constantly running or pouring in at bottom, necessary to reduce the temperature of the milk within forty-five minutes to below 58°; and if night’s milk (to remain in such bath until the time of bringing it to the factory) to below 55°. The morning’s milk not to exceed 60° when brought to the factory.

"4. In winter or in freezing weather the bath shall be kept at the coolest point (it need not be running spring water) by the addition of ice or snow sufficient to reduce the temperature of night’s milk speedily below 50°.

"5. In spring and fall weather a medium course will be pursued, so that the night’s milk shall be cooled within an hour below 50°, and morning’s milk below 55°.

"6. The bath and supply of water shall be so arranged as to let the water flow over the top to carry off the warm water. The can in which the milk is cooled shall be placed in the water immediately after the milking, and shall remain therein until the process of cooling shall be finished.

"7. The night’s and morning’s milk shall be separately cooled before mixing.

"8. No milk shall be kept over to deliver at a subsequent time.

"9. The milk shall be delivered on the platform at the factory every day, except Sunday.

"10. Suitable cans of proper dimensions to transport the milk from the dairy to the milk-works shall be furnished by the seller, and the cans shall be brought full.

"11. The Company shall clean and steam the cans at the factory free of charge, but milk-suppliers shall keep the outsides clean. The pails and strainers employed shall be by the seller thoroughly cleaned, scalded in boiling water, and dried morning and night.

"12. Immediately before the milk is placed in the cans they shall be thoroughly rinsed with clean cold water, and great care shall be taken to keep the cans and milk free from dirt or impurities of any kind. When the cans are not in use they should be turned down on a rack, with the tops off.

"13. All the strippings as well as the first part of the milk shall be brought. No milk will be received from a cow which has not calved at least twelve days, unless by consent of the superintendent or agent, who may determine its fitness sooner by a sample of the milk.

"14. The cows are not to be fed on turnips or other food which would impart a disagreeable flavour to the milk, nor upon any food which will not produce milk of standard richness.

"15. It is further understood and agreed by the parties hereto, that if the superintendent or agent of the Company shall have good reason to suspect, either from evidence furnished or from the state of the milk itself, that water has been added, or that it has not been cooled as provided, or that it has been injured by carelessness, he shall have a right to refuse to receive such milk, or any further quantity of milk, from the person so violating these directions and stipulations."

The issuing of these elaborate rules—which, by the way, are applicable to the production and treatment of milk that is devoted to other purposes than that of milk-condensing—proves that their author was alive to the necessity of preserving milk with the greatest care from injury by filth, from the absorption of ferments, and from carelessness; but the most effective thing in connection with them is the strictness with which they were enforced. Such rules are all very well, but unless they are scrupulously obeyed they are not worth the paper on which they are printed.

There are various methods and recipes for condensing and preserving milk, among which the following may be mentioned:—(1) Add sugar; evaporate to one-fourth; solder in cans. (2) Add carbonate of soda and white sugar; evaporate to dryness; cut into cakes. (3) Add sugar and alkali; evaporate to dryness; crush, powder, and bottle. (4) Evaporate to one-half; heat up white of egg; simmer, skin, strain, and boil. (5) Carbonate of soda one-half draehm, water one fluid ounce; dissolve; add fresh milk one quart, sugar one pound; reduce to syrup in a steam bath, and finish the evaporation on plates in an oven. In many milk-condensing factories the milk is first cooled to 60° and then heated in a hot-water bath for about half an hour until it has reached 160° to 180°, when it is poured into the large condensing-pan, directly above which are two large fans that are kept in motion by machinery; the fans carry off the water from the milk, forcing it through ventilators out of the building as fast as it is formed into vapour. In this way 75 per cent. of the bulk of the milk is carried off in about seven hours.

In Borden’s method, which is protected by patent, nothing except sugar is added to the milk, hence its superiority over most of the others. It is obvious that the addition of carbonate of soda, however useful it may be in preserving the milk, cannot but detract more or less from its value and attractiveness when it comes to be used as food; while sugar alone affects it in no other way than to make it more or less sweeter than new milk. The process in question is described by Mr. Willard as follows:—

"The factory at Brewster is an immense establishment, and every part of the business is conducted with the regularity of clockwork. The building is located on a small stream where there is a 7-foot fall, and the water is thus utilised for
MILK CONDENSING.

running the pumps, which is a considerable saving during the year by way of fuel. The factory has two vacuum-pan, one of which is a 6-foot pan with two coils of pipe, and 2,000 quarts of milk per hour is the usual rate of condensing. Mr. Borden believes in doing the work rapidly, and says the sooner you can get the milk from the cow into a condensed form the better. There are two boilers of 55 horse-power each for supplying steam to the pans, and the average pressure of steam in the pipes, at the pan, is 55 to 60 lbs. to the square inch. The evaporation goes on best in clear dry weather; in damp, foggy weather it takes a little longer to get the water out of the milk. About 10,000 quarts are being condensed per day.

"The milk as it is received goes into square-like boxes or vats, the receiving-room being 4 or 5 feet higher than the bath and heating-room. The bath-tubs are circular, and have a coil of steam pipe at the bottom; they are filled within 6 or 8 inches of the top with water. The heating wells are of copper, egg-shaped, and stand opposite the bath-tubs, a raised platform running between the two. The milk is drawn through a hose from the receiving-tanks into copper cans setting in the bath-tubs, each can holding about 40 quarts, and here it is heated to from 150° to 175°; it then goes to the heating wells, which have a jacketed bottom for steam, and is heated up to the boiling-point; it is then immediately drawn into the vacuum-pan, into which a stream of milk is kept flowing as fast as the evaporation goes on, or at the rate of about 2,000 quarts per hour. When the sugared milk is to be made the amount of sugar is calculated for the given quantity of milk, and then turned into a movable tank or well, where hot milk is poured upon it till it is thoroughly dissolved. The hot sugared milk is drawn up last into the pan, and mingles there with the milk that has been partially condensed. The sugared milk must be eliminated of more water than plain milk, since the addition of sugar partially liquefies the mass—a curious fact. Three pints of milk make 1 lb. of sugared condensed milk. The best quality of white granulated sugar is used, in the proportion of 1½ lbs. of sugar to the gallon of milk.

"The milk remains in the vacuum-pan for about three hours, during which time about 75 per cent. of its bulk in water is eliminated, when it is drawn off into cans holding about 40 quarts each.

The cans are only partially filled, and are then set in a large vat containing cold water, the water being of a height equal to the milk in the cans. Here it is stirred until the temperature of the condensed fluid is reduced to a little below 70°. It is then turned into large drawing-cans with faucets, in order to facilitate the filling of the small cans. The drawing-cans stand in a room set apart for the purpose, and around the outside of which runs a table or work-bench. Here the milk is drawn from the faucets into the small tin cans, holding 1 lb. each, when they go to the table, and are immediately soldered to exclude the air. The cans next have the proper labels pasted upon them and are ready for market. The work of filling the cans, soldering the tops, and labelling is usually performed by females. A number of small soldering furnaces are located along the tables, where the
girls, each with a set of soldering irons, seal the cans as fast as they are brought forward by the fillers."

An article called "Plain Condensed Milk" is now made in considerable quantities, and in the American cities it is daily retailed to customers after the manner of fresh milk, in preference to which it is bought by many people. It consists of milk from which the bulk of the water has been evaporated, and to which no preserving agent whatever has been added. It is, therefore, made for comparatively early consumption, though it will keep sweet for a considerable time when sealed up in cans. It is in this form more easily portable than new milk, and becomes new milk to all intents and purposes when water is added to it. In its condensed form, however, it is convenient to use in the place of cream, and its consistency may be regulated at will.

The building is 16 by 50 feet, with verandah, or shed, 4 feet wide on two sides. The ground-floor is divided into four departments: the first to the right is the can-washing-room, 16 by 16 feet, containing the hot-water washing-tank, with coil of steam-pipe, the hot-water sink and scalding jacket, the cold-water sink and platform for cleaning cans. The steam-pipe leads from the boiler to this room.

The next is the receiving, condensing, and delivery room, 16 by 16 feet. It contains the receiving and cooling tanks, the heating vat, and the vacuum-pan. Then comes the engine-room, 7 by 16 feet, containing duplex engine and pump, with steam-pipes leading to the other rooms. The rooms to the left are the coal-shed and boiler-room, 9 by 11 feet, where is situated the boiler (60 horsepower) and the boiler-pump. Communication is easy from one department to the other by wide doors, and the whole is arranged for convenience in doing the necessary work.

Formerly vacuum-panns were made of copper, but the high price of that metal tempted people to make them as thin as possible, and the collapse of the pan, owing to external atmospheric pressure, was a not unfrequent occurrence. The use of cast-iron instead of copper has obviated these disasters, and cast-iron pans are now successfully used for milk-condensing and for other purposes. The illustration (Fig. 201) shows the construction of one of these vacuum-panns.

The pan A is 10 feet 6 inches in diameter, and is cast in four pieces; B is the dome, connected by the vapour-pipe C to the catcher D, the latter being a cylindrical vessel, divided part way by a partition or apron E; against which, in case of boiling over, the liquor would be dashed and would gather in the bottom, where the amount can be seen at the glass gauge D, and, if necessary, emptied into the pan by means of the faucet and pipe g. From the top of the catcher D the vapours are conducted by pipe E to the condenser F, which is placed 33 feet above the water-level in the basin G, to which the condenser is connected by the stand-pipe H. The water rises in the latter to about 30 feet, more or less, according to the amount of vacuum, and is held therein by atmospheric pressure on the surface of the water in basin G, the condensing water added flowing off from G by overflow y. The water enters the condenser at E, falls over the sieve-plates e, and comes in direct contact with the vapours, which have to pass also through the openings in the sieve-plates e, by which arrangement the greatest condensation is produced with the least amount of water.

At E, the vacuum-pump, in this case a dry one, is connected. To prevent the condensing water from being drawn along with the vapours to the pump, the opening E is guarded by an apron. H is the pipe through which the liquor enters the pan. T is the drop-valve, composed of a rubber disk between two plates on the end of a lever—a simple and most effective construction, the pressure of the outside air holding the valve perfectly tight; R is a semi-globular casing which prevents the liquor from spreading too much when it is discharged. On the end of the valve-stem is fastened a scraper, intended to break any crust of crystallized sugar that may have formed, as any such crust, unless removed, would of course obstruct the exit of the liquid.

The regular mountings of the pan consist of a man-hole; a thermometer (I), the tube of which is enclosed in a pipe, and reaches to the centre of the boiling liquor; a vacuum-gauge (K); a glass gauge (L), by which the quantity of liquor in the pan is observed; a butter-cup (N), butter quieting the liquor if it shows a tendency to boil over; an eye-glass (O), opposite to which is another similar glass through which a lamp gives light to the interior of the pan. Q is a light glass on the top of the pan, through which the entire surface of the
Fig. 201. — Apparatus and Ground-plan of Building for Condensing Milk.
boiling liquor may be illuminated, and it is the tester, by which proofs are drawn to see how far the process has advanced.

Heat is applied in the following manner:—The bottom of the pan is double, and steam is admitted thereto by the pipe \( r \), the upper shell which forms the heating surface being generally of copper. The steam also passes through one, two, three, or even four coils, according to the size of the pan and the amount of water to be evaporated in a specified time. \( r \) is the steam-branch. The pipe \( s \) leads to the bottom, \( s^1 \) to the lower coil, \( s^2 \) to the upper one. As fast as the steam is condensed, the water is led by the pipes \( u \) from the bottom and coils to a steam-trap.

It might at first sight be supposed that cast-iron would fail to resist the corroding action of solutions, but the results of practice show that the scale, which in every case covers the metal, protects the pan completely; and as the liquor is in all cases charged to some extent with lime, the pan speedily becomes covered with a fine scale, or fur, which effectually prevents all injurious action. This is especially the case if the pan be worked continually, but if long stoppages are made, copper possesses decided advantages over cast-iron.

Under ordinary circumstances, however, the cast-iron vacuum-jams answer every purpose, and they can be constructed in such a perfect manner that one similar to that described will retain a vacuum of 29 inches for a space of twelve hours without losing more than one inch.

Under the most promising conditions, however, it is probable that no condensed-milk makers will be uniformly successful; because no system of inspecting the milk on its arrival at the factory can at all times succeed in detecting all the faults to which it is liable, and, after all, the result depends in a great measure on the milk-suppliers, who are not all as careful as they ought to be.

Mr. Willard fitly sums up this part of the question as follows:—"Under the best management and most careful examination losses will inevitably occur from time to time on account of imperfect milk, and a certain percentage must be allowed in making up an estimate of expenses to cover this item. But unless there be some reliability for obtaining good, clean, healthy milk, it would not be advisable to enter upon condensed-milk manufacture. To this end the character of the country where the milk is produced should be studied. The pastures should be upon high, undulating, or well-drained soils; the farms should have an abundance of clear, sweet, running water; while extra attention must be given to the care and management of heeds, never over-driving in hot weather, milking with regularity and with fastidious neatness, together with absolute cleanliness in dairy utensils and dairy buildings."

It is evident, therefore, that cleanliness of the most scrupulous and comprehensive character is the first requisite in milk-condensing. The milk must not only be sound, produced by healthy cows from sound and healthy food and under generous and thoughtful treatment, but it must be kept scrupulously clean afterwards, and perfectly free from the influence of taints and fermentations; to this is added careful watching of the process and attention to details. Lacking these precautions, first-class condensed milk cannot be produced, and the attempt will be a failure. They are equally necessary to the production of first-class cheese and butter; their neglect is the explanation why there is such a large proportion of third and fourth-class cheese and butter in the country.

During the year 1879 there have been ten or twelve milk-condensing factories in operation in the United States, the largest being in New York, Connecticut, Massachusetts, Pennsylvania, Maryland, and Illinois. The Borden patents have now expired, and the right to manufacture is free to all. But a pretty large capital is required for establishing and maintaining a factory; favourable surroundings are necessary; also skilfully trained managers; and so the business remains in a few hands. The largest factories are still controlled by members of the Borden family. It is certain that well-conducted establishments yield a large profit; for while within a few years the price paid for milk at the factories has varied from six to twenty cents per gallon, the selling price of the condensed article has changed very little. So quietly do the proprietors manage their affairs, however, that the data are very meagre for estimating the extent or the profits of this manufacture in America. It is known that the factory at Elgin, Illinois, uses from 3,000 to 4,000 gallons of milk a day, and the one at Brewster's, in New York, a quantity as large. The total product of condensed milk in America may be roughly placed at 10,000,000 lbs. a year.
MILK CONDENSING IN ENGLAND.

following is a statement of the annual value of Domestic Condensed Milk exported from the United States during the eleven years named:

<table>
<thead>
<tr>
<th>Year</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1869</td>
<td>81,758</td>
</tr>
<tr>
<td>1870</td>
<td>140,099</td>
</tr>
<tr>
<td>1871</td>
<td>91,624</td>
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<tr>
<td>1872</td>
<td>86,808</td>
</tr>
<tr>
<td>1873</td>
<td>94,385</td>
</tr>
<tr>
<td>1874</td>
<td>79,018</td>
</tr>
<tr>
<td>1875</td>
<td>123,565</td>
</tr>
<tr>
<td>1876</td>
<td>118,549</td>
</tr>
<tr>
<td>1877</td>
<td>123,801</td>
</tr>
<tr>
<td>1878</td>
<td>128,118</td>
</tr>
<tr>
<td>1879</td>
<td>119,883</td>
</tr>
</tbody>
</table>

Various milk-condensing factories have been established from time to time in the British Islands, but they have not, as a rule, been successful. The price of milk, wages, and general expenses are too high in this country to enable our condensed-milk makers to compete on even terms with those of foreign countries. In Switzerland, for instance, plenty of milk can be bought for 4d. to 5d. per gallon, whereas in England it is worth 7d. to 8d., and in the winter even more than that. Only in summer-time, when milk is most cheaply produced, is it likely that milk-condensing in England can be successfully carried on, generally speaking, and there are obvious disadvantages in having a factory closed during one-half of the year. In this case it could not be well done except in connection with large firms in the milk trade, whose outlet for milk in winter is so profitable that the supply then must be kept up, even at the expense of having to convert a considerable quantity into condensed milk in summer, and in this way to keep the farmers going all the year round.

We do not, in fact, expect to see milk-condensing factories established and permanently successful in England, because, however low a price milk may be at in this country, it must of necessity be still lower in the countries where the manufacture is at present carried on; and as condensed milk is so easily portable, it is just the thing we may expect to import from foreign countries, in the place of its equivalent in cheese or butter. America appears to us to be the country, par excellence, where the manufacture of condensed milk has the most promising future, because she is bound for a long time to come to export a large proportion of her dairy products in some form or other; and if so, why not in part as condensed milk? Clearly cheese-making, from several causes, is on the decline in this country; whether or not milk-condensing is a business which will take its place is a problem whose solution we leave to time.
CHAPTER XXII.

The Milk Trade.


As we have previously stated, the trade in country milk to our cities and towns has expanded greatly in the past fifteen years, and has now attained enormous dimensions, though it is not possible to obtain exact statistics about it. In many dairying districts throughout the entire country, wherever there is a contiguous railway, cheese-making has succumbed to the milk trade. Entire parishes which but a few years ago were wholly devoted to cheese and butter making now scarcely produce any cheese at all, and very little butter. The change is striking and complete. In other parishes, too—one side only of which is, perhaps, within sufficiently easy reach of a railway—the revolution is making its way. The farms lying nearest to the railway commonly send off the whole of their milk the year round, while those on the other side make cheese in the summer and autumn months. But when winter approaches and milk becomes scarce, when, in consequence of colder weather, it can be delivered in town in better condition, the demand for it increases according to its scarcity, and the farmers who are constantly engaged in the milk trade hunt up the milk of those who are not, in order to supplement their own deficient winter production. During at least five months of the winter season the price of milk is such that cheese-making farmers are glad to dispose of all they can possibly spare, and the milk-selling farmers are equally glad to buy it and collect it from the outlying farms, sending it off to town along with their own. And they have two great reasons for doing so. First, it follows that he who can send to the city salesman the largest winter supply—for milk is never too plentiful in winter—will be the better able to dispose of his summer's milk on favourable terms; the salesman, in fact, is always willing in summer to hold back by the farmer who can send him most milk in winter, and thus the winter's milk in a sense sells the summer's. And, secondly, as it is much more costly to produce a large quantity of milk in winter than in summer, it follows that it is much to the advantage of the milk-selling farmer that he should buy all the milk he can in winter from his neighbours, even if he pays for it a price which leaves him but little direct profit; and his neighbours, in their turn, cannot do better than sell it to him at the price he can afford to pay.

It follows then, on this system, that many farmers are in a sense milk-dealers, but they buy in a retail and sell in a wholesale way, and that only, or chiefly, in the winter-time. We know cases in which farmers have bought up the winter milk of the patrons of one or other of the cheese-factories. The patrons deliver it at the factory, as a central depot, and the farmer fetches it away. This arrangement is about as good as any that can be thought of for profitably and conveniently disposing of the small quantities of milk which cheese-making farmers usually produce in winter. The plan, in fact, may be adopted so early in the autumn and continued so late in the spring as the price at which milk is selling may suggest. When, for instance, the milk is only worth 7d. a gallon for cheese-making, and sells at 8l. to the trade, then should cheese-making cease for the time. A comparison of values will thus go hand-
in-hand with the law of supply and demand in the milk trade; and in this is provided a basis on which dairy-farming will henceforth be conducted.

These influences are now changing the aspect of dairy-farming throughout the length and breadth of England. Numbers of farms which were at one time devoted to the one speciality of cheese-making—farms whose every operation was designed to be subsidiary to this one thing chiefly—are now devoted to a greater variety of pursuits, and their eggs are no longer all in one basket. Though they are themselves too far from the railway to adapt themselves to the milk trade, they yet contribute no insignificant quota to that trade. Cheese-making is followed, of course, but less extensively than it used to be, and butter-making has in some measure taken its place. But the way in which these outlying farms contribute to the milk trade is in producing autumn and winter calving cows, which are sold when on note to the milk-selling farmers, and in order to keep up the supply a maximum number of young stock are raised. Thus it follows that even on farms that cannot, by reason of distance from a railway, cultivate the milk trade profitably, except in the indirect manner already spoken of, cheese-making has greatly diminished, and it is probable that there is at least one-third less cheese made in the country than there was ten or a dozen years ago.

The milk trade is, of course, a ponderous affair, for milk is a heavy and bulky product. A man who milks thirty cows sends his half-ton of milk away, day by day, scores of miles to be consumed. Without railways this could not have been done. Stephenson was greater than Macadam, and the iron road is doing what the turnpike must have ever had left undone. Ten miles of turnpike place an effectual bar on the milk trade, but one or even two hundred miles of railway do not, and it is possible that some day Scottish and even Irish milk will find a daily market in the metropolis. As the matter already stands, the counties of Derby, Stafford, Nottingham, Wilts, Hants, Gloucester, Somerset, and many others, are largely employed in feeding London with milk. We have not, however, as yet advanced so far as to have special milk-trains, as they have in America, running hundreds of miles, with milk only, or milk chiefly, as freight; but to most of the fast long-distance morning and evening trains a milk-van is attached, and we learn that a train, mainly loaded with milk, runs daily from the Cheshire district to Liverpool. The distance, it is true, is not great, but once the principle of milk-trains is adopted we shall expect to find it spread to the distant counties whose milk custom is in London.

During the warm weather the farmers always aerate and cool the milk before sending it away, generally in one of Lawrence's refrigerators, a cut of which we give in Fig. 202; and even in winter it is a good thing to get the warmth and odour of the cow out of it. The warm milk is poured into the receiver $A$, and after running in a thin stream over the outside surface of the series of tubes, from $B$ downwards, is collected at the bottom, and has its exit at $c$. The cold water enters by the pipe $D$, and passes upwards through the inside of the tubes, finally emerging at $E$, so that the descending milk passes last of all over the tube which contains the coldest water. The matter, indeed, is so arranged that the water at its warmest comes in contact with the milk at its warmest; and as the milk descends, cooling as it falls, it comes last in contact with the water where both are at their coldest; thus the cooling is gradual. As the milk flows over the tubes it is thoroughly aerated, so that the two processes are completed together. Various patterns of refrigerators suitable for cooling milk have been invented, but they have all given way before the one we have illustrated; of this pattern it must be understood, however, that there are several modifications, though the principle is iden-
tical in all of them. On the continent of Europe this valuable machine has been copied, with more or less fidelity and success, the deviation consisting chiefly of a difference in the shape of the tube, affording more surface for cooling. At the International Dairy Show in Hamburg in 1877 we saw one of these coolers, whose efficiency was even superior to that of Lawrence’s cooler, against which it was tested in our presence. The principle was, however, the same in both, and the German was but a copy, perhaps a piracy, on the English invention.

The milk-cans, or “churns,” as some people awkwardly term them, do not deviate much in general pattern, but some of them are more strongly constructed than others, and consequently more serviceable; the best of them have the fewest possible seams in which the milk can lodge, and the lids are so made as to be easily attached and detached. The best railway milk-can we have ever seen is the one shown in Figs. 203 and 204, and made by Mr. Alway, of London. This can is made of two pieces only, so as to have a minimum of seams; the bottom hoop is double the ordinary strength, and is put inside instead of outside the body, as shown in the cut; the cover or lid is also made of one piece only, and the method of fastening and unfastening it is very simple, while the whole structure is so substantial that the liability to breakage is very small.

One of the chief annoyances to the farmer in the milk trade is the knocking and smashing which the cans undergo en route. They are treated with no tenderness at all by the railway officials, whose carelessness is soon imitated by the servants of the farm. It is chiefly the empty cans which suffer most; the full ones, being heavy, cannot be tumbled about so easily, and they may not be turned topsy-turvy, or the milk would be lost. But the empty cans are pitched here and there with all the contempt which comes of familiarity; the lids and the rims are smashed, the sides are crushed in, the paint is knocked off, and it is not easy to imagine a more forlorn-looking object than a railway milk-can of six or eight months’ service. From this cause the farmer’s loss is heavy, because the cans usually are his property; it is therefore necessary to use only those cans that are made in the best manner and of the strongest material.

Another cause of annoyance and loss is found in the bad debts which the farmers too often contract with the city salesmen. A few years ago this evil was more frequent than now, for at that period too many men of straw went into the milk trade—men who had nothing to lose, and whose commercial morality was much feebleer than their acumen. At the period when the trade began so rapidly to expand, numbers of new salesmen in the towns sprang up, and farmers were not awake to the dodges of the trade. Hence many of them were let in smartly at times by means of bad debts. Time, however, has purged the trade of the greater part of this unpleasing feature, and it is settling down into business-like and trustworthy channels.

Again, the London demand for milk fluctuates day by day, unless the weather remains fine and bright; in wet cold weather it falls off instantly. Now the city salesmen have to watch these fluctuations closely, or they will often have a quantity of milk on their hands which they cannot dispose of, and which is commonly wasted; and when they see symptoms of a falling off in the demand, they at once telegraph to the farmers to hold back one or two meals’ milk; thus the farmer has the milk thrown on his hands, and he must at once make either butter or cheese of it. Another and a less satisfactory dodge of the salesmen is to keep back the empty cans, so that the farmer cannot, if he would, send his milk; this is worse than a telegram, for the farmer is uncertain what to do, and thinks it possible that the cans have gone astray en route, which they sometimes do; he tries then to borrow cans, thinking the salesman is wanting the milk all the while, and his own cans.
are probably standing in the salesmen's yard all the time.

The wholesale price of milk varies with the season, though the public seldom gain the benefit of a reduction. The farmer usually sells his milk by the "barn gallon," as it is termed—that is, 17 pints to the gallon, or half a pint over-measure at each imperial gallon. Many of them are not aware that it is illegal to sell by such measure, and we would refer them to the Weights and Measures Act, 1878, 41 and 42 Vict., ch. 49, sections 15 and 19. The selling by a barn gallon is, of course, an old custom, in which the extra pint was thrown in—for the same reason that extra lbs. of cheese are thrown in at the ewt., and extra ozs. of butter at the lb.—in order to improve the bargain to the buyer. At first these additions were part of the bargain, but they soon became a custom. Other farmers, again, sell their milk at so much "a dozen"—that is, a dozen quarts; this custom is not illegal, but it is rather clumsy. A few sell by the standard imperial gallon, which, we think, is the best.

Milk is generally cheapest in the months of April, May, and June, when the price the farmer receives, less the carriage, is 16d. per barn gallon. In the following three months he gets 17d.; in October and November 20d.; in the next three months 21d.; and in March 20d. These are actual prices contracted for by one who has been in the trade many years, but they are subject more or less to variation in different cases, in different years, and in different localities. The carriage from the midland counties to London is usually 2d. per barn gallon, the empty cans being returned free of charge.

**Town Dairies and the Milk Trade.**

The condition of town dairies, particularly in London, has greatly improved during the past twenty years; they are cleaner, better ventilated, more commodious, and as a rule much superior to what they formerly were at the other end of the period named. The rate of progress, which has been marked in most departments of human industry, has not passed by the cow-sheds in our cities and towns; the spirit of improvement has influenced most things greatly, and one prominent feature is seen in the better and more comfortable and healthier accommodation which has been given to live-stock of most kinds, and, among bovine stock, to dairy-cows in particular. They are now housed, for the most part, whether they be in the country or in the town, in buildings of an altogether superior class, less crowded than they formerly were, better fed, and better attended to in all respects. The principles of hygiene are better understood, and are more widely applied to the keeping of cows, whose prolonged imprisonment is made as tolerable as it possibly can be in the absence of green fields and hedgerows. It does not and cannot be made to appear that the existence of a cow in a shed in the heart of a city, or even in the suburbs, is a desirable thing in comparison with that of a cow in the country, but everything that can be done to make the disparity as small as possible is done with assiduity and regularity. We may now fairly say that dairymen in towns have well learnt the lesson, not only that cleanliness and kindly treatment is no small aid in averting the outbreak of disease among their cows, but that their reward is found in an increased quantity and an improved quality of milk. Kindlier treatment is of course necessary in urban cow-sheds, but necessity has not in the past been always found to contain sufficient reason to bring it about, and we warmly welcome all kinds of amelioration which can be brought to bear on the condition of so useful, so indispensable an animal as the cow.

The suburban dairymen has several advantages over his urban curéries. It not uncommonly happens that he is so situated that he can frequently give his cows a turn-out in the fields, or in some park, during the summer—a convenience which cannot but be regarded in the light of a great advantage; his cow-sheds have no need to be underground for want of room above it; his cows are, at all events, where they can have plenty of air, which circulates more freely and is comparatively pure; and he is always nearer to the source of his supplies of forage, which, particularly in summer, is a matter of great importance. The spread of railways, however, and the facilities which they afford for the rapid conveyance of all kinds of produce that need early consumption, have materially lessened the prominence of the last-named advantage; the first, wherever it exists, cannot well be over-rated, and the second is no mean factor in a dairymen's success. Yet the suburban dairymen has one or two disadvantages, at all events in London. Unless his milk is absorbed by a strictly local demand, he is further
away from his customers; and in any case he is, as a rule, further away from some portions of the cattle food which he extensively employs, to wit, brewers' grains, and foreign feeding-stuffs which lie at the docks or at the railway termini. Yet again, the railways do much to obviate such disadvantages. In any case the labour of bringing in forage and taking out the exuviae of the cows in the city sheds is an enormous work, which is obviated only by the advent of country milk; and, look at the question almost how we will, it would appear to be a mistake to keep cows within the purliens of a large city.

But the sources of our towns' and cities' milk-supply are not where they formerly were, except to a limited extent. It is hardly too much to say that twenty years ago no appreciable quantity of milk was sent into town by rail, except over short distances; and it is equally pertinent to remark that the cities of the kingdom, and many of its towns, now receive the greater portion of their milk from the country districts, brought, in many cases, long distances by rail. This new order of things had begun to recommend itself to the milk-salesmen some time before the advent of the cattle plague, or rinderpest, had destroyed so many town dairies in a wholesale manner, and so created an extraordinary demand for country milk. Many of the cow-sheds that were ruthlessly emptied by the plague in 1866 were never filled again, and so the country milk trade sprang at once into a prominence which has since gone on and promises to go on increasing.

There are, however, still many milch-cows kept in the cow-sheds of our large towns, specially in London, and many more are kept in suburban dairies, within easy reach of the thickest populated districts. In some instances very large herds are kept, containing hundreds of cows; but there are also many herds of medium size, say of forty or fifty cows, while others are small. It is, as a matter of course, quite a common thing for a man to start as a dairyman with two or three cows, gradually increasing the number as funds and his trade permitted. In many cases where large herds are kept, it will be found that the business has descended from father to son, in some instances through several generations.

Just before the advent of the dreadful rinderpest the number of cows in the metropolitan district was estimated to be 24,000; and the quantity of milk brought in by the different lines of railway in the year 1865 was upwards of 3,000,000 imperial gallons, which in two years' time had more than doubled. This enormous and rapid expansion of the trade in country milk was due chiefly to the cattle plague. To provide London with milk would now, on the old system, require a much larger number of cows than in 1865; and if this increased number had been provided for within the metropolitan area, the danger in time of contagious diseases would have been proportionately increased. Happily, however, the tendency is to keep fewer cows in London and its suburbs, and to obtain a larger supply of milk from the country.

Most of the London dairymen are required to keep up a supply of milk which is fairly constant the year through. This holds good in all the metropolitan districts except the West End. In the last-named district the demand for milk is greatest during the "season"—that is, in the spring and summer months, when London is full; in the remaining districts the population does not migrate to any marked extent, and so the quantity of milk required is fairly regular the year through. The dairymen in these districts, then, need to be buying calving cows almost all the year round, but mostly in the spring and autumn, in order to keep up the flow of milk. These fresh relays of cows on note were, and are, of course derived from the country, and the farmers of many districts lay themselves out to provide them in the periods when they are most in demand. In times gone by these cows were usually milked for a few years in the farmers' herds, until they had arrived at full maturity, and in many cases until they were a little past their best. During this time they calved regularly in the spring of the year, but when it became expedient to sell them off, they were kept barren for six months longer than usual, and timed to calve in the autumn, at which period good prices were realised for them; or cows that failed to be in-calf for spring, even though it had not been intended to dispose of them so soon, were then timed to calve the following autumn or winter, and sold off a year or two earlier than they otherwise would have been. The system in these cases was to milk them on through the winter and spring and part of the summer, when they were let dry, and allow to get into good condition by the time when they were wanted by the city milkmen; and if a heifer turned out on the farm to be an inferior milker,
the same system was pursued with her; indeed, the same system is carried out still, on an extended scale, but not so much to be sold to city milkmen as to those dairy-farmers who make the supply of milk to city salesmen a speciality.

In former times great numbers of Dutch cattle have been imported to fill the metropolitan dairies, but they are so inherently liable to pleuro-pneumonia that the practice has been almost discontinued, and now those dairies are filled, many of them, with high-quality Shorthorns, and among them other British breeds. The Dutch cows, having for generations been specially cultivated for that end, are extraordinary milkers, but their liability to disease detracts greatly from their value, and they do not so well as British cows bear transplanting to the close confinement of a London cow-shed—it induces the disease which too commonly is latent in the system.

It is obvious that with cattle who are predisposed to disease it is highly expedient to use every precaution against it, when they are placed within the influence of conditions which are calculated to promote the development of a latent malady; and it is equally necessary to avoid such fittings as are likely to perpetuate a disease, once it has taken possession of the premises. The old-fashioned wooden stalls, racks, and feeding-troughs would retain the germs of a contagious disease for a long time, in a manner which almost placed disinfecting processes at defiance; the germs would get into the pores, or interstices, or joints, or worm-holes of the woodwork, and there they would defiantly stick, only to communicate the disease again and again. Hence it has become the practice to use iron and earthenware fittings, which afford but scant lodgment for contagion, and admit of being thoroughly cleansed and disinfected; the roof-supports, too, are of iron, and the roof itself is designed to diminish infection. Of such a modern cow-shed we give an illustration in Fig. 205. It will be noticed that the interior of the shed is spacious, and that there are ample means of ventilation. Such arrangements are not only easy to clean, but easy to keep clean, as they afford but little opportunity for dirt of any kind to

Fig. 205.—Interior of Improved London Cow-shed.
collect, and where no dirt is, there is but little fear of contagion, providing due outside precautions are taken. Yet, should the premises become infected, they admit of being so perfectly disinfected that it will be safe to bring other cattle into them after a reasonable time.

Many of the London dairymen obtain large quantities of milk from the country to supplement what their own cows produce, particularly in the seasons when milk is scarce. Others, again, in addition to their cow-sheds in town, have a farm or farms in the neighbourhood of the metropolis, where they produce a quantity of milk as may be required, cultivate the necessary forage, roots, and green crops for town consumption—providing they cannot more cheaply purchase them, raise their young stock, rusticate their town cows that are dry for calving or are out of health, and, in fact, perform a number of operations, all of which are, of course, subsidiary to the one great speciality of milk-prodution for town consumers. And it cannot be doubted that such arrangements are beneficial in many ways; the dairyman feels that he has a reserve and an opening to fall back upon to meet the exigencies of his trade; it is no longer a hand-to-mouth system, depending wholly on the markets for a supply of newly-calfed cows; and he is relieved from the necessity of selling off his cows as they begin to fail in their milk. Other dairymen, who have no farm to fall back on, who have to buy all their cows as they want them or can get them, and all the food they eat as well, are bound under an inelastic system, which admits of no variation; and it is their practice to feed their cows to the utmost of their capacity, practically fattening and milking them all the while, so that when a cow falls off in her milk, is infected with a contagious disease, or meets with an accident which requires that she be killed, she is not in any sense a dead loss to her owner; but we certainly object to a system which inexorably sends to the butcher a cow which is still in the prime of life, and would pay well in milk for a year or two longer. This necessity does not hamper the dairyman who has a farm in the country.

HOLLAND PARK FARM.

We select this suburban dairy-farm for description, because it is the best and completest we have seen. It is to all intents and purposes a suburban farm, for Mr. Tisdall, the owner, has 70 acres of land close by his premises, consisting mainly of the park, which is still attached to the renowned Holland House, once the residence of Charles James Fox, and it is situated in Kensington, one of the most beautiful suburbs of London. In Fig. 206 we give an illustration of the interior of the premises, which are very pretty and convenient, choiceiy ornamented with Mintons' tiles and with evergreens, devoted wholly to the retail sale of milk, and very attractive in all respects; and in Fig. 207 we give a ground-plan, which will convey a clear idea of the arrangement of the cow-stalls as they were until recently. Before the cows were removed they could be seen from the interior of the shop, standing in rows, the folding doors having large panes of glass. There are yet other premises adjoining, where the milk-cans are cleaned, the cream raised, and the vehicles stowed away at night. The premises we illustrate were devoted to the cows themselves and to the retail sale of milk; and as a description of the business as a whole we cannot do better, with a few additions and excisions, than quote from a writer in the Livestock Journal of November 1, 1878:

"We will enter by the handsome building, which is practically the 'shop' of Messrs. Tunks and Tisdall, a firm which is of a hundred years' standing as suppliers of milk and other dairy produce to the inhabitants of the old Court suburb. The firm began its business on freehold premises just opposite Lord Holland's gates in the Kensington Road, but in 1852 took the Holland parks and the adjacent fields, and has held them ever since. The 'shop,' as we call it, is built on ground which formed a corner of Holland Park, and is a prominent object in the great western road out of London. All the details of the build-
ing are suggestive of its use. Outside it has a line of tiles, made specially by Minton's, each tile whose pedigrees shall appear in the Herd Book, and which are bred entirely for their milking.

Fig. 206.—Interior of Holland Park Dairy (Retail Department).

containing a portrait of a cow, representing some important strain of the Shorthorn breed. The centre tile contains the portrait of a magnificent qualities. It will be seen that Mr. Tisdall thinks that the breed which does so much as a meat-bearer is also the best milk-producer, and that by

bull, which is the present lord of the Holland Park herd. Mr. Tisdall looks at his dairy-farming as a business, and he has made up his mind that the best animals for his purpose are Shorthorns, and he restricts himself to the use of that breed. He is fast making his herd one of pure-bred Shorthorns careful selection of sires and dams he can the sooner reach his object in dairy-farming.

"Entering the 'shop,' we find it admirably cool and sweet. The floor is tiled, the windows are filled with plants and flowers. On each side are couches, and near are marbled-topped tables, at

Fig. 237.—Ground-plan, before Removal of the Stalls.
which ladies out for a lounge, or who are fatigued with their shopping, can have a dainty glass of milk, or can rest while they give their orders for the same article for home use. In the centre is a fountain, which seems to send up its column of spray perpetually. There are chairs distributed plentifully about, and in each of the two farther corners is a marble-topped counter, at which lemonade, soda-water, milk, and dairy produce generally are served out. We should not omit to mention that in each corner there is a statuette, the four representing the four seasons. These statuettes are the work of Mr. Papworth, the sculptor, and interested many of the visitors of the International Exhibition of 1862. Round the walls there is, as outside, a line of pictured tiles. Those inside represent almost every conceivable subject associated with a farm, and are all from special designs, and made at the famous pottery of Minton's at Stoke.

"Right opposite the entrance are glazed doors, which open straight into one of the cow-houses, and there the cows are to be seen standing, some there to-day being prize-winners at the late Dairy Show. The arrangements are noteworthy; and we may mention that the chief cow-house is modelled upon the late Emperor Napoleon's dairy at Viucennes, but here there are improvements introduced. The cows stand head to head, and over the head of each is her name-tablet. Down the centre is a passage, and on each side of it a row of stone mangers at which the cattle feed and drink, a clear run of water going from end to end. All that could be thought of to secure cleanliness has been done; and an idea of the purity of the atmosphere may be gathered from the fact that the many hanging plants which depend from the roof thrive well. Here, again, the floor is tiled. Each cow has a separate stall. At the far end of this cow-house, and separated from the cows by a covered yard, the lord of the harem has his separate and very roomy residence. He is a magnificent specimen of the Shorthorn breed, and, according to Mr. Strafford, comes from the best tribe of Shorthorns for milking purposes—the well-known Princesses of Mr. Cheney, of Gaddesby Hall. He figures in the Herd Book as Earl of Leicester VI. (No. 38,230).

"From the cow-house we go into the parks, and think how fortunate Mr. Tisdall is to have such a lovely place for the pasture of his cattle. Taking Holland House as its centre, and desiring for a moment to enter and look at its historic treasures, we pass from point to point, at every step finding some new beauty or some suggested association with one or many great names. Then the parks, with their walks and drives, and the studied display of landscape art, make one wonder, and feel certain that the great world which teems and tumbles just outside does not dream of the paradise from which it is shut out. At this point and at that are portions of the herd, each adding to the many attractions of the place.

"Then we go back, chatting with the owner about his views of dairy-farming. We have already spoken of his preference for Shorthorns. This is the result of long study, not of caprice, or for the sake of being in the fashion. The cows are kept largely on grass, which up to July is cut and carried to them in the houses; still, they have a run outside of a few hours daily. After that period they are out at pasture, with the additional help of hay, grains, and meal, always being milked in the houses. The winter feed is mangelwurzel, hay, grains, and meal. In breeding Mr. Tisdall's aim has been to get hold of the principal tribes of milkers and to develop and perpetuate their best qualities. In some cases these qualities are almost obliterated through want of care. He adopts the belief of an American writer, that milking quality is lost by fattening for show purposes, and instances two cases of dams which were grand milkers, and had young which, being fatted for show, have been practically useless since.

"One means of testing the value of the plan adopted here is that of keeping a strict account of the milk yielded by each cow. Each milker's lot has a separate record, and from time to time Mr. Tisdall collects these, and makes entry of them in a book kept by himself. His overlooker has instructions to see that these records are kept regularly and properly. The information thus obtained is, of course, of great value, and aids in the object of improving the herd. We have seen these records, and, congratulating Mr. Tisdall on his method and exactness, make use of the privilege of extracting some of the entries. Take one instance. There is the cow Charmer, milked by James Justice, a man grown grey in the service. She was bought of a good breeder in Buckinghamshire for 10 guineas, and is the cheapest cow the owner ever bought. She
calved at the end of November, 1875, and was in milk for twelve months, that is until December, 1876. She gave 1,368 gallons in that time, being an average of 15 quarts of milk a day over the whole period. She calved again at the end of February, 1877. She was again in milk for twelve months, and yielded 1,521 gallons, or an average of 16.91 quarts daily. She calved a third time in the beginning of May last, and she has since yielded an average of 18 quarts 1 pint a day. A second case is that of a pure-bred cow, Venus, bred by Mr. Hobbs, of Maisey Hampton. Last season she gave 10 quarts daily, being 910 gallons in the year. The year before she gave 12 quarts daily. Another, Infant, a cross-bred cow, with one cross of Shorthorn, last year averaged 19.25 quarts daily, the total record showing 935 gallons; and the year before the yield averaged 12.63 quarts for eleven months, the total being 1,095 gallons. These Holland Park farmers are careful to show us their failures as well as their successes. For instance, there is the record of the doings of Mayflower, a grand roan cow, prize-winner at the Bucks Show of 1874, and daughter of one of the best milkers in the herd, Meadowflower 14th. She calved a fine bull-calf 21st February last, and is now quite dry, having lasted in milk only full six months, and during that time the yield averaged only 3.75 quarts per day. Then there is Miss Pearl, a beautiful descendant of a favourite milking tribe. She calved a red-and-white cow-calf (since dead) on the 23rd December last, kept in milk till August, and yielded only an average of 2.78 quarts a day for seven months. In these two cases the results are meagre, and neither cow returned the cost of her keep. It says something for Mr. Tisdall's attention to his business to say that he has kept these careful records for nearly thirty years.

"Dairy work is carried on by a daily system of churning, which, although more troublesome, is considered more desirable by Mr. Tisdall, to secure freshness of product, and to prevent the decomposition of the cream. He thinks the fewer changes permitted in the composition of the cream the better will be the butter. The system of weekly churning admits of such changes in the cream as are not favourable either to the flavour or the keeping qualities of the butter. In the method of cooling the dairy Mr. Tisdall has departed from the orthodox plan. The walls are made double, and the air is permitted to circulate between them. Thus the inner wall is much cooler than the outer. In place of a cornice to the milk-setting room a perforated pipe is placed there, and being connected with a huge cistern in the barn adjoining, the walls can be made to resemble a sheeted waterfall at will. In the centre of the room, in place of a chandelier, is a depending pipe, fitted with a boat-shaped finial, and from this, day or night, a perfect shower-bath of cold water can be made to descend on the closed milk-cans below. In order to aid in the processes of the dairy there is a steam-engine with a large boiler; by means of this the food is prepared, and the cans and churns used in the conveyance of the milk cleaned rapidly by being placed over jets of steam.

"We should say that the firm has also two large farms at Epsom, worked on the same system as that at Holland Park, and that from the various sources of supply they obtain nearly 300 gallons of milk daily. Messrs. Tunks and Tisdall have invested no less a sum than £1,650 in plant for the mere distribution of milk—that is, in carts, cans, &c.; and they supply regularly 1,200 families in the West End of London, besides hotels, clubs, and other public institutions."

The Aylesbury Dairy Company also supplies a great number of families in the West End of London with milk from the country. This milk is chiefly produced in the western counties, and comes to town by the Great Western Railway; it is, however, derived from other districts too. The Company have built a receiving-house and cheese-factory at Swindon, in Wiltshire; here a great number of farmers deliver their milk, under very stringent terms of agreement as to adulteration and freshness of the milk, cleanliness of the milk-cans, hours of delivery, &c., and in many cases the Company provide their milk-suppliers with refrigerators, so that in hot weather the milk may be cooled and aerated immediately it is drawn from the cows, when it will travel without injury and arrive in good condition. From this receiving-house the milk is sent to London—as much of it, that is, as may be wanted; the rest is set to cream, for there is a great demand for cream in the West End of London, and the skim-milk is made into cheese, which finds a ready sale at a moderate price in
the South Wales Colliery districts. By means of the receiving-house and the various arrangements connected with it, the Company are enabled to regulate their supply of milk to the business in town according to the demand there is for it, a demand which is liable to fluctuate more or less day by day; and so less, arising from overplus of milk, is avoided, such overplus being diverted to other uses.

We need not cite a more favourable instance in the milk trade of London than that of Mr. Collinson Hall, of Brentwood, in Essex. We have here a farmer of some 2,000 acres, milking his 700 cows, and delivering his milk direct to his customers without the intervention of a dealer or middleman. It would be difficult to find a better example of successful farming, either in the milk trade or out of it. The cows are kept at the farms, but they are stall-fed the year round, receiving grass and a variety of green crops in the summer, and in winter roots, brewers' grains, chaffed forage, cake, and other feeding-stuffs; cake and corn, in fact, are freely used in summer, when grass and other green crops stand in the place of hay and roots and grains. Thus the soiling system is carried out thoroughly, and there can be no doubt that, in connection with a milk business of this kind, it is the system from which the most profit can be obtained. The use of large quantities of purchased feeding-stuffs greatly enhances the quality of the farm-yard manure, which in its turn increases the bulk while it strengthens the quality of the various crops of the farm. There is, in fact, no better way of improving the land than by the liberal consumption of purchased feeding-stuffs by the animals kept on the farm; indeed, we may go so far as to say that this is the best way of all.

Another most favourable instance of successful suburban dairy-farming is that of Mr. Stapleton, of Brookland Dairy Farm, Stoke Newington, though it differs in one essential feature from those of Mr. Tishall and Mr. Hall. The difference is this: Mr. Stapleton's cows are kept quite away from the farms which support them, and instead of taking the milk from the farm, the forage is taken and the manure returned to it. In this there is more labour; but there is, as a set-off, the convenience of having the cows kept in the midst of the people whom they supply with milk. We incline to the system of keeping the cows at the farm, because there is less labour and less waste involved in it; it is easier to convey the product than the machinery.

Several attempts have been made to enable farmers at a distance to sell their milk to Londoners without the intervention of middlemen, who pick up a handsome profit between the producer and the consumer. It seems feasible enough to establish co-operative milk-supply companies, with the producers and consumers only as shareholders, but as yet no such scheme has taken root. And, indeed, even were such companies to be formed, we have reason to fear that the shares would eventually gravitate into the custody of directors and mere speculators in stock. The time will, however, come when the producers and consumers will have direct intercourse, without the aid of interlopers who are mere distributors of produce, who reap the lion's share of the profits for the lamb's share of pains; and there can be no doubt that such intercourse will be an immense gain to the community at large. We speak now not in respect of milk only, but of most other products of the farm—of cheese and butter, beef and mutton, poultry, eggs, and vegetables.
CHAPTER XXIII.

VILLA DAIRYING.


Villa dairying is usually supposed to be amateur farming on a small scale, and generally the supposition is correct, but not always so. It is not unfair to conclude that a man who lives in a villa, and begins some of his non-business hours with the details of a miniature farm, can hardly be a practical farmer in the true sense of the word, and yet he may be, and often is, intensely practical in a way. He is usually a country gentleman, a professional or a business man, who delights in a country home and in the possession of a small but select variety of domesticated animals, and fowls as well. His agricultural education, as a rule, has been derived from books, and he has served no apprenticeship to the somewhat monotonous plodding after the plough, lacking which no farmer’s training is complete. He has never done any ploughing and sowing, or reaping and mowing, and he has not in his youth been initiated into the intricacies of live-stock management, as it is conducted on a farm. No doubt he has read Jethro Tull and Arthur Young, more or less, as all cultured Englishmen who love a country life must have done; he may have waded through a dissertation on the theory and practice of under-draining, have studied the laws of animal-reproduction and the mysteries of plant-nutrition, and he has surely wandered through the delightful “Chronicles of a Clay Farm;” but these studies, however useful they may be and are, are not enough to make a man a farmer, and the practical part is never so well learnt as in youth.

At the same time it is a mistake to suppose that farming can only be made remunerative by those who have been brought up to it from their childhood. It is no doubt true that many—the great majority—of amateur farmers lose money by the business; but there are exceptions to the rule, and instances are not far to seek in which men who were bred to other occupations, and followed them for a time successfully, have turned to farming and made it pay. Others, again, while still engaged in mercantile or professional pursuits, have done great service to agriculture by pointing out other tracks than the old beaten ones of many generations—paths which those who are actively engaged in a business cannot always so quickly see as an outsider can, one whose habits of life and thought lie in the direction of reforms and discoveries.

As a rule, however, villa farming, in which dairying is almost always a conspicuous item, is not undertaken with a view to profit so much as to convenience combined with pleasure. Yet to make it pay adds much to the pride of it. To most city men who can afford it, a home in the country has many charms, and such a home comes not up to the owner’s taste unless a little dabbling in farming can be had along with it. This is all as it should be—if kept to a small scale. What so natural as to keep a cow, a pig or two, and a pony, where a few acres of land can be had, and the premises are, or can be made, suitable for the purpose? One’s own milk and cream and butter, produced by a petted cow who is fed on the daintiest bits that can be had, are always better than we can buy, or at least we fancy they are—which is much the same as being so, whether they are or not. And what, again, is so choice in the way of pork and bacon as those fed on the premises? The milk and cream and butter, the pork and bacon, may each and all cost
more than we could buy them for, but the pleasure of producing them is worth more than the difference in cost. The butter, it is true, may not always be a success on so small a scale as one cow, and particularly so when part of the milk is used as it is; but the cream is delightful and simple to raise, and the skim-milk comes in well for the pig.

Take her for all in all, there is no cow so suitable for villa dairying as the Jersey or the Ayrshire among our British breeds; next, we should say, comes the hardy little Kerry—the Irish cottier's cow. The other breeds are either inferior milkers, or they are too large individually. We may, indeed, take it for granted that large-framed cows, even if they are proportionately deep milkers, are not well adapted to villa dairying; they are too unwieldy, and there is a self-evident disparity between them and the office they are designed to fill. For purely dairying or milking purposes, large cows are not desirable, particularly on land that becomes sticky in wet weather and treads up into mud; on such land small cows, by virtue of their lesser weight, do less harm in a wet time—they waste less grass by treading it underfoot and pressing it into the softened soil. Quantity and quality of milk are the first points to be sought for in a cow that is kept at a villa, and these ought to be considered in relation to the size of the animal. It may be true that larger cows give more milk than smaller ones, as a rule, but they do not give so much in proportion to the size of the animal—at least, it is very seldom they do. Again, small cows, as a rule, give richer milk than large ones—richer, that is, in the fats of milk—and so they are better butter-cows, which is an important point in villa dairying. This is accounted for in the relative size of the animals: the smaller cow moves about with less exertion, so there is less respiration and a smaller consumption of fat in the process, the balance going into the milk; less fat, too, is needed to maintain the heat of the cow's body, because her body is smaller. The rate of consumption of fat in the animal economy, and the quality of the milk, have a direct relation to the amount of exercise a cow takes in the search for food or otherwise: these are well-ascertained facts. Again, the cow which an owner of a villa should keep ought to be a pretty, graceful sort of cow, for ornament added to utility is not to be overlooked; and no man would like to see a big, ugly cow about his premises.

We will not discuss the question of size in its bearing on beauty in a cow; but there can be no question that the Jerseys are the most elegant, the most graceful, and the most feminine-looking cows we have, particularly in their beautiful deer-like countenances; their fawn-like colour of skin, too, is more pleasing in the distance, and so is more ornamental, more park-like, more in keeping than any other with the surroundings of a gentleman's residence; and to these qualities we may add the great docility of the Jersey cows—a virtue that cannot be too highly commended. It must, however, be borne in mind that the Jersey is not a hardy cow, and so is not at home in a cold and barren district. Her island-home is warm and sunny, and for many generations she has been treated with great tenderness, so that she has become somewhat delicate in constitution, and needs the kindliest treatment if she is to make the best return to her owner.

Given these conditions, there does not exist a more profitable cow than the Jersey. Her milk is richer than that of most, if not all, other kinds of cows, the average size of the cream-globules in it is larger, and the butter has a deeper and richer colour. For these reasons she is essentially a butter-cow; her milk or cream churns with great ease, because the fat-globules are comparatively large, and her butter is of that deep primrose—almost marigold—colour which is so highly prized by connoisseurs and epicures.

But for cold districts, where the land is none of the richest, the Ayrshire or the Kerry would be more suitable than the Jersey; and it must not be supposed that they are suitable only to such districts, for their productiveness is increased on a richer soil and in a warmer climate. They are not so ornamental as the Jersey—this must be admitted; but they do not require such tender treatment, and they are better able to shift for themselves. So far as form is concerned the Ayrshire is almost perfect as a milch-cow, and she is not too big, and, though she is often very pretty, her colour is not so aristocratic as that of the Jersey. Villa farmers not uncommonly have a keener eye for the ornamental than for the useful in the tout ensemble of a cow's looks, and the Jersey is more a patrician than the Ayrshire, while the Kerry is quite plebeian in character, though eminently useful as a milker. A practised dairy-farmer will almost tell by the look
of a cow's face—certainly by the sweep of her outlines—whether or not she is a good milker, or a better beef-maker; and no build of a cow comes nearer than the typical Ayrshire to what a deep-milker ought to be, and generally is, in most of the best dairy breeds.

Hence the choice, in our opinion, lies between the Jersey and the Ayrshire for the villa, within the limits we have spoken of. Yet are there many who will fancy the Kerry cow, because she is small and very useful; yet others will have a Welsh, a Devon, or a Shorthorn as the case may be, and not a few there are who chose the quaint little Brittanies. The choice will be the result of taste, or of convenience where no taste is. In any case the cow of the villa usually has a good time of it; she is well fed and well tended, and though not always well milked, is usually a good milker, because of the generous treatment she receives, and the comparative retirement of her life. Where one or two cows only are kept, they almost invariably milk better than larger numbers do—the result of tranquility and of kindlier treatment.

There is yet another breed, an English one, which we think well suited to this purpose, chiefly on account of one surpassing merit that very few breeds of cows possess: this is the Norfolk Polled cow; and the merit we allude to is the absence of horns. As a milker she is not equal to the Jersey or the Ayrshire, yet she is a good milker; and she is larger than either of them, which may or may not be a disadvantage in the estimation of the amateur farmers of whom and for whom we are now writing; her colour, too, is usually a bright red, which, though more conspicuous, may not be regarded as so ornamental as that of the Jersey, or even that of the Ayrshire, which is generally a pale red with many patches of white, or white with many patches of pale red. But while the Ayrshire is rather pugnacious, the Norfolk Polled is a quieter cow, and this is probably owing to the absence of the weapons of war. As a cow can do much mischief with her horns when she is so inclined, it is certainly better that she should have no horns to do mischief with, and it is no loss in any sense that she should not possess them. As with a knife in the hands of a boy, so with horns on the head of a cow: the weapon is there; if used at all, it is used to injure something; the ability suggests the temptation, which in its turn is a sure prelude to the act. To those who are not used to her, a hornless cow seems odd at first; a hornless bull seems yet more odd, but the oddity in this case is of the character of a pleasant surprise. Soon the odd feeling wears off, and then the polled cattle are seen to have a kind of beauty all their own.

An important matter in villa dairying is to have a man who understands the management of cows, and who is a good milker. We have previously expatiated on the importance of good milking, and we recur to it because where only one or two cows are kept it is less a speciality than in dairy-farming proper, and is consequently very often imperfectly performed. The man who milks the cow is commonly groom and gardener too, at a villa, and it is hardly to be expected that he should excel in every detail of his duties; but it is important that he should be a good milker, for we have known cows spoiled under such conditions, and we are persuaded that this is a common fault in villa dairying. When such is the case, the cow falls off in her milk, and is so far a disappointment to her owner, who has to change her for another more frequently than he would otherwise need to do. And another fault lies in this: as there is only one or perhaps two cows, the milking is known not to be a heavy duty, and it is therefore often done at irregular hours, just as it happens to suit the convenience of the milker; this irregularity is a thing we wish to protest against once more. Cows should be milked pretty quickly, always cleanly, and at regular hours.

We consider cows should be kept apart from horses in the buildings. They may, of course, be under the same roof, but there should be a division wall between them, so that they cannot see each other, otherwise the horses would disturb the cows too much; and as cows are ruminants they like to be where they can be still and quiet. A cow-house, we think, should be spacious overhead, and it should always be well ventilated, though never cold and draughty. It is not necessary that the house should be open to the roof, for a loft overhead is useful to store forage in, and for other purposes, but the space from floor to floor should be 8 or 9 feet; this, with proper and efficient ventilation, will provide ample breathing-room. Nor should the stalls be too wide or too long; if too wide, the cows are apt to turn round in them,
and they sometimes get hung in doing so—when they cannot turn back again; and if too long, the excreta do not fall into the channel, clear of where the cows have to lie. A space 6½ feet square is sufficient to accommodate two moderate-sized cows, say two Ayrshires, and it is usual to have two cows in one stall, one tied to either side of it, with a smaller division between them, which serves the useful purpose of keeping each cow's food separate from the other's.

In Fig. 208 we give an illustration of a stall for two cows. In this pattern it will be noticed that the fodder-racks are arranged vertically instead of overhead, which enables the cow to eat her food as she lies—a thing which some cows rather like to do. There are also troughs for chaffed food or for water, as may be required. There are many different patterns of cow-stalls, made by such firms as Musgrave and Co., and the St. Pancras Iron-works Company. In some of them a water-trough is so placed that the cow can easily drink out of it; it does not communicate with the other cows' troughs; it may be filled by hand or by pipes, and the food is not apt to get into it. The stalls are made of wrought and cast iron throughout, combining strength with elegance of design. The cows are secured by chains round their necks, and the chains themselves are usually attached by rings to a bar which is fixed to the side of the stall in each case; the chains slide easily up and down the bar, and the cows cannot get their heads together. Projections against which the cows might hurt themselves are carefully discarded. The floors are either paved with stone or cement, or with tiles firmly set in cement, and they slope slightly—very slightly—toward the channel. A strong course of freestone, we think, ought to be next to the channel, for the cow's hind feet to stand upon, and the channel itself should be about 2 feet wide, so that the solid will not prevent the liquid excreta from passing away into the drain which leads to the liquid-manure tank. We assume that there is such a tank, for it is almost a necessity in premises that are always required to be kept clean and in

![Fig. 208. - Stall for Two Cows.](image_url)
FEEDING THE VILLA COW.

In the winter a small supply of hay may be made to serve, if a part of it is chaffed, mixed with brewers' grains, and improved by the addition of meal of one kind or another—maize, rice, pea, palm-nut, or any other kind that happens to be cheap in the market; and the mixture should be dampened and allowed to slowly ferment for half a day or more, to soften the fibre and make it more easily digestible. For butter-making, cows should always be fed, when fed this way, on food that is rich in starch and fats, as meals usually are, and is easily digested; but they should always have a little hay as it is twice a day, because it helps rumination and so prevents maw-bound.

In villa dairying it is better, we think, to churn milk instead of cream, because sufficient cream cannot, as a rule, be gathered whilst it remains sweet, and because fewer milk-pans will be needed. The "streamlet" churn, a cut of which is given on page 317, will be found a very good one for churning milk; and milk that has turned sour may be churned, yet the butter will be inferior. Milk, however, yields more butter, and is easier churned, when it has turned a little—just a little—sour, than when it is quite fresh; and either milk or cream yields more butter and churns easier when the cows are liberally fed on good food.

No food, we think, equals good grass in the month of June for butter-making; and, in fact, grass from the beginning of May to the end of September—providing it is grown in a good sound soil, and the cows can have a weekly change of pasture, so that their food is repeatedly fresh to them—is calculated to produce pleasanter butter than any kind of winter food will produce. At the same time it is true that a little dry concentrated food is a good thing along with the bulky succulent grass; it keeps the cows stronger, and gives a tone to the system. A change of food—even a change of pasture—will, as every dairy-farmer knows or ought to know, be of use to the cows, and the result of it will be found in the milk-pail. Winter butter often has a bitter taste and a somewhat pungent odour, both of which may be greatly mitigated, if not entirely prevented, by treating the food in the way we have recommended, for to make forage more easily digestible is to remove the chief part of the cause of unpleasant butter; but if this fails, scalding the milk up to 150° will drive off the volatile oils to which the unpleasant taste and odour are owing, and scrupulous cleanliness is necessary both in winter and summer, particularly in summer, for it is then that putrefactive ferment are most active. The use of a little sour buttermilk in the cream at churning-time will neutralise the bitter taste and smell of winter butter; and glacialine used instead of salt will remove it.

CHAPTER XXIV.

DAIRY FARMING IN IRELAND.


AIRYING in Ireland is pursued on a large scale chiefly in the province of Munster, where we occasionally find as many as 60 or 70 cows in one dairy. It forms, however, an important object of industry amongst the small farmers in the province of Ulster, many of whom do not possess more than three or four cows. Over one-half of the total number of milk-cows in Ireland belong to occupiers whose holdings do not exceed 50 imperial acres in extent. These men are therefore the great rearers of young cattle; that is, they breed the calves, which they sell at six months old, or as yearlings, to graziers, who carry them on until they are fit to be transferred to the fattening pastures in Leinster, or the stalls of the large tillage farmers in Ireland or in Great Britain. Large numbers of year-old cattle are also purchased from the breeders by dealers who export them to England and to Scotland. This trade is carried on extensively from Ulster.

In many instances the winter management of dairy-cows, at least in the south of Ireland, is conducted in a very primitive manner. It consists simply in allowing the cows to graze upon the bare pastures night and day. In very bad weather some hay, usually of an inferior kind, is shaken down upon the surface of the field. Those who follow the system consider that it is "unlucky" to house cows during winter, alleging that housing causes abortion; which may be the case, owing to the extremely filthy state in which the cow-houses are usually kept. Of late years more attention has been given to the winter treatment of cows. They are regularly housed at night, and are fed upon straw, or good natural meadow-hay, a few roots, some bran, ground oats, or Indian corn. When the cows are fed altogether on hay, about 30 cwt. of it is consumed by each cow. Several farmers use furze (gorse) as winter food for cows with manifest advantage. The furze is bruised or prepared by passing it several times through a chaff-cutter. When cows giving milk are fed liberally on furze, the milk is rich, and the butter has as good a colour as grass butter. Vetches are given to the cows in autumn, also second cuttings of clover, and cabbages in the end of autumn and early part of winter.

Cows are rarely house-fed all the year round, even in Ulster, where house-feeding was at one time more generally practised than it is at present. The cows are, of course, practically house-fed, but that system is now followed in combination with partial grazing. We have known a system of house-feeding carried out on a farm in Ulster under close cropping, the cultivation of forage and root crops being a prominent feature in the management. The farm to which we refer was between 70 and 80 imperial acres in extent, and a stock of 40 to 45 cows was regularly kept, besides pigs and horses. The purchased food consisted chiefly of distillery grains, sufficient to give one meal per day to each cow. The milk was chiefly sold warm from the cow.

We have mentioned that some dairy-farmers in the south of Ireland consider that it is "unlucky" to house cows during winter, and the idea that "luck" is an element in dairy management is rather prevalent. When anything goes wrong in churning it is set down to the interference of some evil-disposed person who is
supposed to have the power to take the "luck" from the cows. We have been told by some otherwise well-informed persons that they have watched their wells on the first morning in May, to prevent any one from skinning the water, the result of such skinning being supposed to be the abstraction of the butter from the milk of the cows on the farm during the succeeding summer. Other beliefs of a similar nature exist amongst the peasantry.

In the south of Ireland it is common for the owners of a herd of dairy-cows, who object to the drudgery of dairying, or have not skilled assistants, to let their cows, for the year, to men whose wives and daughters are competent for the work. The annual rent of a cow is from £9 to £11 or £12, and the gain to the dairyman who rents the cows is, in ordinary years, about £3 per cow. The owner of the cows supplies hay and litter, and allows the dairyman a piece of ground to grow potatoes, and sometimes a patch of wheat or oats; and the dairyman is also allowed to feed pigs on any spare sour milk or other refuse he may have. The year begins on the 1st of January, and each cow for which the dairyman pays rent must calve before the 15th of May. The usual season of calving is from the 25th of March to the 1st of May.

In the case of average dairy land it requires fully $3\frac{1}{2}$ imperial acres to graze a cow during summer and produce hay for her winter keep. In some poor dairy districts we find that fully 3 Irish acres, equivalent to 5 acres imperial measure, are required to keep each cow.

The annual yield of milk on good pastures is estimated at 500 to 700 gallons per cow, but on poor pastures the yield does not exceed 350 to 400 gallons. Milk of fair quality will produce 1 lb. of butter from 12 to 13 quarts of milk. This depends, however, on the period of lactation; the longer it is since the cows calved the richer is the milk in solids, and the more butter per gallon will it therefore yield. Depreciation of value, casualties, &c., or wear and tear, are estimated at about £2 per cow per annum.

In the south it is chiefly cream which is churned, but in the north the whole milk is used for that purpose. The churns chiefly in use are the ordinary barrel-churns, which are driven by power on large farms, the "power" being generally a mule or pony. The firkins into which butter is packed are supposed to weigh each 14 lbs., but from the clumsy manner in which they are made they sometimes weigh as much as 18 lbs. The firkins in which Irish butter is too commonly packed are, in fact, so rude and uninviting as to actually depreciate in the market the value of the butter within them. It cannot be denied that the garb in which an article is presented for sale has an influence, for good or ill, on the price which the article commands; and in the case of so delicate a thing as butter, which is, or ought to be, one of the most comely and cleanly of the adornments of the festive board, this consideration has unusual weight with the buyer. But the clumsiness of the firkins is not all we complain of; the railway and shipping companies, and the farmers too, do not take pains to keep the firkins clean on the outside; too commonly they are rolled about on the muddy quays or along the streets, when they ought not to be allowed to go near dirt of any kind. If we notice the neatness and cleanliness of firkins from France or Holland, Germany or Denmark, those from Ireland suffer painfully in comparison. We desire to press this point on the notice of our Irish friends, knowing as we do that the present state of things is detrimental to their interests; it is, moreover, an evil whose presence is gratuitous, and the result of sheer carelessness.

In preparing mild-cured butter about 3 pints of salt are used to the firkin of 70 lbs. of butter, but in preparing heavy-cured butter 6 pints of salt are used. Over-salting is a common fault in Irish butter, the alleged inducement being that the extra salt sells at the price of butter; but that is a short-sighted reason, because butter which has been over-salted will not fetch as high a price as butter of equal quality moderately salted. High salting was more necessary when the means of transit were slow and uncertain, but it is not required now that Irish butter can be placed in the English markets within twenty-four hours after it leaves the dairy where it was made.

The want of proper accommodation for keeping the milk until it is fit for churning is a very common defect in the case of Irish dairy-farms, especially amongst small farmers. In such cases the milk is usually kept in the barn, and becomes spoiled from the dirt which falls into it from the roof. The clay floor also absorbs spilt milk, which sours and gives forth offensive smells. In many cases milk is set in dishes which are placed in the sleeping compartments of the family, where it
speedily becomes tainted by absorbing animal colours. Even in cases where the milk-rooms are tolerably well constructed, the benefit is lost from the proximity of the apartment to the farm-yard dung-hill. On some estates encouragement is given to the tenants by the proprietors for the erection of improved dairy accommodation; but even with such encouragement there are some serious defects perpetuated in the construction or arrangement of the building, and we are of opinion that the dairy should be erected by the landlord, who could charge a reasonable percentage upon the outlay. It would be necessary, of course, that the builder should work under proper specifications, and it is by no means essential that the building should be of an expensive nature. The chief points to be observed are—(1) a proper aspect and situation; (2) internal cleanliness, as afforded by plastered walls and ceilings, and especially by a well-laid floor of stone or tiles; (3) ventilation; (4) floors, &c., constructed of non-absorbent material.

For this purpose there is nothing equal to Caithness pavement, which can be obtained sawn to any dimensions for floors or shelving.

Inferior quality of butter, caused by improper accommodation, is not directly a fault of the maker, but the case is altogether different when butter becomes deteriorated from fraudulent manipulation. This is the case in a class of butter known to the Cork trade under the title of "cocks." These consist of butter into which a large proportion of water has been introduced during the process of manufacture. From 8lbs. to 10lbs. of water are frequently worked into 60lbs. of butter. Butter adulterated in this manner, if sent to market when newly made, will stand as first quality; but after it has been kept over for a week or ten days it deteriorates so much that it will scarcely rank even as fourth quality. This dishonest practice, in which some dairywomen are very expert, of course injures the character of the Cork or other market butter; because if sent to England with a brand of first quality it must bring discredit on that brand, as by the time it would reach the consumer its quality would have fallen greatly in comparison with that assigned to it at first. It must not be supposed, however, that the owners of dairies in which "cocks" are manufactured are aware of the fact in all cases; for it is well known that dairywomen, who have the sole charge of dairies, frequently practise it for their own private advantage.

Of late years a system of co-operation in butter-making has sprung up amongst small farmers—that is, two or three join in filling a firkin. The different contributions are mixed together and worked up so as to produce a firkin of butter tolerably even in quality; but the system is not calculated to improve the manufacture, as each contributor is paid out of the general proceeds according to the quantity he contributed, without reference to its quality. In fact, if the quality of one lot is superior to that of the other lots, the maker of the best contribution loses all the benefit of the superior quality of his butter, which goes to improve the inferior lots.

Various plans have been suggested for raising the character of Irish butter in the English market, but the most practically useful system set on foot for that purpose is the system carried on by the "Golden Vein Mild-cured Butter Company," which has been established at Mallow, County of Cork. The distinctive name of the Company is derived from a rich tract of pasture which traverses the counties of Tipperary, Limerick, and Cork, and has long been known as the "Golden Vein." The premises occupied by the Company at Mallow, an important junction on the Great Southern and Western Railway, are admirably adapted for the purpose, having an ample and unceasing supply of pure spring water, a large cool cellair, and otherwise commodious premises. A refrigerating chamber is about to be constructed. The supplies of butter required by the Company are procured from dairies, properly constructed, kept scrupulously clean, and under the inspection of the Company's officers. No milk is allowed to be set for more than twenty-four hours, and the butter is sent twice a week to the Company's stores, or as it is churned, the subsequent operations being performed by the Company. The managers are all practical dairy-farmers, and the managing director is Mr. James Byrne, J.P., Wallstown Castle, an extensive and experienced dairy-farmer.

The butter is packed in casks which cannot be rolled about or dirtied, which is a great matter, and the butter is preserved from injury by means of a covering of thin muslin placed inside each cask. In addition to the preparation of tirkined butter, the Company intend to open a trade in fresh rolls suitable for the London market. The Company also intend to try the manufacture of canned butter, on the Danish and American plan, and, in short,
to leave no stone unturned with a view to enhance the character of Irish butter. Hitherto the Company has found its principal market in London, where the butter has held its ground against all comers.

Dairy-farming in connection with large towns consists chiefly in supplying fresh milk to the inhabitants. The owners of those dairies also make a certain proportion of butter, which is sold slightly salted. The buttermilk finds a ready market, but it is usually much adulterated with water, nor have any efforts been made, except at Belfast, to prevent the adulteration. The adulteration of new milk, either with water or with skim-milk, is carefully watched in Dublin, and various dairymen have from time to time been heavily fined by the police magistrates, on the evidence of the City analyst. One or two dairy companies have been formed for the purpose of supplying pure milk at reasonable prices, and these companies have been fairly successful. In the city dairies the cows are pastured in fields adjoining the city, within a radius of six or seven miles, the milk being brought into town morning and evening. During the winter the cows are kept in yards within the city, and fed upon hay, brewers' grains, Indian meal, &c. Some of these yards are kept in a very crowded and filthy state, but it is hoped that the new Act will effect some reformation in their condition. The price charged to the consumer is 4d. to 5d. per quart for new milk, and the trade is evidently a profitable one. Milk is a favourite article of food amongst all classes in Ireland, especially the middle and working classes, and there is ample room for developing the sale of the article, if supplied in a genuine state.

Cheese is not generally used in Ireland as an article of food. It is regarded as a luxury rather than a necessary of life. Hence the manufacture of cheese forms no part of Irish dairy management. A few persons, who are either Scotch or English, occasionally make cheese, chiefly for their own use, but there are comparatively few farmers who make it a speciality in their system of dairy management.

In conclusion we would remark that all who are interested in the matter should strive by every possible means to improve the make of Irish butter, and so enhance its character in the British markets. Butter-making appears to be a point in which we can hold our own, if so disposed, against foreign competition, as regards quality; but to do so effectually every obstacle, such as want of proper accommodation, must be removed, and means taken to diffuse sound instruction regarding the details of manufacture amongst the ordinary class of farmers. This should be done by a system of practical instruction by travelling instructors, similar to that carried on with reference to the introduction of roots, &c., after the famine years, under the auspices of the Royal Agricultural Society of Ireland; and at a later period to extend a knowledge of the cultivation and preparation of flax for the market.

The extension of dairy-farming may also be urged on the ground that rearing calves and store cattle generally is a very profitable undertaking, and likely to continue so, as it is not likely to be seriously affected by importations from America. In carrying out a system of this kind it is essential to breed a generally useful class of beasts, and to ensure this there is nothing equal to thoroughly well-bred Shorthorn bulls. In furtherance of this the owners of purely-bred herds should encourage those families which evince marked qualifications for the dairy, for it is indisputable that a bull descended from a line of females noted for their milking powers will transmit similar powers to his female offspring.

Cork is the great emporium of the Irish butter trade, and the following are some statistics of the trade at that market, which have been kindly supplied by Mr. Egan, Secretary to the Committee of Butter Merchants, Cork.

During the five years from 1864 to 1868, both included, the average number of firkins, &c., which passed annually through the weigh-houses was 378,765; during the five years ending 1873, the average number was 358,349; and during the five ending 14th of April, 1878, the annual average was 401,083 firkins, &c.

The class position of quality for the year last named was as follows:

<table>
<thead>
<tr>
<th>Class</th>
<th>Firkins</th>
</tr>
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<tbody>
<tr>
<td>First</td>
<td>135,044</td>
</tr>
<tr>
<td>Second</td>
<td>181,608</td>
</tr>
<tr>
<td>Third</td>
<td>102,961</td>
</tr>
<tr>
<td>Fourth</td>
<td>15,537</td>
</tr>
<tr>
<td>Fifth</td>
<td>1,153</td>
</tr>
<tr>
<td>Sixth</td>
<td>55</td>
</tr>
</tbody>
</table>

Total: 431,358 firkins, &c.

Butter is also largely exported from Dublin,
Mr. W. Bence Jones writes:—

"Very little cheese is made in Ireland. Many landowners have brought over skilled cheese-makers from their own farms, or as tenants, and fairly good cheese has been made, but none that I have ever tasted or heard of that was of really superior quality, and the attempts to make it have quietly died out. It is probable that either the soil or climate of Ireland is not suitable for cheese.

"The very opposite, however, is the case with butter. Both soil and climate are thoroughly suitable. In the southern half of Munster, especially Cork, Kerry, much of Limerick, Tipperary, and Waterford, the climate (as can be seen from any rain map) is the wettest in Europe (except some small spots, mountainous and other), and besides rain, there is a constant dampness of atmosphere very favourable for the growth of grass. Much of the soil, too, being a light useful loam, with the rock not far off, this moisture is the very thing needed; there is a constant fresh spring of grass and very few hot days, than which nothing could be better for cows and butter. Probably nowhere can better butter, in all respects, be produced. And the reason why so much inferior butter is made in Ireland is wholly from the habits of the people. Carelessness and slovenliness, and often scheming, are the root of the evil.

"In some districts the whole milk is churned. In Munster the cream only is used. Many, however, have a bad way of letting the milk stand till it thickens or sours before it is skimmed. It is more than doubtful if more butter is produced this way, though people think there is. On large farms feeding 20 to 50 cows, excellent butter is often made, which brings the best price in the markets, to which it is sent in firkins of 65 lbs. to 70 lbs.

"In spite, however, of defects—the bad influence of market defects, as well as those from neglect in making the butter—it is certain that in the south of Ireland dairying is much the most profitable way of dealing with land, and accordingly the number of cows kept constantly increases. Of course, if land is out of condition, its condition cannot be got up by cow-keeping, though, from the goodness of the climate for grass, land out of condition will seem to improve for some years under a dairy. Farmers who look far ahead know a very different plan is needful to improve the condition and make the most profit. But whether the land is in good condition or bad, if the best return at once with least outlay is wanted, as it is with nineteen-twentieths of all classes connected with land in Ireland, no mode of farming can compare with dairying. Since the famine, the practice of letting cows to a dairyman has greatly increased. The owner provides cows, utensils, and house and land for potatoes, to be manured by the dung of the cows. The dairyman is allowed to keep two or three sheep and a horse or donkey, according to the size of the dairy. If he has money he pays part of the rent at once; for the rest, or if he has no money for all, he gives promissory notes with two thoroughly solvent securities. From the habit of the country there is no trouble in getting excellent security. The rent is quite safe. About 4 acres of ordinary land are allowed for each cow. The rent is £10 to £11 per cow.

"Winter feeding is little thought of. The climate gives a little growth of grass often in winter. There is a little straw from the oats grown after the previous year's potatoes, and perhaps a cock of hay; and if there is any rough land or waste on the farm, there is some winter picking from it. Not only landowners adopt this plan, but also numbers of tenants, who let their cows to dairymen, instead of getting their own wives and daughters to do the dairy work. There is no doubt the cows thus pay them much better. Very few tenants make anything like £10 a cow from those they do not let. It is a sort of mystery how dairymen manage to pay; yet not a few make money. It is probably partly from no other stock being put on the grass, and to its not being over-stocked. The rest arises from more industry and effort towards a single end, in the dairyman, than in the tenant."

Mr. Richard Barter, St. Anne's Hill, gives us the following record of his dairy operations:—

"My farm is situated 8 miles from the city of Cork, and consists of about 700 acres, principally light land, red sandstone foundation. Two hundred acres have been drained, rocks removed, and subsoiled under the Board of Works, and I am at present engaged in draining 80 acres of flat
alluvial bottom resting on gravel, which I expect will turn out well. I grow about 25 acres of green crops each year, the larger portion mangels, which are always a heavy crop, and 5 acres of forage crops. I manure the green crops with 30 loads per acre of farm-yard manure made in a covered shed (one load of which I consider equal to two of manure made in the ordinary way, exposed to the open air), and 6 cwt. of superphosphate made as follows: The bones are bought whole and the labourers break them by contract, on wet days and winter evenings, into half-inch bones, which are afterwards dissolved in sulphuric acid.

The stock consists of 400 Shropshire sheep, 100 head of dry cattle, and 40 dairy-cows. The dairy-stock consists, principally, of three parts pure-bred Shorthorns, a few pure-bred ditto, and three Kerrys; the latter give milk nearly as rich and as highly coloured as that of Alderneys, and they have the great advantage of being extremely hardy. The dairy is in connection with St. Anne's Hill Hydrophatic Establishment, and a large quantity of fresh milk and butter are required all the year round. In order to keep up the supply of these articles, some of the cows calve in autumn and winter, but the greater proportion in spring. They are fed as follows:—

"Spring.—On the pastures by day, housed at night, getting each day 6 stone of mangels per cow, with a fair allowance of hay, and every evening a mixture of 2 lbs. decorticated cake, 1 lb. crushed Indian corn, and 1 lb. bran, made into a mucilage with boiling water, and given warm.

"Summer.—On the pastures day and night; one feed of green food each day, as the successive crops of rye, vetches, or trifolium come in.

"Autumn.—By day principally in the aftergrass, by night in the pastures; each evening a feed of cabbages, and the cows on full milk a mixture of cake as above.

"Winter.—Same as Spring.

Great cleanliness is observed in the dairy management; the milkers are obliged to wash their hands, and the herdsmen to sponge the cows' udders before each milking.

Each cow is numbered, and the milk accurately measured once a week; 20 have completed their season's milk to January 1st. The average of milk per cow has been 651 gallons; the highest 963 gallons—from a three-parts-bred Shorthorn, ten months' milking, bred on the farm; the lowest 563 gallons—from a half-bred three-year-old heifer, nine months' milking, purchased as a yearling.

The average percentage of cream has been 14° when getting cake, 11° not getting cake; highest percentage 17°, from a three-year-old three-parts-bred Shorthorn. It was found in general that the larger the quantity of milk given, the lower was the percentage of cream. The average yield of butter has been, for each 100 gallons of milk set, 20 lbs. for spring and winter, and 30 lbs., for summer and autumn; the milk is set in galvanised iron vessels for 24, 36, or 48 hours, according to the season of the year—generally 36 in summer, except in very hot weather, and 48 in winter. In cold weather the dairy is heated by means of a small furnace and flue placed under one corner of it, and is kept at a uniform temperature of from 48° to 50°. The cream is warmed to a temperature of 51° before being put into the churn, and the agitation of churning brings it up to 62°, at which the best results are obtained. Experiments were tried during the late cold weather, and it was found that the heating of the dairy and the cream before churning increased the return of butter fully 20 per cent.; the quality was better, and it took a much shorter time to churn than when put in cold. The churn used is an 80-lb. barrel-churn, turned by hand; 40 minutes is the general time taken in churning. The butter is handled as little as possible in the washing; about 1 lb. of salt is put to 50 lbs. of butter for the roll butter. A considerable quantity of butter is sent to Dublin every week in 1-lb. rolls; each lb. is folded in muslin, and packed in trays in a wooden case. In May and June, when the butter is plentiful, some of it is firkined for the Cork butter-market, when 3 lbs. of salt are put to the 70-lb. firkin; it obtains the term "superfine quality," which is a new brand established within the last two years in the Cork butter-market. This quality is a careful selection from the best of the mild-cured, and commands about 2d. a lb. over the price of the first quality. The merchants tell me the demand for it exceeds the supply."

Greater in Ireland than in England is there need for improved dairy-utensils and more careful treatment of milk, cream, and butter; yet it is true that many of the more advanced Irish dairies will compare not unfavourably with corresponding ones in England, so far, that is,
as successful practice is concerned, and in this lies the chief merit of such places. It is at the small farms, and among the cottiers who milk only one or two cows, that the dairy accommodation and equipment may be described as deplorably bad; sanitary matters generally are at a low ebb; the cow-sheds and dung-heaps are absurdly close to the door and windows of the house; the milk is too often kept in the general living-room of the family, or in a closely adjoining one into which the reeking smoke from the peat fire has the greatest freedom to enter; and the general surroundings are anything but conducive to cleanliness.

There is, however, in the present day a widespread and earnest effort being made by many prominent men, who deserve well of their country, to educate the rising generation, and all others who may care to learn, in the art and science of improved systems of dairy management; and it is satisfactory to know that the result of these efforts is already seen in a marked improvement in the average quality of the butter of some districts in Ireland. We trust this reform will go on spreading and deepening, until the habits of the people have become imbued with a spirit of friendly emulation, and the production of first-class butter is the rule and not the exception in the Emerald Isle.

In the re-arrangement of the Munster Model Farm provision is made for a thorough and practical course of instruction in both outside and inside dairy management. The training of the male pupils will extend over two sessions of four and a half months each, at the very moderate fee of £7 10s. per annum, for which sum the Board of Education provides the pupils with everything except clothing. In the months of January and July, at which periods no male pupils will be resident at the institution, farmers’ daughters and dairymaids will be admitted as pupils at an equally moderate fee, and placed under the care of a matron who is distinguished as a maker of prize butter. We hope to see other institutions of this kind rising up in various parts of the country, because we are assured their influence for good will be enormous. Meantime, for the guidance of those who are so situated that they cannot avail themselves of the advantages which are offered by the Munster Dairy School, the following hints on dairy management, over the name of Mr. Barter of St. Anne’s Hill, have been freely and widely distributed:

"The following hints on dairy management are chiefly intended for the guidance of small farmers who may not have the means or the opportunity of availing themselves of new and expensive appliances. The real secrets of success in butter-making are scrupulous cleanliness and the closest attention to every detail. If Irish farmers will believe and act on this, they need not fear any foreign competition; as good butter can be made in Ireland as in any country in the world. The following extract is from the Irish Stock Journal, writing on the Dublin Dairy Show:—"Our friends in Ireland have set to work with a will to improve the condition of the dairy husbandry of their country; and the hearty earnestness which they display is a good assurance of the success they will gain. Properly attended to in all its stages, Irish butter will become, take it for all in all, the finest in the world."

"Cows, both before and after calving, should be kept in good condition. The milk of cows in poor condition will be found deficient both in quantity and in quality. This can easily be tested by a cream-gauge (a small glass, price 2s.), which will be found very useful in showing what pasture and what kind of food gives the best return of cream. In cold weather a tepid drink at night after milking, made with about 4 lbs. of meal and bran mixed, or, better still, 2 lbs. of bran and 2 lbs. decorticated cotton-cake, in half a bucket of water, materially assists the flow of milk. Turnips ought not to be given to dairy-cows; but if the use of them is unavoidable, they should be given immediately after milking, never at any other time, and in this way a stone of white turnips may be given in the day, with very little risk of the butter being tainted. Cows should have free access to fresh, pure water; and they should always be treated with gentleness, and never driven fast. It has been proved that the milk of a cow that has been driven fast, or been hunted by dogs or tormented by flies, will injure the whole setting. They should be kept very clean. The cow-sheds also should be kept perfectly clean; they should be well floored, well drained, and well ventilated, as if cows or cow-sheds are kept in a dirty state, the milk will inevitably be tainted. Before milking, the cow's udders should be sponged.
HINTS ON DAIRY MANAGEMENT.

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with warm water, and allowed to dry; and milkers should always wash their hands without soap before milking. Cows should be milked quickly and gently, and as nearly as possible at regular and equal times. If they are milked slowly, or any of the strippings left, they will soon go back in their milk, and more loss is sustained in this way than most people are aware of.

"Milk should be carefully strained; if hair or any particles of dust or dirt remain in it, they will spoil the butter. Milk should be set in summer in shallow tinned pans, as souring stops the rising of the cream, which is a very slow process, and the great object should be to get as much cream to the surface as possible whilst the milk remains sweet. In winter, deep setting in earthenware pans is better, because they retain the heat in the milk longer, and the gradual cooling of the milk to the temperature of the air assists the rising of the cream, the fatty portion retaining the heat longer than the milk or watery portion. Milk should always be skimmed before it gets sour, as after that any cream that rises is only of the poorest description, and the slight addition in quantity will not compensate for the inferior quality of the butter. The perforated tin skimmer is much the best, as it allows any milk that may be taken up with the cream to run through.

"Dairies should be kept perfectly sweet and well ventilated, and be separated by a partition wall from the dwelling-house. No door or window should look out in any yard or place where smells of any kind could come from. The floor should be flagged, tiled, or cemented, so that it can be frequently washed; an earthen floor, damp and dirty, is most unfit for a dairy. Any splashes of milk should be immediately wiped up, as, if allowed to remain and turn sour, they will taint the milk. The windows should be arranged so that no streaks of light or sun could shine upon the milk, as they produce flecks in the cream, which always show in the butter. Dairy utensils should be cleaned by first washing them in cold water, then scalded, and again washed in fresh cold water. The temperature of the dairy is most important; it should never be allowed to go under 50° or over 55°. Keeping a dairy heated to the proper temperature will largely increase the return, and will well repay the trifling expense of a stove. Cheap stoves to burn either coal or turf can be had, which will keep up the necessary heat even in the coldest night.

"The cream for churning should not be kept too long. Slight ripening is good for the butter, but it should never be allowed to become very sour, and in winter should be churned at least twice a week, and in summer more frequently; it should be kept covered with muslin, both to exclude particles of dust and also to prevent the air acting too much on the surface of the cream and produce unequal ripening. In adding a fresh skimming the contents of the crock should be well stirred, so as to mix all well together, and no fresh cream should be added for twelve hours before churning, as it would not have time to equally ripen, and would take longer than the other cream to churn, so that the churning would be stopped before the butter came on the fresh cream. The temperature of cream before churning should always be carefully tested with the thermometer. It has been proved that 57° is the best temperature to churn at; and the cream in cold weather should be warmed to this by placing it before a fire or in a tub of warm water, or in hot weather cooled by placing it in cold water. The churn also should be rinsed out before churning in winter with hot water, in summer with cold.

"The churn should be turned slowly at first, so as not to break up the butter globules too much, and the churning should be most carefully listened to and stopped the moment the butter comes, so as not to allow it to collect in lumps. The grain and firmness of the butter are thus preserved, and the buttermilk can be easily removed. After removing the buttermilk the butter should be washed in the churn, three times in fresh spring water and twice in pickle, made by placing some salt in a piece of muslin on top of a can and pouring cold water over it. If the butter is at all soft it should be allowed to stand for a couple of hours in the churn in very cold water. In making the butter, handling should be most carefully avoided. By the use of a butter-worker and butter-slices, butter can be made without ever touching it with the hands, and this is the plan adopted in the best dairies in England and on the Continent.

"The firkins, before placing the butter, should be perfectly clean and sweet, and care should be taken to send them clean to market. A very good plan to sweeten firkins, and remove the taint which even the best oak firkins will have, is to
pour boiling pickle into them and let it stand in them for twenty-four hours; then rinse in fresh cold water."

It is to be expected that only such samples as are reckoned to be of superior merit are, as a rule, sent for competition and exhibition at the agricultural shows. No maker of decidedly inferior butter, unless strangely infatuated, would exhibit his goods at all; he would hardly care to publish to the world the fact that he was less skilful than his neighbours, nor would he enjoy seeing his butter compared with much superior samples. It follows, therefore, that the samples exhibited are good ones in the makers' estimation, or in that of their friends, and equally representative in different countries, though it does not necessarily follow that all the best samples of a given district are attracted to the show. As a rule, however, we may take it for granted that the best and second-best qualities of butter which the district is able to produce are fairly well represented by the samples present. These premises granted, we may venture to draw a comparison between the butters of Ireland and of other countries, based on the various exhibitions we have seen.

In the first place we may say that the butters of Ireland, as seen at the leading shows, will not suffer by comparison, all things considered, with those of England, or of the countries of Northern Europe. That there is a larger proportion of inferior butter made in Ireland than in any other country which reckons to be a dairying country at all is probably true, but it is equally true that some of the best butter in the world is made there. It is merely a question of care and cleanliness. At any rate a collection of Irish butters shows more body, substance, and general quality than we have found to be the case in other countries. At the same time we must admit that they are less skilfully made and less neatly finished off and presented than, for instance, the butters of Denmark or of Finland. Possessing an inherent superior quality, they lose the advantage in not being so skilfully made. With one of the finest climates on earth for dairying purposes; with a soil and herbage which are not easily equalled; with a breed of cows excellent in many respects, and still improving; and with milk pre-eminently suited to butter-making—more so, perhaps, than the milk of any other country in the world—the Irish people are provided with the first requisites for becoming the leading butter-producing nation in Europe. But to attain this position requires, in our opinion, the untiring industry, the scrupulous cleanliness, the intelligent thought, and the pride in work which are conspicuous among the Dutch and the Danes.

With English butters those of Ireland compare still less unfavourably than they do with those of the Continent. It is true that English butters are more cleanly though scarcely more carefully made than the Irish, but they are "weaker," and are apt to "go off" earlier. Nor, indeed, are English butters at a show as uniform as the Irish—so far, that is, as our observation has gone; but we admit that, in the general run of the butters of the two countries respectively, and not confining ourselves to show-butter, there is a greater disparity in the quality of the latter than in that of the former, and a wider interval between the best and the worst we could find. Irish butter-makers have a great future in store, if they mind what they are doing.
CHAPTER XXV.

The Dairying of America.


American dairying is chiefly remarkable for its rapid growth, the proportions attained, its relative position among the agricultural industries of the country, and the associated or factory system, which originated there and has become so generally adopted.

Like everything else in America, the dairying is comparatively new. It was without unusual features until 1830, and the great growth has occurred since that time, within fifty years. Then, with a population of 13,000,000 there were less than 4,000,000 milch-cows, and their annual products had a value not exceeding 100,000,000 dollars. Within twenty-five years these figures were more than doubled. In 1850, 49,000,000 of people own 12,000,000 cows, and the dairy products of the year exceed 400,000,000 dollars—300 per cent. increase in production in half a century. An eminent author says: "The dairy business of this country has developed with such rapidity and to such a degree of importance, with the aid of the highest intelligence and the application of the most consummate skill, as to be regarded as one of the highest triumphs of modern agriculture." It exhibits the greatest progress ever made in any branch of agriculture.

The foreign trade in products of the dairy has grown much faster than the total production. Exports of butter and cheese were first made in the last half of the eighteenth century, but were so insignificant as to escape the official reports until 1820; that year the exports of butter reached 1,000,000 lbs., and of cheese 750,000 lbs., the whole valued at 190,000 dollars. In the year ending June 30, 1880, the exports were 44,000,000 lbs. of butter, 140,000,000 lbs. of cheese, together valued at 18,000,000 dollars.

The Americans are the greatest butter-eaters in the world, but consume very little cheese. Figures illustrating these facts are uncertain, but the best authorities estimate the per capita consumption of butter in the United States at 15 lbs. per annum, and that of cheese at 4 lbs. or less.

Local tests show the highest rates of consumption to be in dairy districts producing large quantities and the best quality, and reach in some instances 25 lbs. per capita of butter, and 9 lbs. of cheese.

For the statistics of the dairy interests, the United States census, taken every ten years (1790 to 1870 inclusive), furnishes the best general data, but the figures there found are not altogether trustworthy.* Farms were construed as three acres or more, and the enumeration of cows not on farms was omitted (although estimated), making discrepancies between the returns of State officials and those of the United States for the same years; similarly, the reports of products in some places indicate the total production, and in others represent sales only, home consumption being disregarded. Therefore the State enumerations, made in several States in the years 1875, 1865, &c., and in some cases with great care (New York and Massachusetts in 1875, for example), the annual report of the United States Department of Agriculture, with estimates and the very creditable publications of the leading dairymen's associations, are all valuable adjuncts in

* As these pages go to press the tenth census (1880) has been taken, but its compilation is not sufficiently advanced for the results to be embodied in the text. They will, however, be given in a subsequent appendix.
compiling statistical information on American dairying. If this term be broadened so as to include the dairy in Canada, the census of the Dominion, taken in 1871, must be added; it is a work prepared with much care, under the supervision of the Minister of Agriculture.

The growth of American dairying, and its extent and relative importance in 1880, can be appreciated only upon an examination of the general development of the country. For this purpose the superintendent of the census of 1870 divides the States and territories into three groups; the first consists of the original thirteen and three others afterwards organised from their territory; the second, of those States which were settled between 1790 and 1815; and the third group includes the remainder. The accompanying table (No. 1) is made upon this plan, showing the area of settlement at different dates, the density of population, and the number of cows owned, per square mile.

This gives a view of the advance of dairying; it will repay study, and from it may be easily computed the population and the whole number of cows in these three sections at the different periods. (The figures for 1880 are partly "semi-official" returns and partly estimates.) As each group, however, has a varied geography, the sections where the dairy is most prominent can be seen better in Table No. 2, in which each group is geographically arranged. This table exhibits many interesting facts as to the increase of dairy-cattle in the several States, and the ratio of these animals to the population in different parts of the Union.

Table No. 3 is still more comprehensive, giving the statistics of the general agricultural progress of the country, and a comparison between the values of the most important agricultural products.

It is here seen that the corn crop (maize) alone exceeds in value the annual dairy products; but Indian corn and hay are both, in a considerable degree, accessories of the dairy. Hence it is not erroneous to assert that dairying is the greatest single agricultural interest in America.

The location of the dairy industry of the United States is a difficult matter to explain. For years it was claimed by prominent writers that the profitable dairying of the country would always be monopolised by a district confined within certain narrow geographical limits. Then a "dairy belt" was discovered, and the opinion generally prevailed that the only territory adapted to dairying lay between the 40th and 45th degree of latitude, and was to be found in distinct separated sections occupying about one-third of the area of this belt, from the Missouri River to the Atlantic Ocean. These ideas have been thoroughly exploded; it has been abundantly shown that good butter and cheese can be made, by proper management, in almost all sections of North America between the 32nd and 50th parallels. Generally speaking, good butter can be profitably produced wherever good beef can. Even the influences of climate, soil, water, and herbage are largely controlled, and what is lacking in the natural conditions is supplied by tact and skill. But of the territory named within which dairying is practicable, a very small fraction contains the bulk of the dairy interests of the country in 1880; great natural advantages easily account for certain sections being the conspicuous dairy districts, although these no longer aspire to be the exclusive producers of butter and cheese.

The best idea of the dairy regions as they were in 1870 can be obtained from the map of dairy products in the volume of "Industry and Wealth," in the ninth United States census, and also in General Walker's "United States Statistical Atlas, 1872." This chart is herewith reproduced on a somewhat different scale.

The graded tints graphically illustrate the distribution of this interest in the country, showing the variation in the value of the annual dairy products from 5 dollars to 40 dollars and over per capita; the four grades of tint represent a production of (IV.) 40 dollars and over, (III.) 20 dollars to 40 dollars, (II.) 10 to 20 dollars, and (I.) 5 to 10 dollars, per capita. The territory where the annual production does not reach 5 dollars to each person is not tinted. The fourth grade is confined to portions of New York, Ohio, Vermont, and California; the third is found in those States, and also in Massachusetts, Connecticut, Pennsylvania, and New Jersey; the second occurs in spots, and the first prevails throughout the New England, the Middle, Northern Central, and North-Western States, and California. There is no tinted space
AMERICAN DAIRY STATISTICS.

No. 1.—Growth of the United States, by Decades, in Area of Settlement, Density of Population, and Number of Milch Cows.

<table>
<thead>
<tr>
<th>Date of Statistics</th>
<th>Group I</th>
<th>Group II</th>
<th>Group III</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area Settled, Sq. miles</td>
<td>Population per Sq. mile</td>
<td>No. of Cows</td>
</tr>
<tr>
<td>1780</td>
<td>200,000</td>
<td>15.7</td>
<td>—</td>
</tr>
<tr>
<td>1790</td>
<td>224,005</td>
<td>17.0</td>
<td>—</td>
</tr>
<tr>
<td>1800</td>
<td>256,208</td>
<td>18.8</td>
<td>—</td>
</tr>
<tr>
<td>1810</td>
<td>312,173</td>
<td>25.8</td>
<td>—</td>
</tr>
<tr>
<td>1820</td>
<td>353,135</td>
<td>30.1</td>
<td>8.1</td>
</tr>
<tr>
<td>1830</td>
<td>379,002</td>
<td>36.7</td>
<td>9.3</td>
</tr>
<tr>
<td>1840</td>
<td>361,141</td>
<td>43.8</td>
<td>10.4</td>
</tr>
<tr>
<td>1850</td>
<td>326,346</td>
<td>50.1</td>
<td>11.3</td>
</tr>
</tbody>
</table>

Group I includes the Original Thirteen (13) States, and Maine, Vermont, and West Virginia.
Group II, Kentucky, Tennessee, Ohio, Indiana, Illinois, Michigan, Missouri, Arkansas, Louisiana, Mississippi, Alabama, and Florida.
Group III, Wisconsin, Iowa, Minnesota, Nebraska, Kansas, Texas, the Pacific States, and all the Territories.

No. 2.—Milch Cows in the United States, by States, in 1850 and 1878, with ratio of Cows to Population, and Number of Cows to 100 Persons.

<table>
<thead>
<tr>
<th>States</th>
<th>Cows, 1850</th>
<th>Ratio</th>
<th>States</th>
<th>Cows, 1878</th>
<th>Ratio</th>
<th>Cows, 1850</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maine</td>
<td>133,536</td>
<td>22</td>
<td>Ohio</td>
<td>544,499</td>
<td>23</td>
<td>796,000</td>
<td>23</td>
</tr>
<tr>
<td>New Hamp.</td>
<td>91,277</td>
<td>20</td>
<td>Indiana</td>
<td>285,574</td>
<td>25</td>
<td>189,200</td>
<td>20</td>
</tr>
<tr>
<td>Vermont</td>
<td>146,128</td>
<td>47</td>
<td>Illinois</td>
<td>224,051</td>
<td>35</td>
<td>688,600</td>
<td>26</td>
</tr>
<tr>
<td>Mass.</td>
<td>130,699</td>
<td>33</td>
<td>Michigan</td>
<td>99,676</td>
<td>25</td>
<td>35,300</td>
<td>25</td>
</tr>
<tr>
<td>Rhode I</td>
<td>22,609</td>
<td>15</td>
<td>Kentucky</td>
<td>214,475</td>
<td>25</td>
<td>752,000</td>
<td>18</td>
</tr>
<tr>
<td>Conn.</td>
<td>85,401</td>
<td>23</td>
<td>Tenn.</td>
<td>295,456</td>
<td>23</td>
<td>248,200</td>
<td>19</td>
</tr>
<tr>
<td>New York</td>
<td>361,821</td>
<td>24</td>
<td>Missouri</td>
<td>230,120</td>
<td>34</td>
<td>506,100</td>
<td>25</td>
</tr>
<tr>
<td>New Jersey</td>
<td>118,736</td>
<td>24</td>
<td>Arkansas</td>
<td>93,131</td>
<td>45</td>
<td>182,200</td>
<td>23</td>
</tr>
<tr>
<td>Penn.</td>
<td>350,224</td>
<td>24</td>
<td>Florida</td>
<td>72,876</td>
<td>83</td>
<td>70,700</td>
<td>23</td>
</tr>
<tr>
<td>Dela.</td>
<td>19,458</td>
<td>28</td>
<td>Alabama</td>
<td>227,791</td>
<td>30</td>
<td>205,000</td>
<td>20</td>
</tr>
<tr>
<td>Mary.</td>
<td>86,836</td>
<td>15</td>
<td>Miss.</td>
<td>241,231</td>
<td>35</td>
<td>160,000</td>
<td>22</td>
</tr>
<tr>
<td>Virginia</td>
<td>297,619</td>
<td>22</td>
<td>Louisiana</td>
<td>103,566</td>
<td>20</td>
<td>112,000</td>
<td>13</td>
</tr>
<tr>
<td>W. Virginia</td>
<td>126,700</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. Carolina</td>
<td>221,739</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. Carolina</td>
<td>39,243</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Georgia</td>
<td>384,223</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3,361,492</td>
<td></td>
<td></td>
<td>4,278,600</td>
<td></td>
<td>2,665,185</td>
<td></td>
</tr>
</tbody>
</table>

Totals 3,361,492 4,278,600 2,665,185 3,973,500

Note.—The figures for 1850 are taken from the United States census, and those for 1878 from official estimates by the Department of Agriculture at Washington.

No. 3.—Growth of Agriculture in the United States, and Relative Value of the Chief Products.

<table>
<thead>
<tr>
<th>Year</th>
<th>1840</th>
<th>1850</th>
<th>1860</th>
<th>1870</th>
<th>1878</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pop. United States</td>
<td>17,029,453</td>
<td>23,191,876</td>
<td>31,433,322</td>
<td>38,588,571</td>
<td>47,938,050</td>
</tr>
<tr>
<td>In Agriculture</td>
<td>2,711,750</td>
<td>2,400,583</td>
<td>3,221,574</td>
<td>5,922,471</td>
<td>7,009,000</td>
</tr>
<tr>
<td>Number of Farms</td>
<td>—</td>
<td>1,499,677</td>
<td>2,019,077</td>
<td>2,651,085</td>
<td>3,500,000</td>
</tr>
<tr>
<td>Average size Acres</td>
<td>—</td>
<td>135</td>
<td>135</td>
<td>135</td>
<td>135</td>
</tr>
<tr>
<td>No. of Milch Cows Acres</td>
<td>4,837,943</td>
<td>6,392,044</td>
<td>8,555,755</td>
<td>10,623,000</td>
<td>12,000,000</td>
</tr>
<tr>
<td>Value of Cows</td>
<td>72,555,000</td>
<td>125,848,800</td>
<td>264,643,975</td>
<td>324,179,693</td>
<td>312,000,000</td>
</tr>
<tr>
<td>Dairy Products Dollars</td>
<td>210,929,637</td>
<td>260,159,144</td>
<td>210,406,839</td>
<td>369,823,000</td>
<td>408,000,000</td>
</tr>
<tr>
<td>Indian Corn Crop</td>
<td>197,531,753</td>
<td>250,055,352</td>
<td>439,685,741</td>
<td>478,356,500</td>
<td>473,000,000</td>
</tr>
<tr>
<td>Hay Crop</td>
<td>64,238,408</td>
<td>80,767,494</td>
<td>172,262,152</td>
<td>371,717,033</td>
<td>325,000,000</td>
</tr>
<tr>
<td>Wheat Crop</td>
<td>82,672,246</td>
<td>100,400,501</td>
<td>158,360,279</td>
<td>238,111,520</td>
<td>357,000,000</td>
</tr>
<tr>
<td>Cotton Crop</td>
<td>40,121,290</td>
<td>50,827,562</td>
<td>206,369,936</td>
<td>288,200,000</td>
<td>280,000,000</td>
</tr>
<tr>
<td>Wool Crop</td>
<td>10,754,225</td>
<td>15,353,680</td>
<td>22,258,104</td>
<td>40,000,000</td>
<td>50,000,000</td>
</tr>
<tr>
<td>Tobacco Crop</td>
<td>15,372,200</td>
<td>13,082,626</td>
<td>20,761,900</td>
<td>25,901,241</td>
<td>28,000,000</td>
</tr>
</tbody>
</table>
south of Virginia, Kentucky, and Missouri, or west of the 99th meridian, except in California.*

New York is thus presented, as it is par excellence, true dairy State. One-eighth in value of the whole dairy product of the country belongs to it. More butter is made annually in New York than in any two other States, and more than one-third of the cheese-crop of the Union. Here is a comparative statement.

<table>
<thead>
<tr>
<th>States</th>
<th>New York</th>
<th>Ohio</th>
<th>Pennsylvania</th>
<th>Vermont</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Value of Dairy Products</td>
<td>Dollars</td>
<td>50,000,000</td>
<td>18,500,000</td>
<td>20,600,000</td>
</tr>
<tr>
<td>Value of Annual Product per Cow</td>
<td>Dollars</td>
<td>37</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>Value per Capita...</td>
<td>Dollars</td>
<td>10</td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
</table>

Being without large cities or manufacturing communities, Vermont shows a greater product in proportion to her population, and a rather higher rate per cow, but otherwise the predominance of New York is apparent. In a large part of this State the natural conditions are very favourable to dairying; high undulating surface, a loamy soil, inclining to clay, and running into shale; numerous springs of soft water, clear streams with gravelly beds; sweet natural herbage; freedom from drought, and snow enough in winter to protect the roots of the grasses. The two most noted dairying counties of New York are Herkimer for cheese and Orange for butter. In 1795 a young man from New England built among the black slate hills on the Mohawk River, and established the first dairy of which there is record, in Herkimer County. Five years later cheese-making was quite common, and became general in the county before 1825. The herds were small, however; a few containing 40 cows were regarded then as very large. About 1825 cheese-making spread into the adjoining counties, the increased product sought new markets, and in 1831 Harry Burrell, of Herkimer, made the first shipment of cheese from that county to England—10,000 lbs. An account of cheese-making in Herkimer in 1835 states that the herds were milked in the open yard or pen, the curds worked in tubs, and pressed with log presses; it was not considered fit to use till fall or winter, and was then packed in rough casks, and peddled at 5 to 8 cents a lb., wherever a market for it could be found. There was no order, no system. Forty years later the associated system, originating in 1851 in the adjoining county of Oneida, almost supersedes the private dairy; 100 cheese-factories in the county turn out more than four-fifths of the annual product. This county has about 15 cows to every 100 acres, ranking first in the State in this respect, and its annual cheese product is 10,000,000 to 12,000,000 lbs., besides over 1,000,000 lbs. of butter. Little Falls, in Herkimer County, was for years the largest cheese-market in the United States—probably the largest in the world—but latterly the sales at Utica have been still greater.

Orange County has long been famous for its butter, and such has been the reputation of the same that the name alone attached to the article has sold many a package from distant parts of the State. This county begins on the Hudson River, near New York City, and is the eastern portion of a belt of territory ranging from 25 to 50 miles in width, and extending north-west erly 100 to 125 miles into the heart of the State, all of which is peculiarly adapted to dairying. The Catskill range of mountains, with its many branches, makes a broken and even rough country, but the hills are well covered with soil, and afford the best of pasturage, even including the summits of all but the highest. Abrupt hills, rolling lands, valleys, and streams give great diversity of soil, sandy and gravelly loams, light and heavy clay loams, and rich alluvial bottoms. Along the streams the deep black earth, vegetable mould collected from the hills, carries a soil in many places unbroken for a century. The natural grasses of these meadows are the blue-grass, fowl meadow, meadow fescue, red-top, wire-grass, and in moist spots the sweet-scented vernal-grass. Timothy, orchard-grass, and the clovers have been added, and flourish. The common weeds are also found, the ox-eye daisy, the thistle, and the golden rod. The hills, and the grasses that grow upon them, which are by many considered sweeter and more nourishing for cattle, are as highly valued as the valleys. It has been remarked that this territory was once a region of great hemlock forests, and some of the old settlers

* It may be expected that a similar map compiled during the year 1881 from the returns of the tenth United States census will show very marked changes, and especially an extension of the territory of greatest production, embracing some of the North-western States.
believe that the parts which carried the heaviest hemlock growth are now the best dairying sections. Goshen is the county seat, and an active butter-market. Goshen and Orange County butter became famous in the old days of private dairies, but associated butter-making has largely replaced the old system. The first butter-factory in the country was started in Orange County, the Walkill Creamery Association at Goshen being the pioneer of the new system. Orange County ranks next to from that time; the figures for 1875 are from the State census. The statistics are added of four of the best dairying counties, also from last census. The number of cows to every 100 acres of farms in the State in 1875 was $\frac{1}{2}$, and the average annual yield per cow 1,500 quarts of milk, or 125 lbs. of butter. The dairy associations and markets are very active, and the dairy lands appreciating in value more than any others. In the re-assessment of the lands of the State in 1875,

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No. 4.—Dairy Statistics of New York and Ohio, United States of America.

<table>
<thead>
<tr>
<th>State</th>
<th>New York</th>
<th>Ohio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>1870</td>
<td>1871</td>
</tr>
<tr>
<td>Popul.</td>
<td>3,047,356</td>
<td>3,840,730</td>
</tr>
<tr>
<td>In Agriculture</td>
<td>323,890</td>
<td>370,836</td>
</tr>
<tr>
<td>No. of Farms</td>
<td>170,021</td>
<td>196,930</td>
</tr>
<tr>
<td>Value of Farms, Dollars</td>
<td>554,546,412</td>
<td>833,343,563</td>
</tr>
<tr>
<td>Average size ... Acres</td>
<td>112</td>
<td>106</td>
</tr>
<tr>
<td>No. of Cattle</td>
<td>1,875,638</td>
<td>1,973,174</td>
</tr>
<tr>
<td>No. of Milk Cows</td>
<td>303,324</td>
<td>1,128,634</td>
</tr>
<tr>
<td>Milk sold ... Galls</td>
<td>7,799,094</td>
<td>105,037,280</td>
</tr>
<tr>
<td>Butter made ... lbs</td>
<td>29,743</td>
<td>48,318,290</td>
</tr>
<tr>
<td>Cheese, Dairy ... lbs</td>
<td>49,741,415</td>
<td>48,318,290</td>
</tr>
<tr>
<td>Cheese, Factory ... lbs</td>
<td>78,096,084</td>
<td>90,996,759</td>
</tr>
<tr>
<td>Cheese Factories ... No.</td>
<td>818</td>
<td>1,139</td>
</tr>
</tbody>
</table>

Dairy Counties in the State of New York (from Census of 1875).

<table>
<thead>
<tr>
<th>County</th>
<th>Cows to each 100 acres</th>
<th>Whole No. of Cows</th>
<th>Cow's Milk sent to Factories</th>
<th>No. of Factories</th>
<th>Factory Cheese</th>
<th>Dairy Cheese</th>
<th>Butter</th>
<th>Milk Sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herkimer</td>
<td>14-9</td>
<td>44,257</td>
<td>34,097</td>
<td>88</td>
<td>9,212,428</td>
<td>1,940,367</td>
<td>1,756,747</td>
<td>119,354</td>
</tr>
<tr>
<td>Orange</td>
<td>14-8</td>
<td>44,257</td>
<td>12,872</td>
<td>23</td>
<td>824,315</td>
<td>3,670</td>
<td>1,480,166</td>
<td>18,350,709</td>
</tr>
<tr>
<td>St. Lawrence</td>
<td>12-8</td>
<td>29,999</td>
<td>20,784</td>
<td>47</td>
<td>1,622,033</td>
<td>44,101</td>
<td>8,382,073</td>
<td>70,331</td>
</tr>
<tr>
<td>Dutchess</td>
<td>6-4</td>
<td>23,999</td>
<td>2,412</td>
<td>1</td>
<td>25,000</td>
<td>5,999</td>
<td>1,283,299</td>
<td>5,101,610</td>
</tr>
</tbody>
</table>

Herkimer in the ratio of cows to land, and stands first in the list of counties in the annual butter product per cow. Proximity to New York City and facilities of transportation have caused a falling-off in the butter product of the county, and an increase in the shipments of milk to market; the last census gives the annual sales of milk from Orange County as 13,500,000 gallons, more than twice as much as any other county in the State.

The cows in the State of New York were first counted in 1815, and found to number 999,490; the value of the dairy products was then placed at 20,000,000 dollars a year. A table is here inserted, showing the growth of dairying in New York the valuation of King's County was decreased 37,000,000 dollars, while that of Oneida, a dairy county, was increased 7,000,000. The mean temperature of the State of New York is 47° Fahr. Frost generally appears late in September, and the first fall of snow on an average is the 5th of November. The city of Utica, Oneida County, 22 miles west of Little Falls, is another very large and active dairy market; over 300,000 cheeses are sold there annually.

Ohio bids fair to rank next to New York among the dairying States, if, indeed, that position has not been won already. From 1838 to 1862, and especially from 1841 to 1852, this branch of agriculture was very active. Then wool-growing
took the lead for a few years. Since 1867 the dairy interest has been the most important in the agriculture of the State. Ohio has no mountains, but the greater part of its surface is elevated table-land, from 900 to 1,400 feet above sea-level, intersected with many streams flowing either into Lake Erie on the north or the Ohio River on the south. The mean temperature of the State is 52⁰, and the average rainfall 38 inches. In 1820 four-fifths of the area (10,000 square miles) was covered with forests, and the dairy lands are almost entirely cleared territory. The best portions, known as the Western Reserve,* lie in the north-eastern corner of the State. The soil is better adapted to the growth of nutritious grasses than anything else, and dairying is the leading business of the farmers. The first factory for the purchase of milk and making of cheese was established in Geauga County, in 1855, by Anson Bartlett; in 1880 the associated system prevails, and the number of factories in the State is estimated at 400; three-fourths of them in the twelve counties of the Western Reserve. The average number of cows to each factory is 320, and the season, commencing about the 7th of April, continues eight months. Wellington, in Lorain County, is the great dairy market of the Western Reserve and of the State. It has a Board of Trade, and its shipments of cheese alone exceed 10,000,000 lbs. annually. Next in importance as a dairy centre is Garrettsville, in Portage County; a Board of Trade was organised there in July, 1878. A State census is taken every three years, but the agricultural statistics are not so full and reliable as the activity and enterprise of the agricultural and dairymen’s societies would lead one to expect. With the Table for New York some comparative figures are given for Ohio.

In Pennsylvania the best dairying counties are those which border upon New York and Ohio, and some lying in the south-eastern portion of the State. Philadelphia, the second city in America, is about 100 miles inland from the sea on the west bank of the Delaware River. The Pennsylvania counties of Delaware, Chester, Montgomery, and Bucks, immediately adjoining Philadelphia on the south-west and north, are peculiarly adapted to dairying, and are largely devoted to that industry, producing great quantities of butter and furnishing the city with its chief supplies of milk. Philadelphia butter has long been noted for very delicate flavour, and this characteristic is attributed by many to the sweet-scented vernal-grass, which is one of the most common of the grasses upon the natural pastures of the counties named. This seems to be substantiated by the fact that the high aromatic flavour of the butter, especially notable in May, continues during the development of this grass and declines with the maturing of its seeds; the stems then become hard and dry, the leaves wither, and the cows push the plant aside to obtain fresher and greener herbage. Nearly all the butter of this section is put up in pound lumps, circular in shape, with some suitable figure stamped upon the top, and hence the name of “Philadelphia pound prints.” The quality of this article is of a high average, and the best has long commanded prices beyond those obtained elsewhere, with rare and very limited exceptions; 60 and 75 cents have been usual prices, and the product of certain dairies has readily sold for one dollar, for long periods. This butter is generally made in private dairies of medium size, many of them retaining the old-fashioned but satisfactory spring-house system; the milk-room, usually of stone, is built over a living spring, whose waters flow through a cooling pool.

Two hundred miles west of Philadelphia, adjoining the State of West Virginia, is the county of Somerset, almost exclusively a butter-making district. In the north-west corner of the State, 350 miles from Philadelphia, are Erie and Crawford Counties, containing seventy or eighty cheese-factories, and producing a million dollars’ worth of cheese annually; nearly all of this goes to Great Britain, by way of New York City. Meadville, in Crawford County, is the chief dairy market of this region, has an active Board of Trade, and is also the head-quarters of the Pennsylvania Dairymen’s Association. A factory at Venango, in the same county, took the diploma and medal for the best American cheese at the Centennial Exhibition in 1876, and the second honours at the Chicago Dairy Fair of 1877. The counties of Bradford, Tioga, and Susquehanna, in the northern part of the State, produce large quantities of butter; this district is very hilly, but the water and

* So named because when the territory of Ohio, claimed by older States, was ceded to the United States to form the North-West Territory, 4,000,000 acres were retained by Connecticut and known as its Western Reserve.
DAIRYING IN MASSACHUSETTS.

grasses are of the most suitable kind. All these dairy districts are reached by the world-renowned Pennsylvania railroad and its branches, which afford a quick means of transit for their products. Fifty-six other counties in Pennsylvania contain much territory well adapted to dairying, but yet undeveloped. The mean temperature of the State is 48°, and the average rainfall 41 1/2 inches.

State, but the dairy is an important feature of her husbandry, and the statistics are so complete that a table (No. 5) has been prepared exhibiting those of interest in this connection.

The following facts from the State census of 1875 are not included in the table:—Of the 3,255,179 acres in farms, about one-fourth is non-productive, so that 71,000 persons in the State

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<table>
<thead>
<tr>
<th>No. 5.—Statistics of the State of Massachusetts.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Population...</td>
</tr>
<tr>
<td>1850: 299,514</td>
</tr>
<tr>
<td>1855: 1,132,359</td>
</tr>
<tr>
<td>1860: 1,231,666</td>
</tr>
<tr>
<td>1865: 1,327,003</td>
</tr>
<tr>
<td>1870: 1,427,534</td>
</tr>
<tr>
<td>1875: 1,651,912</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Engaged in Agriculture...</td>
</tr>
<tr>
<td>1850: 55,682</td>
</tr>
<tr>
<td>1855: 57,031</td>
</tr>
<tr>
<td>1860: 61,569</td>
</tr>
<tr>
<td>1865: 67,550</td>
</tr>
<tr>
<td>1870: 74,810</td>
</tr>
<tr>
<td>1875: 76,945</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>No. of Farms...</td>
</tr>
<tr>
<td>1850: 34,699</td>
</tr>
<tr>
<td>1855: 34,821</td>
</tr>
<tr>
<td>1860: 35,601</td>
</tr>
<tr>
<td>1865: 45,934</td>
</tr>
<tr>
<td>1870: 45,000</td>
</tr>
<tr>
<td>1875: 44,549</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Average size of Farms...</td>
</tr>
<tr>
<td>1850: 18.99</td>
</tr>
<tr>
<td>1855: 19.6</td>
</tr>
<tr>
<td>1860: 24.94</td>
</tr>
<tr>
<td>1865: 27.0</td>
</tr>
<tr>
<td>1870: 29.0</td>
</tr>
<tr>
<td>1875: 29.0</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Total Value of Farms...</td>
</tr>
<tr>
<td>1850: 130,178,947</td>
</tr>
<tr>
<td>1855: 130,253,984</td>
</tr>
<tr>
<td>1860: 132,293,984</td>
</tr>
<tr>
<td>1865: 152,946,688</td>
</tr>
<tr>
<td>1870: 180,090,000</td>
</tr>
<tr>
<td>1875: 180,090,000</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>No. of Neat Cattle...</td>
</tr>
<tr>
<td>1850: 270,600</td>
</tr>
<tr>
<td>1855: 231,521</td>
</tr>
<tr>
<td>1860: 298,914</td>
</tr>
<tr>
<td>1865: 221,088</td>
</tr>
<tr>
<td>1870: 219,068</td>
</tr>
<tr>
<td>1875: 224,238</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>No. of Milk Cows...</td>
</tr>
<tr>
<td>1850: 159,969</td>
</tr>
<tr>
<td>1855: 148,569</td>
</tr>
<tr>
<td>1860: 144,429</td>
</tr>
<tr>
<td>1865: 143,284</td>
</tr>
<tr>
<td>1870: 138,099</td>
</tr>
<tr>
<td>1875: 136,034</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Average Value of Cows...</td>
</tr>
<tr>
<td>1850: 25.9</td>
</tr>
<tr>
<td>1855: 25.9</td>
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<tr>
<td>1860: 25.9</td>
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<tr>
<td>1865: 25.9</td>
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<tr>
<td>1870: 25.9</td>
</tr>
<tr>
<td>1875: 25.9</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Butter, lbs. made...</td>
</tr>
<tr>
<td>1850: 8,671,570</td>
</tr>
<tr>
<td>1855: 8,116,000</td>
</tr>
<tr>
<td>1860: 8,297,690</td>
</tr>
<tr>
<td>1865: 8,096,867</td>
</tr>
<tr>
<td>1870: 7,866,455</td>
</tr>
<tr>
<td>1875: 7,922,411</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Average market price...</td>
</tr>
<tr>
<td>1850: 9.19</td>
</tr>
<tr>
<td>1855: 9.21</td>
</tr>
<tr>
<td>1860: 9.25</td>
</tr>
<tr>
<td>1865: 9.32</td>
</tr>
<tr>
<td>1870: 9.36</td>
</tr>
<tr>
<td>1875: 9.35</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Cheese, lbs. made...</td>
</tr>
<tr>
<td>1850: 7,688,412</td>
</tr>
<tr>
<td>1855: 5,762,776</td>
</tr>
<tr>
<td>1860: 5,294,690</td>
</tr>
<tr>
<td>1865: 3,892,592</td>
</tr>
<tr>
<td>1870: 4,131,200</td>
</tr>
<tr>
<td>1875: 4,067,017</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Average market price...</td>
</tr>
<tr>
<td>1850: 8.19</td>
</tr>
<tr>
<td>1855: 8.21</td>
</tr>
<tr>
<td>1860: 8.25</td>
</tr>
<tr>
<td>1865: 8.20</td>
</tr>
<tr>
<td>1870: 8.16</td>
</tr>
<tr>
<td>1875: 8.15</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Milk sold...</td>
</tr>
<tr>
<td>1850: 3,262,665</td>
</tr>
<tr>
<td>1855: 3,262,665</td>
</tr>
<tr>
<td>1860: 10,658,572</td>
</tr>
<tr>
<td>1865: 15,284,572</td>
</tr>
<tr>
<td>1870: 35,058,159</td>
</tr>
<tr>
<td>1875: 9,087,842</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Value Dairy Products...</td>
</tr>
<tr>
<td>1850: 2,100,611</td>
</tr>
<tr>
<td>1855: 2,100,611</td>
</tr>
<tr>
<td>1860: 5,161,263</td>
</tr>
<tr>
<td>1865: 5,161,263</td>
</tr>
<tr>
<td>1870: 6,292,586</td>
</tr>
<tr>
<td>1875: 9,087,842</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Hay Crop...</td>
</tr>
<tr>
<td>1850: 631,807</td>
</tr>
<tr>
<td>1855: 648,010</td>
</tr>
<tr>
<td>1860: 651,531</td>
</tr>
<tr>
<td>1865: 593,185</td>
</tr>
<tr>
<td>1870: 574,133</td>
</tr>
<tr>
<td>1875: 671,144</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Average price per ton...</td>
</tr>
<tr>
<td>1850: 12.42</td>
</tr>
<tr>
<td>1855: 12.42</td>
</tr>
<tr>
<td>1860: 14.50</td>
</tr>
<tr>
<td>1865: 18.90</td>
</tr>
<tr>
<td>1870: 18.90</td>
</tr>
<tr>
<td>1875: 18.90</td>
</tr>
</tbody>
</table>

STATISTICS OF THE COUNTY OF FRANKLIN, MASSACHUSETTS.

In the adjoining States of New Jersey and Delaware, dairying is a prominent industry; large cities and towns furnish markets for great quantities of milk, and an excellent article of butter is produced.

No statistics of the dairy can be found gathered by State authority in Pennsylvania, New Jersey, Delaware, or any one of the New England States except Massachusetts; the United States census is the sole dependence for these.

Massachusetts is far from being an agricultural live from the products of farms averaging 56 acres of arable land valued at 70 dollars per acre. The average net income from each farm is 511.30 dollars per annum, or 9.31 dollars per acre. The farmer also gets the rent of his home, estimated at 109 dollars, making really an annual income of 620.30 dollars. 50,962 males in the commonwealth, earning wages in nine hundred occupations other than agriculture, average an income of 452.72 dollars per annum. So the farmers of Massachusetts fare well by comparison. The
dairy-cattle of the State are of a high order, and the dairying generally managed with intelligence and profit. The cows in Massachusetts average 1,900 quarts of milk a year, and the gross product is worth 72 dollars per cow; these figures being far above those of any other State.

For various reasons the county of Franklin, in Massachusetts, is as good a selection as can be made of a small representative dairy district in the older parts of the United States. It is on the northern line of the State, on the Connecticut River, its most fertile lands lying in the valleys of that stream and tributaries to it. The county was incorporated in the year 1811, an area of 650 square miles, divided into 26 townships. The aspect of the county is broken and mountainous. There are ranges of red sandstone extending along the bank of the Connecticut, and the western towns lie upon spurs of the Green Mountain range. Every town in the county has its fair proportion of hills. Originally forest-clad, the hills are now cleared, in many cases even when rising almost to mountains. In some instances the farmers have placed their houses on the summits, and have around them cultivated and productive fields. But the hills and mountain-sides are usually devoted to pastureage, micaceous-slate formations being common. The rocks of the county are chiefly granite and trap, although red sandstone is abundant, and there is more or less slate and limestone. Springs abound among the hills and form little streams of the purest water, so numerous that almost every farm of any size is well supplied. This description implies soils of varied kind and quality, from light sand and clay deposits to the deep alluvial meadows of the valleys; a rather light loam of fair fertility is the prevailing medium. The mean temperature for thirty-five years was 47°, the average annual depth of rain or melted snow 44 inches, and the depth of snowfall 53 inches. The first agricultural survey was ordered by the State in 1810. That and subsequent returns give this division of the lands:

<table>
<thead>
<tr>
<th>Lands</th>
<th>1849</th>
<th>1859</th>
<th>1875</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unimproved</td>
<td>66,556</td>
<td>65,721</td>
<td>67,483</td>
</tr>
<tr>
<td>In Woodland</td>
<td>64,432</td>
<td>62,669</td>
<td>63,127</td>
</tr>
<tr>
<td>In Towns, Roads, and Water</td>
<td>15,344</td>
<td>17,324</td>
<td>18,280</td>
</tr>
<tr>
<td>Pasturage and Wild</td>
<td>188,016</td>
<td>191,345</td>
<td>194,763</td>
</tr>
</tbody>
</table>

The dairy-stock of the county is based upon "natives," with a large admixture of Durham blood, which dates back to 1835, or earlier. Much attention has been given to improving the cows of late years. About 1855 importations of choice Jersey cattle were made, and the blood of this breed has since had a marked effect upon the dairies of the county. The annual county show of cattle is regarded as one of the best in the New England States.

The county is crossed by one line of railroad north and south, and by another east and west, the junction at its shire town, Greenfield; and the facilities of transportation and courses of trade are such that the case is an unusually good one for verifying the figures of production and consumption, as given in the census, by examination of the market records. Numerous manufacturing villages furnish a good home market for dairy products, and the surplus, almost all in the form of butter, is sent by railway to Boston, 100 miles eastward. Franklin County butter has long had a good name in the Boston market, commanding the best prices aside from those termed "fancy." The general statistics of the county, from the State and National census, are given in connection with those of Massachusetts (see Table No. 5). The following additional facts are from market records:

<table>
<thead>
<tr>
<th>Year</th>
<th>Shipments of Butter From Franklin County.</th>
<th>Range of Prices</th>
<th>Average Price</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Dollars</td>
<td>Cents.</td>
</tr>
<tr>
<td>1875</td>
<td></td>
<td>511,313</td>
<td>20 to 35</td>
</tr>
<tr>
<td>1876</td>
<td></td>
<td>519,671</td>
<td>18 , 43</td>
</tr>
<tr>
<td>1877</td>
<td></td>
<td>530,171</td>
<td>17 , 34</td>
</tr>
<tr>
<td>1878</td>
<td></td>
<td>584,884</td>
<td>12 , 35</td>
</tr>
<tr>
<td>1879</td>
<td></td>
<td>662,389</td>
<td>9 , 35</td>
</tr>
<tr>
<td>1880</td>
<td></td>
<td>769,041</td>
<td>9 , 35</td>
</tr>
</tbody>
</table>

The steadily increasing sales, with no decrease in home consumption, with about the same number of cows, and upon a "falling market," indicate the rate of improvement in dairy-stock which prevails throughout the county. Some herds have produced over 300 lbs. of butter per cow, and yielded from 100 to 150 dollars per annum per cow, for several successive years. The figures show an average annual product of 1,800 quarts of milk and 164 lbs. of butter per cow for the county, and a consumption of 23 lbs. of butter per capita. The latter is probably as accurate a computation of the consumption of butter in America as has
ever been reached, and exceeds the general average in the country by from 5 lbs. to 8 lbs. 

Although no satisfactory statistics can be given for the other New England States, dairying forms the most important branch of agriculture in all of them. Maine and Vermont particularly have active organisations of dairymen, and these States are rapidly progressing in the quantity and quality of their productions. In Maine cheese is largely made, there being a number of factories in successful operation, and the annual butter crop reaches 12,000,000 lbs. Vermont, as already shown, is specially a butter-making State, the greater part of the surplus product finding its way to Boston. St. Albans, in the north-western part of the State, is one of the oldest, largest, and best known butter markets in the country. In New Hampshire the dairy is less prominent, but almost as much butter is made as in Massachusetts, and the southern part of the State supplies large quantities of milk to the many manufacturing towns and cities in that section and in Eastern Massachusetts. Connecticut contributes largely to the New York City milk supply, besides making as much butter and cheese as Massachusetts. Associated butter-making is beginning to be popular and successful in this State, and one of its creameries received the first premium for butter made in New England at the International Dairy Show at New York in 1878.

Rhode Island has 19,000 cows, which are about equally divided between the production of milk for consumption by the people of that densely populated State and the manufacture of an excellent grade of butter; cheese-making is almost unknown there. As a whole, New England is a good dairying section, and its farmers find that, with butter cows and improved methods, the dairy is their surest source of profit.

The North-western States have rapidly developed excellent dairy districts since 1815. For a long time there was much prejudice in the Atlantic States against the butter and cheese of the West, and Eastern people were incredulous as to the dairying capabilities of that section. For years all Western-made butter was classed as "grease" in the New York market, and this continued up to about the year 1870. But Iowa butter received the highest award at the Philadelphia Exhibition of 1876, and the same year the dairy products of the North-west began to command equal prices in New York with the best Eastern articles; since that time Western creamery butter has stood at the head of the list. Up to 1865 Chicago merchants obtained their supplies of cheese from the East; in 1879 over 100,000,000 lbs. passed through that city from the West on its way to the New York market, and 200,000 packages of butter and cheese were also exported to Europe direct from Chicago.

One of the causes of disbelief in Western dairying was the idea that the prairie pastureage was unfit for milk-cows. But it has been abundantly proved that there is no better dairy feed than the native prairie grasses, so long as they keep green; this, however, is only about four months. It appears that butter from cows feeding upon the wild grasses of the West keeps longer than almost any other in the country, and when well made cannot be surpassed in quality. The yields also are large; two cases are on record in Illinois of Devon cows on prairie pasture, one of which gave double her weight of milk in thirty-five days, in May and June, and from the other 423 lbs. of butter were made in a year, the winter feed being prairie hay. In 1851 a grade Durham, owned by a pioneer prairie farmer in Iowa, gave over 50 lbs. of milk a day for several weeks; this cow had never been in a barn nor tasted tame hay. Among the advantages of the West as a dairy district are the low prices of land, lumber, and staple articles of food—good land, improved, 20 to 40 dollars per acre; cows, 30 to 50 dollars each; hay, 10 dollars, and often much less, per ton; Indian corn, 50 cents per bushel and less, sometimes 30 cents; wheat, 80 cents. The prairie farmers naturally prefer to ship dairy products East, for while corn brings but 1 cent a pound, wheat 1½, pork 3 or 4, and beef 8 cents, butter is usually 18 to 20 cents, and cheese about equal to beef, and the cost of sending these articles to market is about the same, pound for pound. The most condensed farm products are thus the most profitable to the farmers who depend upon distant markets.

In Michigan the best dairy counties are those in the south-west corner of the State, bordering upon Ohio and Lake Erie, ranking in about this order in importance—Lenawee, Oakland, Wayne, Washtenaw, Hillsdale, Jackson, Monroe, Macomb; also Kent in the central part of the State.

Indiana has 400,000 cows very evenly distributed over the State, but although the dairy products are large in the aggregate, there
are no localities in which this industry is specially prominent. The counties of greatest production are Allen, bordering on Ohio, with Fort Wayne as its business centre, and Lake County, in the extreme north-western corner of the State, on Lake Michigan. Indiana has but twenty cheese-factories, while the neighbouring States of Michigan and Illinois have fifty and one hundred respectively.

Illinois has an important dairying district, including eighteen or twenty counties, the northern fifth of the State, with an area of about 10,000 square miles. This is one of the most fertile and well-developed agricultural regions in the United States. It is almost level, here and there relieved by a gently-rolling surface. The grass is mostly tame, and the entire district is abundantly watered. The water here, however, as in all this region, is in streams of good size, springs being comparatively few in number; and many farms depend upon pumping from wells for supply of stock and domestic uses. For this purpose windmills are much used, and the country throughout the level portions of the north-west is dotted with them. There are several excellent American patterns, one of which is here represented (Fig. 209). The most productive dairying counties are Cook, Kane, La Salle, Will, McHenry, De Kalb, and Lake, all in the north-eastern part of the State. The City of Chicago is in Cook County, 1,027 square miles in area, with 30,000 cows and a population of 600,000. In Kane County is Elgin, the great dairy centre of the West, a fine town of 10,000 inhabitants, situated on the Fox River, 40 miles west from Chicago. It is the head-quarters of the State Dairymen's Association, founded in 1874, and has a vigorous Board of Trade, organised in 1872, in the dairy interest. In the immediate neighbourhood of Elgin are about thirty factories and creameries, and seventy more make this their market. The Board of Trade sales include about 10,000,000 lbs. of cheese and 2,750,000 lbs. of butter annually, amounting to over 1,500,000 dollars in value. There is also at Elgin a condensed-milk factory, managed by one of the sons of Gail Borden, which uses the milk from 2,000 cows. The first shipments of butter from Elgin were made in 1847; in 1862 the first cheese-factory was built. The first dairymen's organisation in the North-west was formed at Elgin in 1863. The activity of the dairy interest in this region can be judged from the fact that Kane County, with an area of 510 square miles and a population of about 50,000, has more than 2,000 milk-cows. At South Elgin, St. Charles, and Huntley, in Kane County, are located three of the largest cheese-factories in the country, costing from 10,000 to 12,000 dollars each, and using at times over 30,000 lbs. of milk apiece daily. At Marengo, in McHenry County, is the famous butter-factory of Israel Boies and Sons, elsewhere mentioned, which in the year 1874 produced an average of 311 lbs. of first-class butter from its 100 cows. Rockford, in Winnebago County, not far from the Wisconsin boundary, is the centre of the best dairy-butter business of Illinois. Freeport, in Stephenson County, is also a large butter market.

Wisconsin has large dairying interests, and has taken front rank as a cheese-making district. Cheese-making began at Fon-du-Lac, on Lake Winnebago, in 1850; at that time there were but three or four dairies in the State. The era of cheese-factories developed the dairying resources of Wisconsin, and followed soon after the rapid growth of this industry in Northern Illinois. The first cheese-factory in the State was built in 1864,
THE WESTERN STATES.

and within twelve years there were 150 established. Wisconsin cheese was shipped directly East before that of Illinois; it has a special reputation for keeping and for quality, and as an export article commands in the New York market prices equal to New York State cheese. A particularly fine display of Wisconsin cheese was made at the International Dairy Fair at New York in 1878, and several special prizes taken. Wisconsin took most of the cheese prizes also at the Chicago Fair in 1877. This State also won the very highest honours for butter at New York in December, 1879. The Illinois and Wisconsin Dairymen’s Association, formed in 1867, soon became the North-western. In 1872 the Wisconsin State Dairymen’s Association was organised. The best dairy district is the south-eastern quarter of the State, extending up Lake Michigan to Green Bay, and across the southern border of the State almost to the Mississippi River. The land and water are of the best. There is a large proportion of Germans in the population. The following counties each have more than 10,000 cows, and in the importance of the dairy rank as named—Dane, Dodge, Fon-du-Lac, Grant, Rock, Jefferson, Green, Waukesha, Sheboygan, and La Fayette. The centres of the trade are at Sheboygan Falls, and at Fort Atkinson, Jefferson, and Watertown, the last three in Jefferson County.

Iowa is likely to become the foremost dairy State of the North-west, and in butter-making assumed the lead in 1878. It was organised as a Territory in 1838, became a State in 1846, and has had a very rapid growth. Its length, north and south, is 200 miles, and its width, between the Mississippi and Missouri Rivers, about 300 miles. The country is very level, no mountains, or even considerable hills; rolling prairie is the rule. The general elevation above the sea is from 800 to 900 feet, and there is a gradual slope of the whole State from north to south of one foot to the mile, as well as eastern and western drainage-slopes towards the two great rivers, from two to five feet to the mile. This State contains a greater proportion of tillable and fertile land than any other in the country. There are three kinds of soil: the first is formed of the surface part of the drift or diluvial deposit, a dark loam, moderately stiff, from one to three feet deep, which prevails on the prairies; the second, the surface portion of the bluff deposit, very fine, with less clay than the first, drier, as fertile, and deeper; the third is the alluvial of the river-bottoms, as rich, durable, and productive as any soil in the world. The climate is very uniform, with a difference in the growing season of about ten days between the extreme vegetation, north and south; the average annual temperature is 45° Fahr., and the rainfall 42 inches. The number of milch-cows owned in the State more than doubled between 1860 and 1870, and doubled again between 1870 and 1880; the number for the last year is placed at 730,000. Dairying in Iowa began to be prominent in 1864; the State Dairymen’s Association was formed in 1875. All parts of the State are about equally adapted to dairying, but the eastern portion, a belt, 100 miles wide, along the Mississippi River, is the oldest, and leads in the industry. The counties of greatest production are Clinton, Cedar, Jackson, Clayton, Delaware, and Dubuque; Manchester, in Delaware County, is the chief centre of the trade. The factory system is largely followed in butter-making. Butter from Iowa factories and creameries took the highest honours at the Centennial Show in 1876; and at the International Dairy Fair at New York in 1878 a large share of the special prizes and the sweepstakes, “the best butter of any kind made at any time and place.” This was the product of a factory at Monticello. At the second “International,” 1879, of the highest thirty-two prizes for butter, open to all the States, fifteen were taken by Iowa.

Minnesota is a still newer State, but very extensive, growing rapidly, and with large dairy interests already (1880). The south-east corner is the largest butter-producing region, and most attention is given to this branch of dairying. But Minnesota has the same natural conditions with her neighbour Wisconsin, and with Canada, still further east, and only needs a market to produce, like those districts, an article of cheese of superior keeping qualities. The State Dairymen’s Association, at its yearly meeting in 1878, made this one of the leading topics of discussion. The State is without mountains, but its general elevation gives it the characteristics of a mountainous region; the yearly mean temperature is 44° Fahr., and the atmosphere very dry. Limestone drift, clay, and trap are the geological divisions of the soil; the latter generally appears dark in colour, fine in texture, and abounding in organic matter; it is highly fertile. In 1858, of its 5,000,000 acres but 300,000 were
under cultivation; in 1878, 3,000,000. In 1858 there were 30,000 cows in the State, and 250,000 in 1878, yielding about 15,000,000 lbs. of butter. An intelligent farmer in Sherburne County, 70 miles north-west of St. Paul, states that he keeps ten cows, good common stock, some with a little Shorthorn blood, and makes an average of 125 lbs. of butter per cow, from calf to calf. The butter for several years was sent to St. Paul, and averaged 22 cents a pound, 20 cents in 1878. The cows are pastured from the 15th or 20th of May till the middle of September, and the natural grass pastures are sufficient; they remain out till October 15th, but this last month must be fed to prevent loss of milk, the pasturage suffering from frost. Seven months of stall-feeding follow. For hay, selected meadows of natural wild grass are cut, often requiring hauling for two or three miles; the hay thus obtained costs about 3 dollars a ton at the barn. Wheat, bran, and shorts can be obtained in any quantity at very low rates at the numerous flouring mills.

Kansas, Nebraska, and Missouri have together about 1,000,000 cows, and their dairy products are large, although beef-production receives more attention. In 1879 and 1880 a good deal of cheese reached Chicago and New York from these States; one lot from a ranch on the North Platte River in Nebraska, on the eastern edge of "the plains" region, was ranked as first-class. Large dairy-herds are kept there, and a cheese-factory has been built. A few factories were in successful operation in Kansas as early as 1867.

Maryland, Virginia, West Virginia, and Kentucky have within their borders exceedingly fine districts for dairying, but these are not generally developed, the famous blue-grass pastures being devoted more to the production of beef than of butter and cheese. The dairy products of this section are large, however, and the same is true of North Carolina, Tennessee, and Arkansas. These seven States have 1,250,000 cows, about 18 per cent. of the population, and although they are not as good dairy animals as those in the more northern sections, they just about supply the local demands for milk, butter, and cheese, the cities excepted. The other Southern States have a still larger proportion of cows, and of a still less value for the dairy; so that although, Texas excepted, the cows number over 20 per cent. of the population, the large Southern cities are constant buyers of Northern dairy products.

Texas is an exceptional State. It had in 1880 two cows to every five inhabitants, besides 4,500,000 other cattle, but its cows are almost all breeders, the dairy products being inconsiderable. To illustrate—the following are the figures of the census of 1870: Population, 818,000; cows, 428,000; other cattle, 3,066,000; butter made, 3,700,000 lbs.; cheese, 31,000 lbs.; milk sold, 63,000 gallons. This is about 100 quarts of milk per year devoted to the dairy for every cow in Texas.

The Southern and Southern-central States, as a whole, may be regarded as a great undeveloped winter-dairying region. Below the blue-grass districts natural pasturage is not general, but the other facilities for successful dairying are very great, except during the season of excessive heat. There is but a small portion of the South where the climate is such as to materially interfere with dairying during the greater part of the year. Good pasturage is easily made and available during months when the cows of the North and East are closely housed. With a little care the best of dairy-cattle are acclimatised, and the Jerseys are becoming favourites in this section. In 1875 Virginia, North Carolina, Kentucky, and Tennessee had together a dozen cheese-factories, but beyond this there were no establishments for associated dairying. The private dairies of the South are generally small, and the old and excellent spring-house system is preferred. Since 1875 private dairies in different parts of the South have introduced their products, especially winter-butter, not only to the markets of Southern cities, but in Louisville, Cincinnati, Baltimore, and Washington. It cannot be long before the Southern States will be supplying to the North and East large quantities of grass-flavoured butter all through the winter. This will develop the dairy districts not only in Virginia, Kentucky, and Missouri, North Carolina, Tennessee, and Arkansas, but in the higher parts of the Gulf States. Dairies are in successful operation among the old cotton-fields of Central Mississippi, and one is known in the high lands of Florida, at lat. 31°; but south of the 32nd parallel, as a rule, dairying will never amount to much in the United States.

Between the valleys of the Mississippi and Missouri Rivers and the Rocky Mountains there is
a vast area, once known as "the Great American Desert," which has become a beef-producing section, and may yet, if need be, contribute its quota to the dairy products of America. Mention has already been made of successful dairying in Kansas and Nebraska.

The Rocky Mountain region itself has most unexpectedly developed excellent dairying districts. This is especially true of "the Centennial State" of Colorado. Nearly a parallelogram, 380 miles long by 280 broad, this State is crossed near the middle, from north to south, by the Rocky Mountain system, whose snow-capped peaks form the watershed of the continent. The system consists of two or more ranges, their courses presenting undulating lines which in Colorado alternately separate and unite, forming the wonderful series of "parks" which extends across the State. Some of these are small, being little valleys at the sources of single streams, or the beds of small lakes; others equal in extent some of the principal Eastern States. The most important are the North Park, Middle Park, South Park, and San Luis Park. These high valleys are apparently the basins of former lakes, upheaved and deprived of their waters by volcanic agency, with their original shape and situation at the foot of high mountains undisturbed, and having now an elevation of from 6,000 to 11,000 feet above the level of the sea. The surface of these parks is alternately forest and meadow, the soil particularly fertile, and vegetation very little affected by the great elevation. Luxuriant pastures of nutritious grasses are found here 11,000 feet above sea-level. East of the mountains, to the boundary of the State, is the plains region, high, rolling prairie, watered by the South Platte and Arkansas Rivers and their tributaries. The soil of this section rests upon calcareous rocks, and is principally alluvial, containing elements of great fertility. Near the streams a large proportion of vegetable matter enters into the composition, united with ashes and sand; on the plateaux the soil is sandy loam and friable clay. About one-third of the State is good agricultural land, and the abundance of nutritious grasses indigenous to the soil on park and plain, good water, and an even, dry, healthful climate, make Colorado an excellent grazing and dairy region. The range of temperature in the parks is from 20° to 80° Fahr. The grasses which once supported vast herds of buffalo prove to be as good for domestic cattle; they ripen and dry upon the stalks, forming hay equal to that prepared by the most careful curing of the tame grasses of the Eastern States. The winters are so mild that not more than one year in five is there any necessity for sheltering or feeding cattle. A dairymen near the centre of the State that he has kept an average of over 30 cows for 16 years, and during that time he has not expended a hundred dollars for any feed beside pasturage. Colorado ceased to import dairy products in 1874, and became an exporting State in 1877. The first cheese-factory was started in the spring of 1876, and in 1878 seven large establishments were in operation. The pioneer factory was built by G. R. Gwillem, a Welshman, who is still the largest producer in the State; in 1878 he made a successful shipment of 10 tons of cheese to Wales, a special freight rate being obtained of 2 dollars per cwt. from Denver City to Liverpool. This cheese was examined in the factory, and pronounced by so good a judge as Mr. Gardner B. Weeks to be entitled to rank as strictly fine in the New York market, and to excel in quality most of the cheese made in the North-western States. This factory, during the season of 1878, was in operation from early in May until November; it received the milk of 37 dairies, numbering about 600 cows, the largest single day's receipts being 8,300 lbs. of milk. One dairy contributing milk was 14 miles distant, and several were from 6 to 10 miles from the factory. A notable feature of the dairying of Colorado seems to be the remarkable richness of the milk made from the natural herbage. At the Gwillem factory it required a little less than 9 lbs. of milk to make a pound of cheese, on an average, for the entire season of 1878; this is 10 per cent. below the required average according to the best New York factories. On a trial on the 10th of September, 1878, Mr. Gwillem from 6,000 lbs. of milk made 819½ lbs. of cheese as it came from the press; the shrinkage in curing was 5 per cent. The ratio of milk to cheese therefore was 7·32 to 1; green, and 7·7 to 1; cured. This is an extraordinary result, even for the best of September milk. Reports show much attention to the improvement of the dairy-stock of Colorado, the Swiss cattle and Jerseys being the favourites. The latter predominate at the shows, and this youngest of the States even claims one of the champion cows of America in a Jersey at Boulder City, which,
on native pasturage only, made 3 lbs. of butter a day, on repeated trials.

The Pacific Railway was opened in 1869, and fifteen car-loads of butter formed a part of one of the first freight trains westward bound, shipped for consumption in the mountain territories and upon the Pacific Coast. Within ten years these territories became self-supplying as dairy districts, and Utah and the State of Nevada even exporters of butter.

Montana is one of the most remote territories, lying upon the northern boundary of the United States between latitude 45° and 49°. The nature of the country is implied by its name; within its limits are the sources of the Missouri River. It was settled as a mining country, but wool-growing, cattle-raising, and dairying have become leading industries, induced by the fine pastures of the high valleys. One of the favourite spots is Smith River Valley, having about the same latitude with the City of Quebec, but an annual average temperature of 47° Fahr. This valley has an area of 800 square miles in luxuriant grasses, capable of sustaining 1,000,000 head of cattle. A young man, raised as a dairyman on the Western Reserve of Ohio, after trying mining for several years in Montana, located in the valley named, in 1871, hired 21 cows, and started a cheese-dairy. At the end of the first season he purchased his cows from his profits, added to his stock, and in the season of 1877 made 100,000 lbs. of cheese. This readily sold at 20 cents a pound in the mining settlements. His dairy has grown to a completely-equipped establishment; his greatest difficulty is in finding competent assistants, although he pays 40 dollars per month and board for common milkmen. As to the cattle, Mr. Proctor says: "I turn them out in the autumn, cows, calves, and all, and let 'em rustle; I find them all fat in May. I only have to work half the year, and call this the best dairy district in the world." A dozen miles distant is an extensive butter-dairy; the owner puts up large quantities of "gilt-edged" butter in 10-lb. tin cans, and by holding till mid-winter, when the prices are highest, gets usually one dollar a pound. Good butter sells at an average of 40 cents a pound the year through. Yet cows in Montana cost only from 25 to 50 dollars each, and it does not cost as many cents a year for keeping.

California has already been named as one of the few States in parts of which, in 1870, by the census, the annual value of the dairy products exceeded 40 dollars per capita. The original American settlers in this State were of wandering frontier habits, and regarded the country, aside from occasional river-bottoms and a few small valleys near the coast, as sterile and without agricultural value. Walked in between the Sierra Nevadas and the Coast Range of mountains, the great interior valleys and plains, producing immense quantities of wild oats and indigenous grasses, were considered only fit for supporting a poor race of half-wild cattle, whose only value lay in their hides and tallow, sold to the few trading vessels that yearly visited the coast. So ignorant were Californians of the agricultural resources of their State, that as late as 1852 it was the general opinion of the people that, although immensely rich in minerals, it would always be impossible to support her then existing population of 200,000 without importing the greater part of the necessaries of life. See the following statistics of dairy development:

<table>
<thead>
<tr>
<th>Year</th>
<th>No. &amp; Cows</th>
<th>Butter Production</th>
<th>Cheese made</th>
<th>Milk Sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>1859</td>
<td>2,800</td>
<td>705</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>1860</td>
<td>2,000</td>
<td>3,000,005</td>
<td>1,343,659</td>
<td></td>
</tr>
<tr>
<td>1870</td>
<td>164,000</td>
<td>7,903,741</td>
<td>3,295,074</td>
<td>3,003,021</td>
</tr>
<tr>
<td>1878</td>
<td>350,000</td>
<td>12,000,000</td>
<td>5,000,000</td>
<td>5,000,000</td>
</tr>
</tbody>
</table>

The increase has been so rapid that the estimates for 1878, based upon State authorities, are believed to be considerably below the true figures.

California has an extreme length of 760 miles, and an average width of 260 miles; its soil and climate therefore vary greatly in the different sections. There are four great natural divisions of the State, as follows:—The North Coast district includes the valleys from the Coast Range of mountains to the ocean, north of Point Conception in Santa Barbara County (lat. 34° 12' N.), and is, on an average, 40 miles wide; San Francisco is near the middle of this district. Lying directly upon the Pacific Ocean, this district has a peculiar climate, the winters free from excessive cold, snow rarely falling below an elevation of 3,500 feet, and temperature seldom below 30° Fahr. Winters are frequent when no snow falls, and there are only slight hoar frosts in December and January. The first hay-crop is gathered in April; the general temperature from April to November ranges from
55° to 70°, and during this period strong north-west winds prevail all along the coast. These blow with great regularity from noon to sunset, day after day, and are often attended by dense fogs, which continue from 4 p.m. to 8 a.m. A large amount of moisture is thus precipitated upon the hill-sides and valleys next to the coast, keeping the grasses fresh until late in the autumn. This gives the north coast peculiar advantages for dairying, and the greatest production in the State is within this district, principally in the counties of Marin and Sonoma, north of San Francisco, and San Mateo, Monterey, and Santa Clara, south of that city.

The South Coast district is without the summer moisture described, but has instead periods of burning weather, not frequent, but occurring so often as to seriously affect vegetation and prevent dairying.

The Interior district is composed of the Sacramento and San Joaquin Valleys, extending north and south hundreds of miles, one being virtually a continuation of the other. The valleys are named from the two principal rivers, and the counties of the same names, with those of Yolo and Mereed, neighbouring, do most of the dairying in this district. The summers are too long, too warm, and too dry to be favourable to this industry, except in small well-watered valleys among the mountain-sides.

The Sierra Nevada district comprises the hill-sides and valleys in the mountains of this name, which form the eastern boundary of the State. There are really two parallel ranges of mountains, with numerous narrow valleys lying between and along their sides; these are very fertile, with excellent natural grass lands to an altitude of over 6,000 feet. The winters of this district are quite mild, although there are deep snows in places above an elevation of 3,000 feet; ice seldom forms over an inch in thickness. During the summer the days are temperately warm and the nights as cool as desirable; vegetation remains green throughout the season in the higher portions. In this district a system of dairying has been established resembling that of the Alps, and which is thus described:—The migratory dairymen of the Sierras have winter residences and the real homes of their families in the foot-hills, at about the altitude of Folsom, Latrobe, Jackson, and Oroville, and not far from these well-known places, within 100 miles of Sacramento City. Their summer homes and really active dairy-farms are high up on the summit of the Sierras, on the elevated plains, watered by living springs gushing out in secluded vales, and on the shores of the numerous lakes that abound in those regions. The foot-hill home, nestled in one of the cozy and picturesque localities so frequent in that section, forms the base of supplies and operations. In the early days of this mountain-dairy business, the establishment consisted of a plain, cheap, pioneer ranche house, with few, if any, outbuildings; a corral served to confine the stock at night, and they ran at large in the daytime, there being no crops to damage. Now the home generally shows thrifty enterprise and frugal prosperity. The early-day ranche has been succeeded by a well-cultivated farm, substantial farm-house, spacious hay and stock barns, with yards and feeding-sheds. The barren-looking hills bear rye, oats, barley, and such other products as will turn off the most food for the dairy-cows. The family vineyard and fruit orchard, with ornamental trees and shrubbery, make up the characteristic dairy villa of the Sierra foot-hills. The cows are generally from common stock, the American "natives" rather than the Spanish race, and now often show the good results of Shorthorn, Jersey, and Devon sires; the Devons are favourites in these establishments. The cows have their calves between February and the middle of April. The promising heifers are raised, all others turned off forveal. Until early in May, some of the dairymen make butter, and others cheese. About the middle of May, all things being in readiness, the dairy, including cows, herders, milkers, butter-makers, and all the necessary dairy tools and furniture, are started for the mountains. The owner and such of his family as intend to spend the summer with the dairy accompany them. Arrived at the place of destination, the spring is just opening, and the grasses are tender, luxuriant, and in great variety. Red clover, white clover, and the various California wild clovers, also nearly all the natural grasses of recognised value as forage plants, such as timothy, red-top, wild rye-grass, orchard-grass, bunch-grass, are found in abundance. Water for stock is pure and plentiful everywhere. The weather is cool and delightful, healthy and invigorating. The summer residence and the butter-house are put in order, and the business of the season commenced at once in
DAIRY FARMING.

earnest. Under such conditions the milk comes up to the utmost capacity of the cows, the cream rises rapidly and completely, the butter "comes" readily, and is of the very best quality, if from good makers. The milking begins at 4 a.m., and again at 6 in the evening. The churning is done every other day, usually in large rectangular boxes hung in frames at opposite corners and turned over and over by a crank. The butter is packed in kegs of white fir, which impart neither taste nor smell to their contents. The location is a most fortunate one, not only as a producing district, but for markets as well. Being on "the divide" between the mining settlements of Nevada and California, steady demand for the butter exists on either side. The bulk of the butter is sold as fast as made for immediate use, the surplus generally packed and delivered upon contract for winter consumption. The season lasts from May to November, when the campaign closes, the cows are driven down before the snow begins to fly upon the mountains, and the party goes into winter quarters. The cows are generally allowed to go dry when thus brought in, and so remain till about February following. They are kept upon the dry feed of the meadows and stubble till the rains set in, when all are fed on hay and other forage till the early grasses make their appearance after the first rain. These grasses, and such green crops as are often provided in addition, help materially in wintering the cows, and bringing them out in fine condition for the operations of the next season. The first experiments in this new enterprise were made about 1870. These proved so successful and profitable that they were followed up by the enterprising pioneers of the business, and others followed suit, until in 1880 the migratory dairies of the Sierra foot-hills and summits are not only numerous but extensive, and their owners are among the wealthiest dairymen in California. These dairies are most numerous in Lassen County, although they are scattered northward to Siskiyou and southward to Mono, a region 300 miles in length. All along are numerous small lakes, kept full by the melting snow from the high peaks around them, and from which flow the many rivers and creeks into the valleys below. The borders of these lakes and valleys of the streams constitute a district unequalled for grandeur and beauty of scenery, elasticity of climate, variety and excellence of vegetation. As a rule each dairy occupies a little valley of its own, surrounded on all sides by high mountains covered with fir and yellow pine forests, and of a size sufficient to support a herd of from 80 to 120 cows. In Lake Valley on the shores of Lake Tahoe, on a tract 15 miles long and 8 miles wide, are thirteen dairies of about 150 cows each, having one owner, but leased separately by the season, at from 20 to 30 dollars per cow, depending on the quality of the stock and the completeness of the dairy equipment.

The Interior district of California contains large areas of a swampy nature, fresh-water tide lands and such as are periodically overflowed by the mountain torrents, and so remain for some time. These are known as the Tule lands, and are largely of a peaty formation. Their moisture ensures a natural verdure during nine or ten months in the year, including eleven different kinds of native clovers and nutritious wild grasses; and about as many more of the well-known cultivated grasses, including alfalfa, have been successfully tried for permanent additions to the dairy pastures. By inconsiderable outlay for sheds and dry sleeping-places for the cattle, and provision for feeding ten or twelve weeks in the year, these tule lands become available for dairy purposes. The trials have been so satisfactory that at some points extensive works are in progress, combining systems of dykes, reservoirs, and irrigation, intended to utilise these apparently waste lands, and establish successful dairies within very short distances of many large towns and cities.

The North Coast district was the scene of the first dairying operations in California, the pioneer establishments being started in Marin and Sonoma Counties about the year 1855. Some of the early proprietors have enlarged their business until the magnitude attained is something remarkable. In July, 1857, the firm of Steele Brothers was formed; they first bought 200 "American" cows at from 75 to 125 dollars a head, and established themselves on the peninsula of Point Reyes, in Marin County. There they secured an annual average money yield of 64 dollars per cow. In 1863 the firm sold out at Point Reyes and moved to San Mateo County, established the Pesadello ranch of 15,000 acres and stocked it with 1,500 cows; 1,100 of these were bought at 15 dollars a head, delivered at the ranch, and the rest in Sonoma at 11 dollars a piece.
Two years later, Knight's Valley ranche of 7,000 acres, in Napa County, was added to their possessions; and in 1866, going 150 miles farther south into San Luis Obispo County, they purchased Corral de Piedra, a tract irregular in shape, some 20 miles in length, and averaging $\frac{1}{2}$ miles in width, an area of about 45,000 acres. The herds of this acquisition included 5,000 cows. The Messrs. Steele still hold these estates, and they are mainly devoted to dairying. Similarly, Messrs. Howard and Shafter, present owners of the Point Reyes tract, are proprietors of 100,000 acres of dairying property in Marin County, upon which they keep in all at least 6,000 cows. The estate is divided into dairy ranches, located at convenient distances for the pasturage and care of stock, and subsist on an average 180 cows each. These ranches are leased for a term of three years, the owners furnishing cows, buildings, dairy fixtures, and lime, lumber, &c., for repairs. For some years prior to 1879 the usual rental was 27 dollars per cow. The tenants also contracted to raise annually one heifer-calf for every five cows, and at expiration of lease to make good any loss in cows received; then, if there were any surplus animals raised by the tenant, he received 10 dollars per head therefor, and they remained on the ranche. The tenant may raise forage for his team, roots for the cows, fruit and vegetables for his family, and poultry for home use or market. The income of tenants making butter alone, and converting the skim-milk into pork, has been estimated at from 75 to 80 dollars per cow, in gross—the price of butter reckoned at 38 cents for the year. One of the most successful tenants on this estate has been a Swede, who managed two ranches, including 500 cows, and made both butter and cheese, getting 10 cents for the skim-cheese in San Francisco when about eight days old.

Cheese-factories succeed as far south as Los Angeles, in the South Coast district, but the locality most noted for the excellence of this product in California is Santa Clara County. The "Bloomfield Factory," near the town of Gilroy, is a type of several in that vicinity. It is upon a ranche of about 1,000 acres, 675 acres in pasture, 43 in grain for hay, 30 in sowed maize, 15 in beets, and 15 in squashes, or pumpkins. The dairy is of 225 cows. The soil is rich, and the growth of green feed unsurpassed in its season. Aside from the pasture, many acres partake of the moist character of the valley lands, and give immense yields of the crops named, grown for extra feed for the cows. The arrangements are such that at no time is it necessary to use dry feed alone. The cows come in mostly in January; from this time until March the pasture-grass is so wet and rank that one feed of hay is given. From March till July the pasturage is perfect. In July sowd corn (maize) is fed, and in some cases the milk from 100 cows has been thereby increased 300 lbs. a day; this constitutes the extra feed till August. Then beets are added, and in September hay also. From September to January, hay, cured maize, beets, and pumpkins. A barn, 162 feet long and 40 feet wide, has stanchions for 100 cows, the animals remaining in it only while being fed and milked; there is also ample storage for cured fodder. The factory buildings are of the usual pattern; the season commences in February and runs to September; the cheeses made weigh from 24 lbs. to 30 lbs. each, which is a favourite size in California.

At Bruno Station, in San Mateo County, there is a milk farm of 2,300 acres in one body, stocked with Jerseys, 600 in number, including the grades; the proprietor ships an average of 750 gallons of milk daily to San Francisco, and from a city depot of his own delivers directly to the consumers. In different parts of the dairying sections of California, herds of 100 to 400 cows in the hands of one owner or lessee are very common, and land being abundant, 6 to 12 acres are allowed to a cow. From the first settlement of the State until 1878, the prices of dairy products ranged high; good butter sold at from 1 dollar down to 50 cents a pound, and cheese at from 50 cents to 20 cents. In 1878 the retail prices in San Francisco, for home products, fell to 40 cents for butter and 15 to 18 cents for cheese.

The following is a curious instance of the profits of dairying in the early days of the mining excitement in California. In December, 1851, a shrewd Yankee at Ophir, in the Sacramento Valley, procured two American cows at a cost of 400 dollars, and set up business. The cows averaged 24 quarts a day for two months, which he readily sold at 50 cents a quart; income for the two months, 720 dollars; total cost of keeping, 100 dollars. The next two months the yield fell off somewhat, but the cost of feed decreased steadily also, and so the profits continued about the same several months.
In the years 1877 and 1878 a beginning was made in establishing a market for the dairy products of the Pacific Coast in Siam, China, and Japan; although the exports thence were not large, they steadily increased. There were received at San Francisco, during the year 1877, 11,927,200 lbs. of butter and 7,008,349 lbs. of cheese, and exported, 231,400 and 193,000 lbs. respectively.

California has thus been given a prolonged description; but it must be recollected that this is a great State, larger than the combined areas of all the New England and Middle States, almost equal in extent to France, and with natural resources commensurate with its territory.

Far-distant Oregon must not be omitted from the list of the dairy districts of America. As yet comparatively undeveloped in this industry, the following figures show a growth which, if continued, will command greater attention in the future:

<table>
<thead>
<tr>
<th></th>
<th>1850</th>
<th>1860</th>
<th>1870</th>
<th>1875</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (No.)</td>
<td>13,294</td>
<td>52,465</td>
<td>90,923</td>
<td>104,929</td>
</tr>
<tr>
<td>Cattle (No.)</td>
<td>41,729</td>
<td>154,131</td>
<td>176,197</td>
<td>276,466</td>
</tr>
<tr>
<td>Hay (tons)</td>
<td>373</td>
<td>27,986</td>
<td>74,437</td>
<td>161,433</td>
</tr>
<tr>
<td>Cheese (lbs)</td>
<td>39,800</td>
<td>105,349</td>
<td>70,233</td>
<td>190,884</td>
</tr>
<tr>
<td>Butter (lbs)</td>
<td>211,944</td>
<td>1,900,157</td>
<td>1,418,373</td>
<td>1,555,298</td>
</tr>
</tbody>
</table>

The milk-cows enumerated in 1870 were 48,325, and in 1875, 76,400. The estimate for 1880 is 120,000 cows, population 175,000. The State has an area of 95,000 square miles, a mean temperature of 52°, and a large proportion of valuable agricultural lands.

Canada may be properly included among the dairy districts of America, although this industry is prominent in only a small portion of the whole territory of the Dominion. Ontario, the most fertile and most densely populated province, resembles some of the best dairying regions of the United States in soil and climate, and is the scene of the most active and successful Canadian dairying. The statistics show a considerable manufacture of butter for 30 years, and no remarkable increase therein; yet it is noticeable that while between 1852 and 1871 the increase in the number of cows in Canada was 77 per cent., the butter product increased 134 per cent. Cheese-making has been the branch which has experienced the most wonderful development. In 1861 less cheese was made than in 1852; the census shows 4,500,000 to 5,000,000 lbs.

to be the annual crop during that period. In 1871 the cheese product exceeded 22,000,000 lbs., and the 1880 crop is estimated at 60,000,000 lbs. Prior to the year 1865 Canada consumed large quantities of dairy products from the United States, importing cheese by the million lbs. In 1880 the exports of cheese from the Dominion will reach 45,000,000 lbs. The abrogation of the Reciprocity Treaty seems to have given the first impetus to Canadian cheese-making, particularly in Ontario. Under the patronage of the Hon. Robert Read, the first cheese-factory was built at Front-of-Sidney, and began operations in 1866. The census of 1871 reported 333 such establishments in the Dominion, and in 1879 the number was placed at 500, three-fourths of them in the province of Ontario. These are mainly joint-stock concerns, although some are proprietary, where the cheese is made at a fixed rate per lb. from any milk brought to the factory. In 1868 the Canadian Dairymen's Association was formed, and three or four years later, in the eastern part of the province, they organised the Ontario Dairymen's Association. These two organisations were consolidated in 1873 and became the Dairymen's Association of Ontario, meeting in turn, twice at Ingersoll and once at Belleville. This arrangement did not prove advantageous, and the union was dissolved in 1877. Since that time Eastern and Western Ontario have had separate associations, with headquarters at the two places named. Both organisations hold annual conventions lasting two or three days, including shows of dairy products; both issue annual reports, and each receives a Government grant of 1,000 dollars a year.

The first president of the united society was Thomas Ballantyne, M.P.P., of Stratford, Ontario, who won the first honours for Canadian cheese at the Philadelphia Show of 1876, and at New York in 1878. Mr. J. Carruthers Hegler, of Ingersoll, has proved an indefatigable secretary to the Western Association from the start, and among the most active members have been Messrs. E. Caswell and C. E. Chadwick, of Ingersoll. The Eastern Association, during its separate existence, has found efficient officers in Messrs. K. Graham, of Belleville, P. R. Daly and Harford Ashley, of Foxboro, and H. Farrington, of Norwich. Harvey Farrington, formerly of Herkimer County, New York, was one of the pioneers in associated cheese-making in Canada, and performed valu-
Influence of Pasturage.

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able service; he died in December, 1878. At the annual meeting in February, 1876, the subject of butter-making was the specialty considered, and a practical result was the establishment of the first butter-factory in Canada, the same year, at Hungerford, Hastings County, Ontario.

The St. Lawrence River is the natural outlet for the surplus dairy products of Canada, and the Montreal market an interesting point. The receipts of cheese for the four years beginning with 1872 and ending with 1875, in boxes averaging 65 lbs. each, were as follows: 195,031; 375,093; 383,711; 518,140. This shows an increase of 22,500,000 lbs., or 178 per cent. in four years. During the same period the receipts of butter increased from 142,350 packages in 1872, to 157,097 in 1875, or 24 per cent., the average weight of butter packages being 100 lbs. The discrepancy between the above and the larger figures previously given for the total Canadian productions may be accounted for by the fact that during some of the months when trade is quite active the St. Lawrence is closed to navigation, and large shipments go to Portland, Maine, by the Grand Trunk route, while more or less is always forwarded from Western Ontario over the railways of the United States.

There is, however, a steady tendency towards direct shipments from Canada to Great Britain. When the Dominion ceased to import dairy products and began exportation, most of the butter and a large part of the cheese went to the States. In 1868, of 10,500,000 lbs. of butter exported by Canada, nearly 6,000,000 lbs. were sent to the United States, and of 6,000,000 lbs. of cheese, more than one-eighth also went there. But in the year ending June 30, 1880, of 19,000,000 lbs. of butter exported, the United States received only 564,000 lbs., and of 43,000,000 lbs. of cheese, but a little over 1,000,000 lbs., or about one-fortieth. A full table of Canadian dairy exports is given later.

Climate and soils have been incidentally mentioned in the foregoing description of dairying districts, and about enough said on those topics. In general terms the dairying of America is carried on between the isothermal lines of 45° and 62° Fahr., the mean temperature of the best regions being about 50°. Excepting the Pacific Coast and the Southern States, the average annual rainfall in the same districts ranges from 40 to 47 inches. A dozen conspicuous points of observation, well scattered, show the following results for a term of years: Boston, 44; New York, 45; Philadelphia, 43; Washington, 40; Cincinnati, 47; St. Louis, 42; Charleston, South Carolina, 45; St. Augustine, Florida, 32; Mobile, Alabama, 64; New Orleans, 51; Portland, Oregon, 39; San Francisco, 23. In the primitive modes of dairying, climate, water, and soil had a controlling influence upon the quality of the products, but with the varied artificial means brought into use natural deficiencies are often made good. The only obstacle to dairying in America now regarded as insurmountable is intense and long-continued heat, for although this may be guarded against, so far as the care of the milk is concerned, the effect during its secretion and before it is drawn from the cow cannot be reached. Such heat, however, as already noted, is experienced in a very small portion of the territory of the United States.

Grasses have also been incidentally referred to, but they require more attention. Of the several thousand varieties of grasses known to botanists, about twelve hundred are found in the United States, and of these, again, nearly two hundred in the older dairying districts. But not more than twenty-five varieties are known to the agriculture of the country, and hardly a farmer uses or recognizes on his farm more than half a dozen kinds. With variety so desirable for the permanence and value of the pasture and the quality of hay, it would seem that the American dairyman might well consider the introduction of new grasses, and the domestication in parts of the country where they are now unknown of some of those wild varieties which are found thriving in other sections. Some of these are believed to be of great value.

The grasses in most favour with American dairymen are nearly all well known to the agriculture of Great Britain and continental Europe. Among these are the following varieties, some of which are elsewhere treated of in this work:—Timothy (Phleum pratense), Red-top (Agrostis vulgaris), Blue-grass (Poa pratensis), Perennial and Italian Rye-grasses (Lolium, Perenne, and Italianum), Orchard-grass (Dactylis glomerata), Rough-stalked Meadow (Poa trivialis), Fowl Meadow (Poa scrota), Sweet-scented Vernal or May grass (Anthoxanthum odoratum), Meadow Fescue (Festuca pratensis), Tall Oat-grass (Arrhenatherum arenaceum), Meadow Fox-tail (Holcus pratensis), Reed Canary (Phalaris arundinacea),
Blue Joint Grass (*Calamagrostis canadensis*), Velvet Meadow-grass (*Holcus lanatus*), Annual Spear-grass (*Poa annua*), and Wire-grass (*Poa compressa*).

Timothy is very generally the mainstay in those sections where the hay-crop is of importance. It is cultivated with ease, and on strong and rather moist soil has been known to yield four tons to the acre of the best quality of hay. It enters largely into almost all mixtures on American dairying lands for pasturage or mowing.

Red-top, Fine-top, or Fine-bent is almost as commonly used as Timothy, but good judges believe that its value is overrated in America.

(The name Herb's-grass is applied to Red-top in Pennsylvania and States farther south, while Timothy is known by this name in New England and the Middle States.)

Orchard-grass, or Rough Cook's-foot, on the other hand, although generally a favourite with those who have tried it, is not as largely used as it deserves to be. Properly treated, it has proved a success in almost all parts of the United States. It is one of the most abiding of the cultivated grasses, palatable to stock of all kinds, makes excellent hay, is two weeks earlier than Timothy, and preferable to it for growing with clover, because ready to cut at the same time, endures considerable shade, resists drought (which kills Blue-grass and Timothy), is one of the best grasses for soiling, for pasture gives an earlier bite in the spring than any other grass except the Meadow Fox-tail, affords an amount of aftermath exceeded only by the Kentucky Blue, and continues to send out root-leaves until very late in the autumn. One author, in writing of the surprising rapidity with which it springs up after mowing or close cropping, remarks that these circumstances verify Virgil's description:

"Cool dews restore, beneath night's transient hours, All that the herd each livelong day devours."

In fact, five or six days' growth in summer suffices to give a good bite. Its disposition to grow in tussocks is easily remedied by proper treatment, one satisfactory method being to use with it a mixture of blue grass and red clover. It flourishes upon a variety of soils, over an extensive territory, and with its long list of virtues may safely be placed among the most valuable of grasses in American dairy districts.

The Sweet-scented Vernal-grass is regarded of special service as an element in dairy pastures because of the fine flavour it imparts to butter. In some sections, as for instance around Philadelphia, the high reputation of the butter is believed to be largely due to the abundance of this grass. "The ripe harvest of the new-mown hay gives to the air a sweet and wholesome odour" just about in proportion to the presence of this variety among the grasses cut. It is also desirable for its specially early and late growth. It finds a place readily in any pasture, occupying vacant spaces, but never crowding other grasses, and its seeds retain their vitality so long in the soil that once introduced it springs up whenever it is given a chance. Although not classed among the highly valuable grasses, this variety is prized in the Eastern and Middle States for these special attributes. Yet it is unknown to many of the dairying districts of the United States.

Only one other of the grasses named in the list needs special mention. The *Poa pratensis* of the botanist has obtained a very wide reputation as the Kentucky Blue-grass, and led many into the mistaken belief that it was a peculiarly American grass, confined to the famous pastures of the region whence it derives this name. On the contrary, it is one of the most common grasses in nearly all parts of the country, being variously known as June-grass, Green Meadow-grass, Common Spear-grass, and Rhode Island Bent-grass.

And it is the well-known Smooth-stalked Meadow-grass or "Greensward" of England (Plate 3, Fig. 7). There is no grass which accommodates itself to any given locality with greater facility, whether it be the Mississippi Valley, New England, Canada, the shores of the Mediterranean, or the North of Russia. It is found thriving upon gravelly soils, alluvial bottoms, and stiff clay lands, in the permanent pastures of Missouri, and along the roadsides of Minnesota. Soil and climate cause great variation in its size and appearance, and this protean habit accounts for the various names by which it is known. It probably attains its highest luxuriance and perfection as a pasture grass in its apparent home, the far-famed blue-grass district of Kentucky, and it may be well to describe it as seen there:

"Surely you have heard Of the fair plains where the sweet grasses grow, Just grass, naught else; and where the noble herd Of blooded cattle graze, and horses bred..."
For victory—the rare Kentucky speed that wins the race.
The lovely rolling land of the blue-grass,
The wild free park spread out by Nature's hand,
That scarce an English dukedom may surpass
In velvet beauty—while its royal sweep
Over the country miles and miles away,
Dwarfs man-made parks to toys; the great trees keep
Their distance from each other, proud array
Of single clumps that stand apart to show
How gracefully their swaying branches grow;
While little swells of turf roll up and fall
Like waves of summer sea, and over all
You catch, when the straight shafts of sunset pass,
Lighting up all the lances of the grass,
The steely glint, the blue of the blue-grass."

The central part of Kentucky, an area of
15,000 square miles or more, over limestone formation, seems to be the richest portion of the blue-grass country. There its seed-stalks are 2
or 3 feet high, with several long parallel-sided blades to each plant, and radical leaves often numbering thirty to a stalk. The stems are
slender, smooth, and round; the flower-clusters often have five or seven bunches from the same point, and the spikelets are one-tenth to one-sixth
of an inch long, three to five flowered. The root
is perennial, and throws off numerous and long
creeping root-stocks, enabling it to form a dense
matted turf. The general appearance of the plant
is shown in Fig. 210, also the form of the
spikelet, magnified. The chief reputation of
the Kentucky Blue is as a pasture grass; the sod is easily obtained and very enduring, there
being no such thing known as its running out on
good land. Pastures sixty years unbroken afford
their owners an annual profit of at least ten
dollars an acre. It starts very early in the spring,
and grows rapidly after being grazed off; it will
furnish more late feed than most grasses, and no
amount of pasturing is sufficient to utterly destroy
it. Eaten until no appearance of it is seen on
the ground, the earth in a few days is again
covered with the soft green foliage. It endures
the frosts of winter better than any other grass on
the continent, and therefore pushes its way northward into the Arctic Circle; if allowed to grow
rank in the fall months, it will turn over and hide
beneath its covering luxuriant croppings, often
available in the mild winters of Kentucky and
Tennessee. An eminent cattle-breeder in Ken-
tucky wrote: "Whoever has limestone land has
blue-grass; whoever has blue-grass has the basis
of all agricultural prosperity; and that man, if he
has not the finest horses, cattle, and sheep, has no
one to blame but himself." Severe droughts injure
blue-grass, yet it grows as far south as the hilly
parts of Georgia and Alabama, and in Arkansas;
not, however, as vigorously as farther north. In
seasons of drought it is usual to leave it unpastured or but lightly cropped, where fully
exposed to the sun during the months of July and
August. But the grass thus left, although it
often becomes dry enough to burn, is greedily
eaten by stock; it dries full of nourishing prop-
erties, and cattle will fatten upon it, unless it
has been drenched with rains. It makes little
growth during the hottest weeks, unless there is
an unusual amount of moisture in the soil, but
the 1st of September a strong second growth commences, which continues till the ground is frozen.
Blue-grass exerts a truly wonderful power on the
animals that feed upon it. The exact causes that
produce these striking results are not traceable.
According to the tables of analysis, several other
grasses should be more valuable, but the force and the uniformity of the operation of blue-grass feeding are matters of experience, and their existence cannot be questioned. When used for hay it is cut just as the seed begins to ripen, and if well cured it then makes excellent feed, and is highly relished. Blue-grass cannot be recommended for the meadow, as it is hard to cut and difficult to cure; the foliage is too short and too light after being dried. It is an excellent grass for lawns, as it makes a dense, uniform mat of verdure, and sends out but one flowering stem a year; for this purpose it is thickly seeded and kept closely mown. The lands most productive of blue-grass are calcareous. Lime seems to be a natural stimulant to it, and it flourishes best where this is abundantly supplied by nature. In a pasture that has an occasional outcropping of limestone, the sprigs of grass surrounding the rock are found more luxuriant than anywhere else. But it is far from true, as sometimes asserted, that blue-grass flourishes only in a limestone country; in parts of Ohio, where the geological formation is the same as that of Central Kentucky, the blue-grass does not do so well, while in other parts of Ohio it is as luxuriant as in its best estate, and yet the bouldered limestone there lies beneath 100 feet of drift. And pasture lands abound in all the States adjoining Kentucky, especially Ohio, West Virginia, Virginia, Tennessee, and Missouri, which carry a magnificent blue-grass sward.

From the foregoing it will be understood that in the older parts of the country, where American dairying was first developed, and throughout the sections mentioned as most actively engaged in this industry, up to 1881, the climate in general is such as to permit the adaptation of those species of grasses which are known to the agriculture of England and Europe. But for a large part of America, different species are necessitated by the climatology of the country; those of English origin, at least, and those best suited to the Northern and Eastern States, cannot go into the plains and arid districts of the West; and they generally fail in the humid climate of the South, when the mean temperature of the summer months attains to 80°.

For the West, such species, new to agriculture, have been abundantly provided, and the American interior presents an interesting field for gramineous study. The native species of the prairie districts of the States bordering on the Mississippi River include many of value, well adapted to this intermediate climate. The turf of this prairie growth is very strong, enduring in its native state, and made excellent dairy pasturage during the period of settlement. But most of these grasses give way at the approach of cultivation, and will hardly be domesticated, the " tame" varieties generally being substituted.

Between the Rocky Mountain ranges and the Missouri River lies the great plains region. Of the grasses indigenous to that region 143 species have been named, belonging to 57 genera; 91 varieties extend across the Missouri River, some of them eastward to the Atlantic, but 52 species properly belong to the plain and mountain districts. Some of these are singular in all respects. The larger part of these 52 species could be dispensed with without material injury to the grazing interests of the country; some are entirely worthless, and many of little value compared with others. On "the Plains" three species far exceed all others in value; these are Finger-spiked Wood-grass (Andropogon farctus), the Purple Wood-grass or Broom-grass (Andropogon scoparius), and the Indian-grass or Wood-grass (Sorghum nutans). "In all the eastern portions of this district they comprise at least three-fourths of the grazing resources. Next to these in importance is the Strong-scented Vilha (Sporobolus heterolepis). This species is peculiarly palatable to cattle, and they are seen roving over rich pasture of other species in search of it. This is, in a great measure, the winter forage species in Kansas, where it abounds. It flourishes chiefly on the moister portions of the plains, and many local areas are almost exclusively occupied by it." These are specially sought after for dairy locations. All four of these species are found eastward as far as the Atlantic, but are regarded as of little value east of the Mississippi, even classed as "remarkably worthless" by eminent writers, while in the prairie and plains country they not only predominate in pasturage, but are the chief dependence for "wild" hay.

In the Rocky Mountain region the three species of wood-grass named above are exceeded in quantity and value by but one, the Sheep's Fescue (Festucu orina). This is common to mountains and plains, extending north-eastward to New England, but varying much in form
THE BUFFALO-GRASS.

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according to locality, and often having such sensitive constitutional qualities as to make artificial treatment impossible. In the mountain region it is the most valuable of the abundant grasses, and esteemed highly nutritious, notwithstanding the hard wire-like appearance of its leaves. It there grows chiefly in bunches with erect, stiff culms, attaining in favourable places a height of 2 feet.

Equal in value is the largest and best of the "Gama" or "Gramma" grasses peculiar to this region; it is known as Mezquit in Texas and Mexico, and as Perennial Bunch Grass in Montana. It is the Bontelona oligostachya of the botanist, and desirably only for grazing, as it grows too thin and too short for hay. The usual height is from 8 inches to 1 foot. It grows in small bunches, close and fine, has a solid stalk, and the head is well filled with small, firm, nutritious seeds. It shoots from the root very early in the spring, is unaffected by frosts and frequent rains, and when exposed to the hot sun it soon ripens, is cured thoroughly in early autumn, and then affords an unharvested forage which unites with all the desirable qualities of good hay the fattening principles of grain. The A. farcatus, A. scoparius, and the S. nutans are also important grasses among the Rocky Mountains.

The noted Buffalo-grass (Buchloë dactyloides), also called "Small Gramma," is common to both plains and mountains of Western America, found as far north as the British possessions, rarely, if ever, east of the 98th meridian, and extends indefinitely south-westward. This little plant, insignificant in a single specimen, was the favourite herbage and chief subsistence of the immense herds of buffalo in former years; but with the disappearance of those animals, and the advent of civilisation, the grass has receded westward, being found at its eastern limits in small, distinctly outlined patches a few feet in diameter. An excellent representation of this interesting grass is herewith given, of its natural size. For a long time it was a puzzle to botanists. Abundantly provided with runners as a means of spreading, and with no seeds visible, it was thought to have only abortive flowers. Then male and female flowers were found on separate plants, and these, so unlike, mistaken for different species. In its best estate, however, the same plant produces both male and female flowers, although as distinct as the tassel and ear of maize.

The growth is low, dense, and tufted, attaining a general height of less than 4 inches, except the male flower-stalks, which often run 2 or 3 inches above the leaves, terminating in a few flat spikes, as shown in the engraving. The female flowers are clustered close to the earth, and surrounded by a leafy covering, which, as the seed ripens, becomes hard and shining. The roots are strongly interlaced, all near the surface; the leaves narrow, and after the growing season

Fig. 211.—Buffalo-grass.
curled and twisted into a closely matted mass, forming a compact turf which withstands excessive drought. The plant seems to require moisture only during the growing season, and this varies with the climate. It thrives, therefore, in all parts of the south-west, where there is a rainy period at any time during the year. Upon a very thin, poor soil, and one saturated with alkaline matter, it flourishes as well as upon better food. Through the dry season it remains in the curled, dry form, but preserving all its nutritive qualities; in the winter, an examination shows the stolen to be still green. So, where the ground is scantily covered with these

brown, crisp bunches, to all appearance useless, the cattle feeding thereon are sleek and fat. Whether the Buffalo-grass can be utilised in the South-eastern States, is an important question not yet determined, and it must be done soon, if ever. In experiments it has been successfully cultivated east of the Mississippi, and flourished finely for a time, but, unable to compete with stronger intruding neighbours, it was overrun and disappeared. As an instance of its tenacity of life, it withstood the treading of the animals in a farmer's feed-lot, when every other green thing had been destroyed.

The Southern States, by their climate, water, and other natural facilities, tend toward the development of a winter dairying region. And the condition of Southern agriculture demands the incorporation of some feature in their system, by which crops for the improvement of the soil shall receive as regular attention as crops for sale. First among such crops are the artificial grasses. Both these causes stimulate a search for grasses fitted for the humid districts of that section. That the greater part of the South was once covered with a carpet of nutritious grass, as Texas is still, is beyond a doubt. Certain grasses were then natural to Southern soil, but nearly all of those have disappeared, the result of continual, injudicious grazing, and of an exhaustive system of cultivation. Under favorable conditions, the standard English and Northern grasses can be used to some extent in the Southern States; the habits of the plants are changed, however, and winter becomes their growing season. But winter grasses alone will not answer, and, as a rule, success does not attend the introduction South of grasses from colder and drier climates. Southern agriculturists seeking grasses that will live and grow all the year round, naturally turned their attention towards semi-tropical sources, and have received the greatest encouragement therefrom.

Bermuda-grass (Cynodon dactylon) has proved the most satisfactory in the South for all soils and difference of humidity and temperature. Regarded as a pest at one time, because of its powers of rapid spreading and tenacity of hold when once established, it has come to be regarded as a blessing. It was the terror of cotton-planters; where it took possession the owner found he must raise live stock or abandon the land. But the grass was found to improve worn soil, the animals helped still more, a little watchful care kept the cotton-fields free, and thousands of acres have been therefore stocked with it in Georgia and the Gulf States. The accompanying sketch, about half the natural size, shows the form of the plant and its habits of growth. The most striking thing about Bermuda-grass is its strong stems, or runners, which extend upon or just below the surface in every direction; single shoots run 10 feet in a season on good soil. It has been known to throw its runners over a rock 6 feet across, and soon hide itself from view. The
joints in the stems are about 2 inches apart, and at every one roots are put out and stems thrown up which bear the foliage and flowers. The upright stems are slender, the leaves narrow and delicate, and produced in spikes which radiate from the top of the stalk. Seeds are rare, and not an article of commerce. The plant is propagated by cuttings, is sometimes chopped up, the pieces scattered broadcast and then rolled, and sometimes sod is cut into small pieces and planted in hills like potatoes. It will live on land so poor as to be incapable of supporting other grasses of value, although its worth is as the soil it grows on. Left uncut and unpastured below the mountainous parts of the Southern States during the summer and autumn, although the ends may be nipped by frost, there is sufficient green grass underneath to feed stock during the winter. In the moist bottoms of Louisiana, on the dry plains of Texas, among the sandy hills of Virginia, the Carolinas and Tennessee, it seems equally at home and indestructible. It has the capacity to withstand any amount of heat and drought, and in months that will check blue-grass, if not kill it, the Bermuda keeps up its pale-green colour, despite the burning suns. It grows luxuriantly on the top of Lookout Mountain, at an altitude of over 2,000 feet, where the winters are excessively cold for that latitude. Cattle and horses are very fond of Bermuda, prefer it to clover, and thrive upon it, and hogs feed upon its succulent roots. No other grass will, in the same climate, yield as much grazing, and for this purpose, taking the whole year into account, it stands unrivalled in the Southern States. On rich land it grows tall enough to cut, and makes hay of the very best quality in large quantity. At a State fair in Georgia, the premium bale of hay was made from Bermuda-grass. At Greensboro, Georgia, in 1872, one acre of Bermuda, good soil but not manured, made 5½ tons of hay, which sold for 114 dollars. At another place in the same state, there is authentic record of 16 tons of Bermuda-hay being produced from an acre by the use of nitrates and alkalis. It is said that one hundred pounds of the grass, as cut, afford over fifty of hay, and five tons of hay per acre is regarded as the regular crop. The plant will take hold upon the sides of the steepest gulley and stop its washing; hence it is advantageously used to bind the levees on the banks of the Mississippi, and also the embankments of railroads. It does not thrive in the shade. It is a native of the West Indies, and was introduced from Bermuda into South Carolina and Mississippi, early in the present century.

Among other foreign grasses which are found desirable in the South are the Guinea (Sorghum vulgare) and the Tall Meadow Oat-grass (Arrhenatherum arenicola); and of the natives which serve a useful purpose, the Wild Rye (Elymus Virginicus), Crab-grass (Panicum sanguinale), and the Broom-grass or "broom-sedge" (Andropogon scoparius).

The standard grasses of the Northern and Eastern States are available for the northern portion of the Pacific Coast, and the mountainous territories. The Red-top is very much at home in Utah, Nevada, and Montana, grows luxuriantly on alkaline soils, and upon land never broken yields enormous crops. In the southern part of the Pacific slopes, and especially in California, valuable native grasses exist. The bunch-grass (festuca) is abundant on the upland slopes and valleys, and is there, as everywhere, of great value. The gramma and similar grasses also abound. In the lower plains and valleys, oat grasses and annuals form a larger share. Several varieties of the Alfalfa family (medicago) are indigenous to this section, being generally known as "the Californian clover." The tendency of the climate is towards a less permanently perennial character in most of the grasses of this section, and they often assume graminaceous forms. Some writers describe deposits of seed upon the ground in parts of California, so abundant that animals can feed upon it, like threshed grain.

Wherever in America grasses are valued and cultivated, the clovers are also used and valued. White clover (Trifolium repens) has always had many enemies, but the general verdict is that it is one of the most indispensable of the pasture plants, in all parts of the country. It seems especially at home in the Blue-grass region, and well to the South, being an excellent companion of Bermuda-grass.

Red clover (Trifolium pratense) was introduced to America late in the eighteenth century, appearing first in Pennsylvania. Its use is now almost universal, and in some sections it is regarded as the corner-stone of agriculture. It does not succeed as far South as the white clover, but flourishes wherever wheat can be successfully grown.
DAIRY FARMING.

Alsike clover (Trifolium hybridum) has been received with favour in some of the dairy districts, chiefly as a soiling crop, but it is not extensively used.

Alfalfa or Luceerne (Medicago sativa) proves in America its origin as a child of the sun, and revels in a heat destructive of all other species of clover and of most grasses. Cultivated for green fodder, this plant is destined to be a great blessing to the agriculture of the Southern States, and in the arid districts of California it is largely used and highly prized. It has been grown successfully also in different parts of Canada.

The hay crop of the United States was compared with other staples in Table No. 3. Some additional facts may be interesting. The annual hay product of the country has been reported by the census as follows:—

<table>
<thead>
<tr>
<th>Year</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1860</td>
<td>10,248,168</td>
</tr>
<tr>
<td>1875</td>
<td>13,838,642</td>
</tr>
<tr>
<td>1889</td>
<td>19,083,896</td>
</tr>
<tr>
<td>1876</td>
<td>210,000,000</td>
</tr>
</tbody>
</table>

The figures for 1879 represent the estimate of the United States Department of Agriculture, and the general average given is 14½ tons to every 100 acres of mowing. The hay crop of the United States is worth over 300,000,000 dollars, and the grass consumed green full as much more. Six hundred and fifty million dollars is a fair estimate of the value of the annual grass crop of the United States. Seventy million dollars may be added for that of Canada.

The Indian Corn (Zea Mays) constitutes an important adjunct to the dairying of America, and may be properly noticed here, both because of its classification among the true grasses, and of its very general use throughout the United States as a forage plant, independent of the value of its grain.

In North America this plant is cultivated from the Gulf of Mexico to the valleys of the St. Lawrence and the Red River of the North; and, excepting districts of great elevation, across the continent, from ocean to ocean. "The varieties of Indian corn are very numerous, as its flexibility of organisation makes it easy of adaptation to different climates and soils, and they are constantly changing in character and in number, from the shrubby reed on the shores of Lake Superior to the giant stalks of the Mississippi Valley; the tiny ears with flat, close, clinging grains of the Canada; the brilliant, rounded little pearl; the bright-red grains and white cob of the Haematite; the swelling ear of the Gourd-seed of the South." Thus, within the limits of the United States, the mature plant may be found of all sizes, from 18 inches to over 20 feet in height, bearing from one to ten ears, and the ears from 2 to 15 inches long, with from eight to thirty-six rows, sometimes with less than a hundred grains and sometimes one thousand grains upon one cob. The average for the country is an ear of twelve or fourteen rows, with from 35 to 50 grains in a row, and two ears to each stalk; and the plant from 5 to 12 feet in height, according to climate and variety. The plant matures in from 70 to 210 days from the seed, and the grain product is from 10 to 200 bushels per acre, with an average of about thirty bushels. As a rule, two bushels of ears make one of shelled corn, the standard weight of a bushel being 56 lbs.

Since 1860 there have been over 40,000,000 acres planted in corn annually in the United States; since 1876 over 50,000,000 acres. This has given a grain crop of from 1,000,000,000 to 1,500,000,000 bushels per annum. But attention is here specially invited to the immense quantity of forage which this vast acreage produces. Each acre of corn yields from two to three tons of dry fodder, and every portion of the plant is available for food, after the grain matures, except the hardest joints and heaviest butts of the stalks. In many parts of the country corn fodder or stover is the main-stay for long forage, and although some farmers strongly oppose its use as food for milch-cows, it is difficult to see how its value can be questioned. In the experience of the writer, the blades of the maize, stripped from the stalk and cured in bundles, have been found as good feed for cows in a butter dairy as the best of hay, pound for pound. The usual method of harvesting is to cut the stalk just above the ground, tie in bundles, and set up in stacks to completely cure; then shoot out the ears, leaving the husks upon the stalk, and put the fodder in stacks or ricks till wanted. Another way is to remove the ear, in the shuck, before cutting the fodder. Again, the part of each stalk above the upper ear is cut off, while the grain is still soft, and this "top fodder," well cured, is highly valued; after gathering the ripened corn, the butts are cut close to the ground. In 1877 one acre on Waushakum farm was found to yield by actual weight, besides a large crop of grain,
2,613 lbs. of cured tops and 5,536 lbs. of dry butts, or over four tons of stover. Careful experimenters feeding for milk, find five tons of well-cured stover equivalent to three tons of good hay. With hay at 20 dollars a ton, the corn fodder, at this rate, is worth 12 dollars, but it is usually valued at about 8 dollars per ton.

The corn plant is largely used by dairymen as a green-crop, to feed during the weeks of dry pasturage in July and August. For this purpose it is grown thickly, in drills, heavily manured and cut before the ears form; from thirty to seventy tons of excellent green fodder may be thus obtained from an acre. By careful treatment, the surplus may be cured and made into superior winter feed. The practice of preserving the fodder in a green and moist state by ensilaging in silos is also coming into favour, but is yet (1880) in an experimental stage in America. The Southern white and sweet varieties of corn are preferred for fodder. Thus, in its various forms, with and without the grain, maize is one of the commonest and most valuable of American forage plants. 

H. E. A.
CHAPTER XXVI.

THE DAIRY CATTLE OF AMERICA.

History of American Cattle—Breeding and Management—Crossbreed Buffaloes—Produce of American Dairy Cows—Prices of Cattle.

The first domestic cattle in America were brought over by Columbus on his second voyage in 1493. The Portuguese introduced neat cattle into Newfoundland and Nova Scotia in 1553, and voyagers found them plentiful there thirty years later. At the opening of the seventeenth century, French cattle were brought into Canada. The Virginia colony received its first importation of cattle from England in 1608 or 1609, and cows were obtained from the West Indies in 1610; the next year Gates brought over 100 cows, and these estimates are found of the neat cattle in the James River settlements—500 in 1620, 3,000 in 1630, 30,000 in 1640, and 40,000 in 1650. The first cattle for New England arrived at the Plymouth colony by the ship Charity, in charge of Agent Winslow, in 1624, and were probably of Devon stock, three heifers and a bull; in 1626 twelve cows were brought to Cape Ann, and 150 head of cattle reached Massachusetts in 1629 and 1630. In 1636 cows were worth £25 to £30 in New England, and the prices of products were, milk 1d. per quart, butter 6d. per lb., and cheese 5d. Cattle were brought to New York by the Dutch in 1625, by the Swedes to Delaware in 1627, and by the Danes to New Hampshire in 1631. Wade Hampton imported English cattle for the Carolinas about 1670. Travellers found domestic cattle in the possession of the Indians on the Red River in Louisiana in 1690, doubtless the increase of some of the earliest Spanish arrivals.

Among the early colonists there were severe restrictions upon the killing of domestic animals for food, but at the same time great losses occurred from neglecting to care for them. The "Virginia Historical Register" gives these statements as authentic:—"All the inhabitants give their cattle in winter is only the husks of their Indian corn, unless it be some of them that have a little wheat straw, neither do they give them any more of these than will serve to keep them alive; by reason whereof they venture into the marshy grounds and swamps for food, where many are lost." . . . "They neither housed nor milked their cows in winter, having a notion that it would kill them." Even as late as the middle of the eighteenth century, in the comparatively mild climate of Virginia, it was generally expected by each farmer that enough cattle would die of privation during the winter to furnish the annual supply of hides and leathers for the plantation. In sections where the climate was more severe, somewhat better care was necessitated, and very soon cattle were handled with special reference to the dairy, and valued accordingly. As early as 1750, there were farms in New England where 100 or more cows were owned and kept mainly for dairy purposes; there is a record of about that date in Rhode Island, where seventy-three cows produced 10,000 lbs. of butter in five months, an average of nearly a pound a day.

From such varied sources came the progenitors of the greater part of American cattle as they now exist. There are authentic accounts of trading and interchange of live stock among the colonists, and the consequent amalgamation resulted in the common, or, as it is called, native stock of the United States. These "natives" cannot properly be compared with any race or distinct breed of cattle; they have no distinctive character, are
of all possible sorts, colours, shapes and sizes, average much better in some States than in others, but, as a whole, they form an excellent basis of hardy stock on which to build.

It is only within the nineteenth century that systematic attempts have been made to better the general stock of the country by infusing the blood of improved breeds, and the dairy cattle of the United States and Canada may, in the year 1880, be stated at but 1 per centum thoroughbreds, 14 per cent. grades, and 85 per cent. natives. The dairy cows from this common stock produce less than three times their weight of milk per annum, and, as a rule, they are bought and sold without reading or study, almost at random, little care or attention being given to the breeding. A prominent dairymen in the famous Herkimer County of New York states his belief, that of the cows of his region, one-third do not pay for their keeping, one-third just about pay, and the remaining third makes good the loss of the first, and yields all the profit.

Great attention is being given to the improvement of American cattle, especially towards securing better dairy stock, not only by the introduction and crossing of thoroughbreds, but by careful selection and breeding from the native stock. The Gueron theory of escencheons is more and more accepted and acted upon; an official commission acting under the Agricultural Board of the State of Pennsylvania in 1878, reported this theory verified by 95 per cent. of a large number of tests made by it. On the other hand, this is stoutly opposed as lacking sufficient proof, and most animals are judged by their performances and by those "marks" which are familiar to all experienced in breeding and handling dairy-cattle.

The first importations of improved stock, kept pure after reaching America, were made in 1781-5; Mr. Miller of Virginia, and Mr. Gough of Maryland, then introduced Shorthorns on the Potomac and into the Valley of the Shenandoah. In 1795, Mr. Heaton of Dutchess County, New York, imported Durhams. In 1797, Matthew Patton of Virginia took Shorthorns to Kentucky, and from these descended "the Patton Stock," great favourites in that section for many years. Between 1815 and 1820, several importations of Shorthorns were made by parties in Kentucky, Virginia, New York and Massachusetts, and from that time others arrived from England every year or two. The first importation direct from the Bates Herd was made in the year 1839 by Mr. George Vail, of Troy, New York, and quite a number of fine animals were purchased for Americans at the sale of Lord Ducie's Herd in 1853. In 1845 the "American Shorthorn Herd Book" was commenced, connecting with the Coates series. In 1866 it was estimated that about 800 pure Shorthorns had been brought into the United States and the Canadas; the seven volumes of the "American Herd Book" then contained the pedigrees of 6,410 bulls and over 10,000 females, and its editor estimated the number of pure animals of this breed living in the country at 6,000, one-third males. In 1875 direct importations had reached 1,500, and the pedigreed Shorthorns alive in the United States and Canada were placed at 20,000. The twentieth volume of the "American Shorthorn Herd Book" published in May, 1881, will carry the number of recorded bulls to over 40,000, and of cows and heifers to 60,000. Of these, Mr. L. F. Allen, "Herd Book" editor from the first, estimates 95 per cent. as American bred, and that the recorded animals alive in the country number at least 35,000. To these may be added 20,000 well-bred Shorthorns not recorded.

The Shorthorns are largely in excess of all other pure breeds in the United States; and although their influence is felt mainly in the improvement of beef cattle, many dairymen hold them in high favour, and certain families have made remarkable records at the point. Mr. Harris Lewis, one of the best known dairymen of New York, writes:—"There is no way known to me by which our dairymen can so easily and certainly improve the milking qualities of our native herds, as by using a thoroughbred Shorthorn bull, and raising the heifer calves of the best milkers. The bull should be from a good milking family of Shorthorns. I commenced this practice several years ago, and the result has been so favourable to the Durhams that I am now running into the thoroughbreds for my dairy. The first cross of the native cow with a Shorthorn bull usually produces better results than subsequent crosses, but this rule may not hold good if the bulls used for the second or third crosses are of superior milking stock to the one first used. The very best milker that I ever owned was got by a Shorthorn bull out of a native cow, and I find that our Herkimer County dairymen, with all their prejudices against Durhams.
as milkers, will first select from droves of cows brought in for sale the Shorthorn grades, and pay better prices for them than for superior natives. I must confess that our breeders of Shorthorns have bred almost all the milk out of them, preferring beauty to utility, and have made that pay the best too, but this will not always continue." Several of the most successful butter-makers in New England hold like opinions, and use Shorthorns mainly. The editors of the "American Shorthorn Herd Book," in the latest volumes and by special circulars, appeal to breeders not to neglect the milking qualities of their stock, and call for records of milk-yields by Shorthorns, singly and in numbers, to publish in the "Herd Book" as evidence of the value of this breed for dairy purposes. Mr. Allen writes:—"The early importations of Shorthorns into this country were, as a rule, first-class milkers. But, with the exception of those living in the dairy districts east of Ohio, our American breeders of Shorthorns have not kept up the lacteal development of their cows. Giving attention mainly to flesh-production, they have neglected and largely lost the milking faculty in their stock."

Devons were imported by Americans in much greater numbers some time ago than they have been of late years. Some of the first cattle which arrived at the Massachusetts colonies were probably from Devonshire, and others of the same blood were brought to Plymouth in the year 1500, according to the description of the animals. The first importation of which the record is positive is thus mentioned in the fourth volume of the old "American Farmer":—"June 10th, 1817, the brig Margaretta, Captain Gardner, arrived at Baltimore from London, with six beautiful young cows and one bull (Taurins) of the Devonshire breed, for Mr. Robert Patterson, the whole being a present from Mr. Coke of Holkam" (afterwards Earl of Leicester). In 1818, the Hon. Rufus King took a few animals of the same stock from England to Long Island. Several other valuable importations were made between 1835 and 1855 by private parties, and by the Massachusetts Society for the Promotion of Agriculture. The Patterson Herd has continued the largest and most important in the United States, has been kept up by Messrs. Wm. and Geo. Patterson and Richard Caton by frequent importations, and the greater part of the Devons in this country are descended from this stock. A portion of it was early taken to Connecticut, and the continuation of that passed in 1858 into the hands of Governor E. H. Hyde and Mr. H. M. Sessions, the latter of Hampden, Massachusetts, and editor of the "American Devon Herd Book." That publication branched from the "Davy Herd Book," and is a continuation of it. The first and second volumes of "Davy" (1851 and 1854) were re-published in the United States in 1855, and contained the records of the best Devon herds in this country, one-fourth of the contributors to the second volume being Americans. It is also worthy of remark that the pedigrees of American Devons in the "Herd Book" antedate the earliest English pedigrees by ten years. In 1859, volumes were simultaneously published in England and America, the former by Mr. Davy and the latter by Mr. S. Howard. Howard's volume recorded 258 bulls and 399 cows, from 54 different herds, all in America. In March, 1863, the first volume of the "American Devon Herd Book" appeared, published by a Committee of the Association of Breeders of Thorough-bred Neat Stock, and compiled by Mr. Sessions. The second, third, and fourth volumes of this series were published respectively in 1868, 1872, and 1876. The fourth volume contained the records of 1,205 American Devons, the property of 263 different breeders and owners in the United States and Canada. The fifth volume appeared in 1879; and the sixth, to be published in 1881, will show a total registry of over 1,500 bulls and about 3,500 cows. The Devons seem to do well everywhere in America, are as well liked in Georgia as in Maine, are great favourites in the dairy ranches of the Sierra and Rocky Mountains, and are noted alike for excellence as working cattle, as beef, as fatted calves, and for milk. There are several fine herds in the United States in 1880, and it is certain that they do as well in America as in Devonshire, but their numbers are far below what is warranted by their good qualities.

The first Jersey cow known in America was owned by Mr. Richard Morris, of Philadelphia, kept at his farm on the Delaware River near that city, and is mentioned in the "Annals of the Philadelphia Society for the Promotion of Agriculture" for 1815, as remarkable for making 8 lbs. 12 ozs. of butter per week for several weeks. In 1840, three cows were imported by Nicholas Biddle, of Bucks County, Pennsylvania; these were
soon added to, and the herd thus established is still in existence. About 1850 this stock began to attract attention, and several large importations were made, notably those of Mr. John A. Taintor, of Hartford, Connecticut, and Mr. Roswell L. Colt, of Paterson, New Jersey. Five years later, Jerseys, then very generally called Alderneys, became quite numerous in Maryland, Pennsylvania, New Jersey, New York, Connecticut, and Massachusetts. The American importations of pure Jerseys are estimated by Colonel George E. Waring, Secretary to the American Jersey Cattle Club, at seventy per year from 1870 to 1876, and from 100 to 150 annually since that time. At first cattle were brought rather indiscriminately from the Channel Islands, a good many Guernseys being mixed in with the Jerseys. But the distinction was soon made; animals were bred pure, in 1865 "The American Jersey Cattle Club" was formed, and in 1870 the first volume of "The Herd Register" was issued under its direction. This publication has reached its eighth volume, and contains in all the pedigrees of 5,091 males and 10,815 females. Another "American Jersey Herd Book," commenced in 1866 by a committee of associated breeders, has reached its eighth volume, and contains 6,695 pedigrees; a good many animals are recorded in both. Want of care on the part of the early importers and owners both in breeding and in records, prevented the entry of many excellent animals in the "Jersey Club Register," under its rules. The great service rendered by this club in introducing and advertising the Jersey blood is admitted by all; but appearances of exclusiveness, jockeyism, and ring rule have caused distrust and impaired its usefulness. Of 25,000 genuine Jerseys alive in America, not more than half are entered in the "Register" named. The non-registered animals are, as a whole, fully as valuable for dairy purposes, and include some of the finest cows in the country. The increase in full-blood Jerseys in America will probably be 10,000 in the year 1881, while the grade Jerseys are becoming still more numerous. Grades of this breed are much sought, and are multiplying as fast in the dairy districts as Short-horn grades are in the beef-producing sections. Jersey blood is undoubtedly doing more than any other to improve the dairy-stock of America, especially in the butter-producing sections. Jerseys are great favourites for gentlemen's estates, as family cows, and are fast gaining as farm dairy-stock. They are owned in nearly every State in the Union, and are very popular in the South and on the Pacific coast.

Ayrshires began to attract attention in the United States soon after 1830, and first in New England. A few importations are noted in New York in 1822, and in Canada in 1832. Mr. Cushing, of Watertown, Massachusetts, had a fine herd in 1837, and the Massachusetts Society made importations that year, also in 1845 and 1858. There are records of Ayrshire importations almost every year after 1845. There are two Ayrshire herd-books published in America. The first was begun in 1863, under the auspices of the "Association of Breeders of Thoroughbred Next Stock," and four volumes were edited by Mr. J. N. Bagg, of West Springfield, Massachusetts. The second volume appeared in 1868 as the "American;" the third and fourth were published in 1871 and 1874, and called "The American and Canadian." July 1st, 1874, the pedigrees numbered 1,576 males and 3,309 females, and the owners 376. In 1876 the fifth volume of this series was issued as "The Ayrshire Record, Vol. I., New Series," J. W. D. French, of North Andover, Massachusetts, editor. Vol. II. appeared in 1878, and Vol. III., in November, 1880. The latter brought the total entries up to 8,000—males, 2,525, and females, 5,475. Henceforth this "Record" will contain pedigrees of such animals only as can be traced directly to importation. This was not the rule in the early volumes, and it was that lack of thoroughness which led to "The North American Ayrshire Register," commenced in 1875 by the Messrs. E. L. and J. N. Sturtevant, of South Framingham, Massachusetts. Its fourth volume, published in 1880, shows 970 bulls and 2,154 cows, and every animal is traced to importation. What the Jerseys are doing for the butter interests of America, the Ayrshires are fast repeating among the cheese-makers and the milk-producers for city supply. There are not nearly as many Ayrshires as Jerseys in the country, however, and they are less widely scattered. Although want of data makes the matter very doubtful, it is estimated that the Ayrshires in America in 1880 number 8,000, mainly held by 600 owners in Canada, New England, and New York, with more or less scattered south and west.

Herefords were first imported in 1816 by
Henry Clay, the Kentucky statesman, in 1824 by parties in Massachusetts; and in 1840 Messrs. Corning and Latham, of Albany, New York, brought over 5 bulls and 17 cows and heifers, soon after adding largely to these numbers. There have since been a few breeders of this race in the United States; but while they appear occasionally at shows, and in the agricultural journals, and the white faces are more or less seen in mixed herds, they never have been owned in sufficient numbers to make any decided impression upon the stock of America. During the year 1880 several large importations were made by Americans, the animals being intended, however, for use in improving beef-stock rather than for dairy-cattle. No herd-book for Herefords has been issued in America up to 1881.

The same is true to a great degree of the Holsteins, or Dutch cattle, although this breed is somewhat increasing among the producers of milk near the large cities. Importations are frequent, and there are several breeding-herds of twenty to fifty animals in different parts of the country. "The Herd Record of American Holstein Breeders" has reached its fifth volume.

Guernseys and Swiss cattle have latterly been imported, and purely bred to some extent, and both are great favourites with those who know them. The "American Guernsey Cattle Club" published a herd-book in 1879, containing the pedigrees to importation of about 500 animals of this breed, and have evidence of nearly as many more in America which for one cause or another cannot be registered. These are held mainly, by about 100 owners, in Pennsylvania, New York, Connecticut, and Massachusetts, very few yet in the West, the South, and Canada.

Breeding and Management.

No class of American agriculturists embody more intelligence and enterprise than the dairy-men, and the remarkable increase in the general product of this industry is largely to be attributed to the steady improvement in the quality of the dairy cattle. The first step taken in this direction was the better care given to the stock; and throughout the country it is now generally found provided with comfortable quarters when not in pasture, and with sufficient food. The next step was to raise the average quality of native heards by selection and breeding; this has been less generally practised, and a decided majority of the heifers of the country at large are still brought to milk without regard to parentage, or with sole reference to the quality of the dam. But in the leading dairy districts, breeders are using good judgment in the selection of native calves to raise, and recognising the profit of introducing the blood of improved breeds, especially by the use of thoroughbred bulls. Enough is thus accomplished to materially raise the general average quality. Many farmers are either keeping only high grades, or raising herds of pure bloods of different breeds according to local preference. Few dairymen yet find it really profitable to keep only thoroughbreds, unless they are able to advantageously dispose of their surplus stock at breeders' rates. But high grades are comparatively cheap, and nearly equal thoroughbreds at the pail.

All sorts of crosses have been tried between the different improved breeds and the natives of various sections. Among the experiments in this line has been the attempt to domesticate the American buffalo, and to cross upon it. The most successful crosses have been with a domestic sire upon a buffalo cow. The gain expected has been from the unusual sweetness and great richness of the milk of the buffalo cow, often one-third cream; but the cream is colourless, the quantity of milk small, and improvement in these points has been looked for as the result of the cross. Trials have been made at intervals since 1830 in Kentucky, New York, and Canada, among other places. The results have been successful so far as domestication is concerned, and the cross-bred animals are larger than either parent, hardy, and often a real improvement upon the average common stock, both for beef and as dairy-cows. But the trials have been few in the aggregate, so disconnected and carelessly conducted as to be productive of little good, and the true value of utilising the buffalo blood has thus been allowed to remain in question until it is probable that it never will be fully determined. The subject is here mentioned chiefly as one of the curiosities of cross-breeding in America, and the accompanying engraving is presented in this connection. It represents a half-buffalo cow, about five years old, weight 1,330 lbs., and a heifer calf of the former, about twenty months old. The resemblance of the latter to the Jersey type is marked, yet its
three-fourths of domestic blood is from common
native bulls as sire and grandsire.

Another experiment at cross-breeding in
America has been so successful as to be worthy
of notice; indeed it may be said to have laid the
foundation for a new breed of cattle in the State of
Massachusetts, known as the "Jamestown." They
are hornless cattle, and begin with a bull "James-
town," dropped in 1854 by a Suffolk polled cow
admixture of other blood. The "Jamestown"
became so uniform in excellence and appearance,
and so numerous, as to be recognised in 1878
by the Norfolk County (Massachusetts) Agricul-
tural Society as a separate class, in its premium
lists. The most noted of the bulls of this breed (°)
in 1878, was "St. Patrick," owned by Mr. A. W.
Cheever of Sheldonville, Massachusetts (editor of
the New England Farmer). A likeness of this

Fig. 213.—Cross-bred Buffaloes.

imported from Ireland during the famine of 1847,
in the United States' relief ship from which this
bull was named. The sire was a full-blooded
Jersey from "Motley's Flora," a very famous
cow, imported in 1851 by the Massachusetts Society.
The progeny of the bull "Jamestown" proved re-
markable, the females very deep and rich milkers,
as were his dam and grandam, the males hardy,
thrifty and gentle, and all of both sexes polled,
no matter what the dams. The family has been
kept up by crosses of Ayrshire and Jersey, the
polled calves only retained, until it is sufficient
in numbers to perpetuate itself without further
bull is herewith given. His dam was a James-
town cow, "Ruby," who lived to be fifteen years
old without ever being dry, and whose calves were
all polled, although several were by pure Jersey
sires. Mr. Cheever's herd consists mainly of
cows by "St. Patrick," and they are quite uniform
in appearance, although the Jersey blood some-
times shows in the colour. The breeding has
been for quality rather than quantity, and the
annual butter product, per cow, the herd through,
has been 210, 255, 266, 261, 256 and 265 lbs. for
the last six years. The companion of the bull in
the engraving is "Susie," a cow in Mr. Cheever's
herd; she was about six years old when photographed. This cow usually gave 14 to 16 quarts of milk a day when at her best, and held up to 10 quarts for months. She was butchered in 1880, when ten years old, and while still giving some milk—650 lbs. was her dressed weight.

Experience seems to demonstrate that the best cow for the average American dairy, yielding the greatest returns in proportion to cost, is to be got out of a well-selected native cow, by a thoroughbred bull. If milk or cheese is wanted, the sire is Ayrshire; if butter, a Jersey. Some prefer the Shorthorn bull from a good milking strain, that the animal obtained may, when desirable, be more readily turned into beef. The most competent judges agree that the very best milk-cow for all purposes is the cross of a Jersey sire upon an Ayrshire dam, but with prevailing prices of pure bloods this makes an expensive animal to raise. On this point, the following is valuable as the testimony of one of the most successful breeders of milch-cows in America, Mr. Thomas Fitch, of New London, Connecticut:

"My experience in breeding dairy-cows for profitable use began in 1844, when I purchased and stocked a farm near this city, and have continued right here for thirty-five years. I had Devons for a time, then Ayrshires, crossing them without successful results. About twenty-five years ago I purchased a few thoroughbred Jerseys from some of the early importations to Connecticut, to try them and to cross with the different breeds then on my farm. I have tried them with all the various breeds ever owned by me, and the result of my experiments is, that the cross of a Jersey bull with an Ayrshire cow produces the best cow for all purposes ever bred or owned by me. Next, in my judgment, is this same cross with a good native cow; next, with a good milking Shorthorn; next, with Dutch; next, the sacred cow of India; and last, with the Devon. The fact is well established that with whatever breed you cross a Jersey bull, the infusion of his blood adds to the richness of the milk, and the hardiness of the breed crossed on is not impaired, and, as a rule, the udder and teats, as
well as the carcass, of the grade, are enlarged. So
that you really have a better cow, in all points,
in a high-grade Jersey than in a thoroughbred.
By 'all points' I mean production, economy in
keeping, form, size, and beauty. I feel confident
that if these facts were known and appreciated, and
pure Jersey bulls were generally used in the dairy
districts of America, a race of cows could be pro-
duced, by raising the heifer calves of the best
milkers, that would double the annual products of
the average herds as they now are, and this with
ence. The largest yield of milk per day of any
cow I have ever bred was 57 lbs., and the largest
yield of butter in one week, 17½ weighed pounds,
both produced when fresh on grass, and 6 quarts
of ground feed per day.'"

Mr. Fitch furnishes the accompanying portrait
of one of his cross-bred Jersey-Ayrshire heifers.
This one is about two years old, has been in milk
four or five months, and yields on grass and two
quarts of bran, 17 lbs. or 18 lbs. of milk a day,
which makes rather more than one pound of butter.

but a small outlay for thoroughbred Jersey sires.
The animals bred and handled by me number many
hundreds. The best age to allow heifers to calve
the first time is when they are about two years old
and at grass. I make it a rule to turn the bull
with my young heifers on the 25th of August each
year, making it certain that they will have their
first calf in pasture where they can choose their
place to bring forth their young as nature shall
dictate. They almost invariably do well, and make
better cows than to come in a year later. I never
had a case of milk fever in my herd, and think
they would be quite rare if cows were not forced
with high feed and fussed with. I have only had
four or five cases of abortion in my whole experi-
The owner considers her a fair sample of the dairy-
cows of this class bred by him.

Another cross which promises exceptionally
good results, but has not yet been tried long
enough to establish any definite facts, is that of
the Jersey bull and the Swiss cow.
The dairy districts do not, as a whole, raise
heifers enough to supply the local demands; dairy-
men are able to buy average native cows, three
years old, and in some cases superior milkers, bred
at a distance, for much less than the cost of raising
such animals at home. In an essay on dairying,
which won a handsome prize, and which was open
to all Americans, the writer's advice to the dairy-
men of the United States was:—"Let the calf suck

Fig. 215.—Cross-bred Jersey-Ayrshire Heifer.
three times, and kill it; its rennet is of more value than its life." The cost of raising a heifer well, until the first calf, is estimated in New York and New England at fifty dollars among butter-makers and at seventy dollars among milk-dairymen. They can therefore only afford to raise cows worth seventy dollars or more, which is far above the average price of young dairy-cows. The calves raised in sections where milk has a low market value, generally run with their dams, and the most successful breeders of strictly first-class animals, although comparatively few in number, let the mothers suckle their calves, even when milk has its highest value, or sometimes put two calves to one cow. The usual practice in dairying regions is to take the calf from the cow when very young, teach it to drink, feed it on new milk for a few days, then change to skim-milk, often stirring in a little oilmeal and oatmeal, and many prefer sour milk after the calf is five or six weeks old. As soon as possible, the calf is taught to eat oats, bran, and fine hay. After weaning from the dam or the pail, the young animals generally have only pasturage and bulky food, hay, or "long forage" of some sort, until arriving at maturity; although among choice stock, where the prospective value of the heifer warrants the expenditure, grain food is added in the judgment of the breeder. Some breeders do not turn their calves upon grass at all the first year, but give only dry food till the second spring, claiming that, although unnatural, this method gives the best results. Heifers of common stock usually calve first the spring they are three years old, high grades being brought to milk a year earlier. Some eminent breeders of dairy-cows prefer to have their heifers come in on dry feed, during the autumn or winter before completing their third year.

The general management of milch-cows in America is on the basis of pasturage in the summer and feeding during the winter in stalls or sheds, hay or "fodder," and more or less grain. The details of herd management differ greatly. The pasture season ranges from five to eight months in different parts of the country, averaging six months through the regions where dairying is a leading industry. There are places where dairying is prominent, that have a climate enabling the cows to sustain themselves mainly by grazing throughout the year. Various tests show that the average cow eats 100 lbs. of grass daily while in pasture, and accordingly the necessary area of pasturage depends upon the productiveness of the land. The average allowance is about two acres per cow, for the season. This is considered enough in the West, where the pasturage is of the best natural grasses on prairies and strong uplands. In Herkimer County, New York, and Berkshire County, Massachusetts, the best judges state that three acres yield the necessary pasture and hay for a cow for the year. Prize dairy reports in the State of New York, in different years, give these facts:—16 cows on 30 acres; 13 cows on 30 acres; 29 cows on 55 acres; 28 cows on 60 acres. Dairymen differ very much on the subject of frequent changes of pasture; some shift the herd to fresh pasturage fortnightly, and others consider this practice highly injurious. Soiling is not often resorted to by practical dairymen in America, although trials prove that the system enables the number of animals on a given area to be doubled, and the increase of manure saved is a great item. It is usual, however, for green crops to be raised to feed at times when the pastures are short and dry, as is often the case in August in many parts of the country. In sections where stable manure is valuable, it is a common practice to keep the cows in yards or stalls at night, and at pasture daily, during the spring and fall, and through the day during the hottest weather and the fly season, turning them into pasture at night.

When not at pasture American dairy-cows are, as a rule, well-housed. Indeed, in the best dairy regions the line large barns, which not only give comfortable quarters to the entire stock, but cover all the food needed for half the year, are the pride of the farmers. The barns are so capacious, that stacks of hay and straw in the open air are rarely seen in the Eastern and Middle States. When at the barn, the cows remain most of the time in their stalls, and are usually fed there, being turned into yards for water and exercise; sometimes they are fed "foddered" in racks in the yards, or under sheds. The term "foddered" is used to cover all long forage, hay, straw, and stover, although more especially applied to the latter, the cured stalk and blades of the flaxian corn plant. In some sections of the country, "roughness" is an idiomatic synonym for fodder. On many dairy farms the good hay is regarded as a crop for sale, and fed to cows as a rarity, unless low in price. If the hay is sold, corn-fodder mainly replaces it. When the latter is
fed whole, as is the general practice, there is much waste, and at least 50 lbs. of stove per day is needed for each cow. Many cut into inch lengths, saving at least one-third in weight, and greatly facilitating the handling of the yard and stable manure. Some make an additional saving by steaming the corn-fodder, as well as hay and other food. It has been pretty well established that the good resulting from steaming the food for stock arises from the moistening rather than the cooking, and the moisture can be obtained much more economically than by the often elaborate apparatus for steaming; hence the advocates of cooking all food for cattle are fewer than they were some years ago. By cutting and coaxing, much straw is used as cattle-feed, but with little profit in the dairy; in the East, the wheat and rye straw, which is limited in quantity, goes to the paper-mills, or is sold for stable bedding in the cities and towns; in the Middle States it is worked into manure by bedding, &c., when not fed; and in the West, wasted or burned to get it out of the way.

The addition of roots to the winter diet is becoming more and more common in the best dairy regions of America, the favourites being common turnips, swedes, mangolds, and potatoes; many cabbages are used. Carrots can be profitably added in some sections, but are generally found too expensive because of the labour required, and parsnips are seldom used in this country for stock. The "coming root" for dairying districts of the United States is believed to be the sugar beet, in connection with the establishment of beet-sugar factories.

As to grain-feeding, dairymen generally agree that it increases the milk product, improves its quality, adds to the value of the manure, thereby benefiting the farm, and enables more animals to be kept on a given number of acres at a greater net profit. Yet heavy grain-feeding is attended with much risk, and some find that by greater care in improving the quality of the pastureage, and using only the best early-cured hay as winter food, grain can be entirely dispensed with, and the returns of the herd remain undiminished. Indian corn-meal is the most common grain-food used by dairymen, and undoubtedly the best; the coarser parts of wheat (known variously as bran, shorts, middlings, brown-stuff, and mill-stuff), rye-meal, oats to a limited extent, and brewers' grains, are all in use as food for milk-cows, in the United States and Canada. Brewers' grains are decidedly objectionable, unless used very moderately and with good judgment. Near corn and potato-starch factories—numerous in some localities—the refuse called "starch-feed" is added to the list. The expensive linseed meal has been largely replaced by cotton-seed meal, which is valuable if carefully used, but beyond a certain limit imparts a bad flavour to milk and butter.

Twenty-five pounds of good hay, or its nutritive equivalent, and ten pounds of grain, may be stated as the average daily feed for the milk-cows of enterprising dairymen, at least one peck of roots being added when practicable. The grain being a mixture of corn-meal and bran, careful butter-makers object to more than half bran, and prefer three-fourths meal, while milk-producers desire these proportions reversed.

The following are good examples of the systems of feeding prevailing among dairymen in different parts of America:

Some years since, Prof. E. W. Stewart, of New York, selected 100 acres of land on his farm for trial, and took the judgment of his neighbours as to how many cattle that area would pasture during the summer. It was thus decided that thirty-five head would be a fair number. He accordingly put in his barn that number of dairy-cows, from 3 to 8 years old, to be fed from those 100 acres from May 20th to Dec. 1st. Ninety acres of the land were left in fair meadow, 5 were in clover, 3 in corn-fodder, and 2 in oats. He began cutting the clover when 8 inches high; the grass was also cut and fed. But instead of using it all, he had a surplus of 65 tons of hay to put in the barn for winter use, or to sell. The grass was cut by a machine, raked with a horse, and drawn to the barn in a cart, one man being employed six hours a day in cutting and collecting fodder, and feeding the stock. About two hours of horse-labour was also required daily. The whole cost of the extra labour amounted during the summer to less than 100 dollars, and the hay saved was sold at the barn for 972 dollars. Adding the cost of cutting and storing the hay, there remained a net profit of soiling over pastureage of 775 dollars for the season, on 100 acres.

Mr. A. W. Cheever, of Pine Hedge Farm, Sheldonville, Massachusetts, gives this account of his methods, dated Nov., 1875:—"I use the term
‘soiling’ only as it relates to feeding in the stall, as against pasturing. I do not aim to have just enough green fodder for my animals, and no more, but feed green or dry material as is most convenient. I feed in the stable because I thereby save fodder, and can keep more stock. I have few acres to cultivate, and aim to make the most of them. My farm consists of 26 acres under cultivation, and 6 in pasture, besides what is occupied by garden and buildings. I have bought no hay or other food for animals, except grain, since 1876, and the stock has all been kept at home. Last year I kept an average of 28 animals through the winter, and had about 4 tons of hay left over when I began feeding the new crops. Have 26 head now, including 3 horses, 15 milch-cows, a large bull, 4 yearling heifers, and 3 summer calves. I have plenty of fodder to carry me through the winter, without doubt. Every fall I sow a broad area to winter rye, begin to cut it in the spring just as the heads first show themselves, and continue to cut and feed green till it gets too hard, which is before the blossoms fall. The rest is then all made into hay for winter feeding. By the time the rye is too old, I have orchard grass ready to mow, and the pasture affords some feed at that time. Orchard-grass is followed by red clover, and frequently these two are grown together. These, with June grass (Ky. blue) which often grows with both, fill up the time between the feeding of winter rye and the main crop of English grasses, chiefly red-top and timothy. Oats are sown as early in spring as the condition of the ground will permit, and the crop is ready to cut immediately after the English grasses. I have sown spring rye several years, and obtain a cutting a week or more before the oats are ready, but as the spring rye comes just when the pasture is at its best, I find little need of this crop. It is a valuable one when soiling is practised exclusively. The next crop sown after oats is corn, then millet. These both need warm weather for profitable culture. Oats, corn, and millet are each sown at intervals of a week or ten days, to bring a succession of tender feed through the season. Corn and millet are sown to last till early frosts in autumn, when their place is taken by barley sown in midsummer. The latter is very valuable for feeding in October and November, as it is not much injured by frosts. Cabbages and turnips may be used still later, but as my milk is designed to make a choice article of butter, I have not felt quite safe in feeding such rank-flavoured food. I also feed freely of corn fodder during the late fall months, by cutting it when in bloom, and preserving in stocks in the open field, or by standing it up in long, wide piles against fences. All the crops named can be cut and cured for winter fodder if there should be a surplus. In order to certainly have enough of everything for feeding green during its season, I grow more than needed in the more favourable seasons. The land of ‘Pine Hedge Farm’ is very uneven in quality, and although I do not consider the keeping of one animal to the acre the year through (grain excepted) its maximum production, I cannot expect here to obtain the results possible on better land. One who adopts soiling, and carries out the system judiciously, will soon find he can feed dry hay or other fodder in summer, quite as economically as in winter. Dry hay is just as good for a cow in July as in January. A liberal supply of dry early-cut and well-cured fodder should be provided for feeding during stormy weather, and for mixing with green food when the condition of the animals seems to require it. Dry feed is a great deal better than green fodder covered with water in stormy weather, to say nothing of the job of collecting fodder in a hard rain for a barnful of hungry cattle. I endeavour to keep the whole farm in growing crops from early spring till the ground closes up, and most of the land is made to produce two or more crops during the season.”

One of the Massachusetts Charitable Institutions has a large farm attached, including much hilly pasturage, and has carried a herd of Ayrshires which has made a fine milk record. The Superintendent states that he kept the cows for their milk, and regarded as the best food the sweet grass which grows upon the hill-sides, and is cropped by the cows day by day; with plenty of this nothing else was needed. In the summer, when grass was short, he fed early mown hay, cut with some meal or bran upon it. He considers hay and corn-fodder inferior food for milch-cows, if fed dry. In winter he feeds twice a day, with cut hay and fodder, and two quarts of bran per cow each time, wetting with warm water in box of steaming, and from a peck to one half-bushel of roots per cow, daily. He tries to feed roots from the time the cows are put into the stalls in the autumn until they are turned out to pasture in the spring. Never found root-feeding injurious
to the flavour of milk; always fed the roots immediately after milking.

At a meeting of the “Connecticut Board of Agriculture” a prominent member stated that he was engaged in developing an enterprise involving the winter production of milk for city supply, in a section formerly much occupied in the fattening of cattle. He regarded hay as the basis of all winter-feeding, and that made from the natural and cultivated grasses, grown on upland meadows, as the most valuable, if cut early and nicely cured. This to be supplemented with sowed corn and the annual grasses. The system adopted by him to secure the greatest yield of good milk was as follows:—A light feed of hay was given the first thing in the morning, and eaten up clean in ten or fifteen minutes, during the milking; then the grain feed, ground, was given dry with a little salt. In about an hour the cows were let out to go to water, and he preferred they should go several rods to drink from warm springs and get exercise, rather than drink almost frozen water from a tank in the yard. While absent, the stables were cleaned, and another feed about the same as first given, and the cows put up immediately on their return. They were then able to stand or lie down, at their choice, in an atmosphere almost as genial in respect to temperature and purity as that of the family sitting-room. If feeding roots they were given just before milking at night, and the last feed of the day was given immediately after; this being always the fullest of the day, for cows are observed when at pasture to always make their largest meal just before night.

The President of the American Jersey Cattle Club, from whose fine herd a “gilt-edged” article of butter has been made that sold for 75 cents a pound for several years, gives this simple statement of the treatment of his cattle:—“They are pastured when possible, and fed during summer and autumn, more or less sowed corn, pumpkins and sugar beets. During the winter good moderately early cut hay is fed, morning and evening, after having been cut and moistened with cold water, and sprinkled over with equal parts of Indian meal and wheat bran, at the rate of one quart of the mixed grain per cow, at each feed. After this cut-feed in the morning, each one has about a peck of sugar beets, also a little salt. A feeding of long hay is given in the middle of the day. The cows are let out into the yard for water, after their morning and mid-day meals. They are carded and brushed every morning. In the stable, they stand in stanchions on a platform. They have the liberty of a warm, sunny yard for several hours, every fine day. On this regimen the cows keep in good store and breeding condition.”

Mr. Burnett gives this account of the management of butter-making Jerseys upon his famous Deerfoot Farm in Eastern Massachusetts:—“My cow stables are warm and sheltered; in the winter a trough of pure water is always in front of the cows; the entire interior of the stables is white-washed every month. The cows are bleded with dry loam or sand, and brushed or carded twice every day. In the spring they are let out into a sheltered yard, open only to the south, for about one hour every day. The morning milking is done at half-past five in winter, and at five in summer, the second at five in the afternoon. A daily record is kept of each cow, on printed blanks, which are handed to me every Sunday morning. One man does all the feeding, beginning the first thing in the morning, with a generous feed of rowen hay, while the others are cleaning up the stables before milking. I always cut my grass early in June, and two crops and often three, during the season. After breakfast, at half-past six, the feeder gives each cow in milk, four quarts of meal of Northern corn, ground with the cobs, or, if our supply gives out, two quarts of clear Western corn-meal, mixed with an equal quantity of wheat bran. After this, more hay which they clean up by nine o’clock. They are not fed again until 3 p.m., when one bushel of yellow globe mangolds, that have been through a root-cutter, is divided between every three cows. Then a liberal feed of hay, which is final; this fed slowly, a little at a time, prolonging the meal. In dry seasons, I feed some grain during the summer, and at night add one feed of rowen or wilted clover.”

The following is a fair sample of many condensed statements of management by average farmers, in the Agricultural Reports of the Eastern States:—A.D. 1874. Thirteen cows, averaged 2,315 quarts milk per annum. Income, 90 dollars per cow; net income, 23½ dollars per cow, and manure pays for care. Milk at 5 a.m., and then feed all the hay cows will eat. Card and water, then give 3 quarts shorts and 1 quart either corn-
meal or cotton-seed meal. Leave cows till 3 p.m. Repeat feeding and watering and milk at 5 p.m. Cows dry about ten weeks.

Experiments upon the comparative value of corn-meal and wheat-bran in making milk and butter were carefully made at the New Hampshire Agricultural College in 1877, with these results:—Taking two lots of cows as equal as possible, those of lot No. 1 were fed on bran during the month of February and on corn-meal in March; lot No. 2 on meal in February and bran in March. Those fed on corn-meal gave the most milk, or the greater increase, and decidedly more and better butter; they also increased most in weight. Weight of lot No. 1, March 1st, 1,900 lbs.; same, April 3rd (meantime fed corn-meal), 2,056 lbs.; gain, 156 lbs. Weight of lot No. 2, March 1st, 2,021 lbs.; same, April 3rd (after bran-feeding), 2,117 lbs.; gain, 93 lbs. Lot No. 1 for February required 33.2 oz. milk to 1 oz. butter; same, for March, 28.5 to 1. Lot No. 2, for February, 29.2 to 1, and for March, 32.4 to 1.

"The Miller System of Meal Feeding," so called because of its chief advocate, L. W. Miller, of Chautauqua, New York, has received a good deal of attention, and been much discussed at meetings of dairymen. It substitutes corn-meal for coarse forage as much as possible at all times, making it the exclusive food for the cow when dry. Herds have been thus maintained in good condition for weeks without hay or other long fodder, and afterwards produced fine calves and made excellent dairy records. The corn-meal is fed dry, from 3 to 5 quarts per day, with a little salt, and water carried to the cow; but she drinks very little. Mr. Miller has carried a herd of twenty cows through an entire winter with meal alone, all the cows being dry at the start, but most of them calving five or six weeks before hay was fed; for the cows in milk the meal was wet, and 5 quarts fed daily (about 10 lbs.). The result was a full quantity of superior butter. The Miller System has been published in pamphlet form, and well explained in the tenth annual report of the American Dairymen's Association, 1875.

The foregoing illustrates only the management of careful dairymen. In the great corn-growing States of the West, where land and grain are cheap (and cattle, too, comparatively), there is far less care of the animals and much more primitive methods of feeding, often involving great waste. This, too, in regions already famous for the quantity and excellence of their dairy products. There, especially in the milder sections, sheds are often the only protection for cows in winter, the prairie grass the summer feed, and for winter bundles of corn-fodder, the entire plant of the maize as cut from its root, including the ears of grain. Still worse, the treatment by some who think their cows pay is described as a combination of "wind and straw" for care and food.

On the contrary, the best dairymen of the West are as careful as those of the East, and some are even higher feeders. For example, Mr. Boies, of Illinois, a very successful butter-maker, keeping in milk one hundred cows, selected from the native stock, considers his success owing to the best of food and care. For summer he has good tame pasture, with plenty of clean, sweet water, and at each end of the day, while milking, he gives 2 quarts of corn-meal and 4 quarts of bran. For winter, a warm stable, plenty of early-cut hay or cured prairie grass, well-cured stover, Hungarian hay, and oats cut when about half turned and well cured; then each end of day a feed of 8 lbs. of corn and oats, ground fine, 4 lbs. of wheat-bran, and 2 lbs. of oil-meal—more if the cow will bear it, less if it prove too much. "Bear in mind there are live cows at least that don't get food enough to make feeding pay, to one fed too much. The cow should always have a comfortable bed of clean straw or saw-dust—in short, the cow should be treated like a fine horse." Mr. Boies practises on this theory, and finds it profitable. Although the cost of feed consumed by each cow has reached, at the low Western prices, $2.50 dollars for the year, the butter product alone sold for $110 dollars the same year, a net profit on each cow of $67 dollars cash. Besides that, the buttermilk and skim-milk, by being fed to swine, gave in pork and manure an additional income sufficient to pay for the stabling and care of the cow, and a fair interest upon her cost! Under this management cows are kept four or five years, then disposed of and replaced by purchase.

**Produce of American Cows.**

The records of the performances of dairy-cows in America are voluminous and interesting. The census of 1870 reports dairy products, which, when reduced to a milk equivalent, show an average
annual product of only 705 quarts per cow, for the United States. This is manifestly too low, and probably the milk consumed at home, at least one-third of the total yield, was not generally reported. Mr. Dodge, while Statistician of the United States Department of Agriculture, estimated the annual yield at 1,500 quarts per cow in the best dairy sections; 1,200 quarts, or less, between latitude 35° and 40°, and about 700 quarts on the Gulf coast; an average of 1,300 quarts for the whole United States. The best authorities substantially agree with these figures for the year 1875, but believe the general average to be steadily increasing since. Dr. Sturtevant says, 1,300 quarts for the annual average yield of the native cows in the dairy regions, and 1,500 quarts for superior dairies. This means an annual income of from 25 to 45 dollars, or more, per cow, at the pail. The following particulars are given as to the products of different kinds of dairy cattle.

Natives.—The records of 67 dairies of native cows, which received premiums from State Agricultural Societies between the years 1846 and 1876, cover 2,228 cows, and give an average annual yield per cow of 2,103 quarts of milk; 180 lbs. of butter, or 393 lbs. of cheese. Among these are the following cases:—A New York dairyman, after several years' careful selection from common stock, obtained a herd of 16 cows, which averaged for two years 3,268 quarts of milk each, per year, and with milk worth 2½ cents a quart, gave a net return of 100-50 dollars per cow. The herd of Zadock Pratt, a well-known dairyman of Greene County, New York, of which a careful record was kept covering the seven years from 1857 to 1863, inclusive, gave as the average result, 55 cows, 4,710 lbs. or 2,160 quarts of milk, 186 lbs. of butter. The milk product steadily decreased from 1852 to 1861 and then remained stationary, while the butter product increased from 130 lbs. per cow in 1852 to 225 lbs. in 1863; and the value of each animal's annual product, including skimmed milk turned into pork and veal, increased from 37½ dollars to 68 dollars.

At Waushakum Farm, in Massachusetts, a dairy of 33 native cows was obtained by careful purchases, and a standing offer by Dr. Sturtevant of 100 dollars for any cow giving over 40 lbs. of milk a day; this herd produced in the years 1867, 1868, and 1869, an average of 2,079 quarts of milk annually per cow.

Among numerous records of the performances of single native cows, the following are well authenticated:—A cow in Western Massachusetts, in 1838, had averaged 377 lbs. of butter a year for three years, and produced 942 lbs. in 911 consecutive days. The "Vermont Cow" or Scott cow, 9 years old in 1865, gave 504 lbs. of butter, which sold for about 100 dollars in gold; the most remarkable thing in this case being that the only feed of the cow was grass and hay. The Canadian cow "Ep-pie" averaged for seven years 4,350 quarts of milk, sold for 175 dollars a year; she was in milk 270 days each year, only three-fourths of the time, so averaged 16 quarts a day for the whole milking period. On Waushakum Farm, before mentioned, the greatest annual product of one native cow was 3,703 quarts, and the greatest average of one cow for three years was 2,672 quarts. The most wonderful native record is that of the "Oakes Cow," so called, winner of the first premium for milch-cows at the Massachusetts State Fair in 1816. This cow was bred in Kennebec County, Maine, and was bought from a drover on its way to Brighton market, near Boston, 1813, by a Massachusetts farmer from whom the cow was named. She was then about five years old, and her fame as a milker having reached the officers of the State Society, the trial was made under their supervision. As a type of the best dairy-cows of the common stock of America, at that time, her portrait is here given, borrowed from Flint's

Fig. 216.—The "Oakes Cow."
"Milch Cows and Dairy Farming." She calved May 15th, 1815, and for 31 weeks averaged 16 lbs. of butter, with a total of 581 lbs. in 9 months, when she went dry, February, 1816. She was fresh again April 5th, 1816, and in 25 weeks made 480 lbs. of butter, besides suckling a calf for five weeks. The fair then occurred, and the record ceased, but this cow must have produced 600 lbs. of butter in that year. Her feed during the whole trial was the best of grass or hay, and all her own skimmed milk, thickened with 7 lbs. of Indian corn-meal a day; her greatest yield in one day was 4½ lbs. of milk, not large. None of her calves proved remarkable milkers.

**Grades.**—No herd records of grades are of any value, as the animals in almost all cases vary in the degree of improved blood, and often in the breed used in crossing. Among the famous single yields are these:—A grade Shorthorn in New Jersey is recorded as giving 4,823 quarts of milk, making 423 lbs. of butter, which yielded a net profit of 123 dollars; Henry Saltonstall of Peabody, Massachusetts, owned a grade cow seven-eighths Jersey, which gave 13,065 lbs. or 5,974 quarts in one year, the largest flow being 28 quarts a day. The Allis Cow, at Springfield, Massachusetts, a c.r.s. of Durham and Ayrshire, eight years old, weighing 1,070 lbs., calved April 28th, 1877, and prior to July 1st, 1878 (14 months), gave 15,043 lbs. or 6,912 quarts of milk, being over 6,000 quarts a year. This cow, dry in July, calved again in August, 1878, and at the present writing is repeating her previous record; her food is good hay, grass, green corn-fodder, and a wet mess twice a day, warmed in winter, of five quarts of mixed corn-meal and shorts, potatoes and turnips being added occasionally. The largest milker known in America was "Old Creamer," a grade or cross-bred cow owned by General S. D. Hungerford of Adams, Jefferson County, New York, who kindly furnished a photograph of the animal from which the accompanying engraving was made. The likeness was taken in 1873, when the cow was nine years old and weighed 1,080 lbs. Little is known of her parentage, but she was bought on the supposition that she was seven-eighths Ayrshire, with a mixture of Shorthorn blood, and perhaps some Jersey. In the year 1873, she gave in June 2,820 lbs. of milk; in July 2,483½ lbs., and in September over 2,200 lbs. Her average for June was 94 lbs. or 43 quarts a day, and in that month she made the unprecedented record of 400 lbs. of milk in four days, as follows:

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<th>Date</th>
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<th>12 M.</th>
<th>5 P.M.</th>
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<td>June 10th</td>
<td>3½ lbs.</td>
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<td>&quot; 11th</td>
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<td>&quot; 13th</td>
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<td>Four days</td>
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<td>400</td>
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</table>

The fact of this seemingly incredible yield is well established. This cow refused to drink milk, and never did; her feed at the time stated was all the fresh clover she would eat, and four quarts of ground oats and wheat bran, mixed half-and-half at each milking. Unfortunately, no prolonged or systematic trial was made of the performances of this cow, as a milker. Among the measurements taken from "Old Creamer" were these: Total length, 71 ¼ inches; girth about belly, 96¾ inches; at flank, 71 inches; depth of flank, 22 ½ inches;udder, oval, broad, extensive, and hanging with the skin in folds—length, 18 inches; depth of gland portion, 20 inches; along gland front to rear, 29¼ inches; semi-circumference, 58 inches.

**Shorthorns.**—Herds of Shorthorns exclusively kept with the dairy as the main object, are so rare that not enough records can be found to give any general average. The best examples of this kind seem to be the herds of Harris Lewis, of Herkimer County, New York, and J. C. Newhall, of Franklin County, Massachusetts. The records of these herds for several disconnected years give an average for about forty cows of 3,200 quarts of milk and 290 lbs. of butter a year; the cows 272 days in milk. Mr. Newhall's herd of 10 cows, from three to twelve years old, averaged in 1871, 3,577 quarts of milk and 325 lbs. of butter made. That year the income per cow was 133 dollars, cost 76 dollars. The best single performances of dairy Shorthorns to be found are those of the cows "Maid of Athol" and "Rose," which gave 5,812 and 5,444 quarts of milk respectively in the year 1873, from which there was made 513 and 471 lbs. of butter. The "Stevens Cow," at Ithaca, New York, a son, weighed 1,200 lbs. In June, 1878, being eight years old, she gave in six consecutive days 19½ lbs. of butter, her flow of milk being 71 lbs. a day, and her only food being grass.
Holsteins.—For the same reason as in the case of the Shorthorns, no general average can be given for the cows of this breed in America. There are, however, several authentic records of remarkable production by Dutch or Holstein cows, singly and in herds. Gerrit S. Miller, of Peterboro, New York, owned three cows, which for six years averaged 4,064 quarts of milk each; their ages at beginning of trial (1870) were 4, 5, and 6 years. A herd of twelve of these cows in one year averaged 4,003 quarts of milk and owned by Mr. Hoxie; beginning with the season of 1876, when five years old, her average yield for four years was 14,645 lbs. of milk. She calved April 3, 1878, and again February 23, 1879; during the 336 days she was milked, she produced 15,960 lbs., an average of 47½ lbs. of milk a day for eleven months. These are but two of several wonderful statements of milk-production by Dutch cows in the United States, fully verified; the butter records are few in number, but there are several claims of 12, 14, and even

308 lbs. of butter. S. Hoxie, of Whitestown, New York, gives the complete record of the "Dutch-Friesian" (Holstein) herd of the Unadilla Valley Association, eleven cows, ranging from 2 to 8 years in age, average 4½ years; the average product was 11,286 lbs. or 5,250 quarts of milk, and average number of days actually milked, 341. All calved during the year, and four of them were milked every day in the year. Smiths and Powell, of Syracuse, New York, own "Netherland Queen," who dropped her first calf in April, 1879, when just two years old, and her second calf at two days less than a year after, yet produced meantime 13,574 lbs. of milk. The best single record is that of "Maid of Twisk," 18 lbs. produced in a week. It should be noted, however, that these records are mainly of imported animals; the American-bred Holsteins, as a rule, have yet to make their reputation.

Ayrshires.—The records of Ayrshire and Jersey herds are much more numerous and complete, as they should be, having a closer relation to the general dairy interests of the country.

Eighteen well-managed herds of Ayrshires, selected from different sections and averaging twelve cows each, with complete records running from two to eight years, give an average annual production of 2,493 quarts per cow. Only a part have butter records, but these average 238 lbs. to the cow. The best record on the whole is that of
Sturtevant Bros., of Waushakum Farm, Massachusetts, although other herds, smaller and tested for a shorter time, show larger products. The record selected as representative, extends through eight years, being complete as to every milking of every animal, the average size of the herd being 13 cows. The herd was kept mainly for breeding purposes and not highly fed. The following is a statement of the annual average product per cow, and the general average at the end of each year:

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual Average</th>
<th>Average to Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quarts</td>
<td>Quarts</td>
</tr>
<tr>
<td>1870</td>
<td>2,698</td>
<td>2,567</td>
</tr>
<tr>
<td>1871</td>
<td>2,386</td>
<td>2,628</td>
</tr>
<tr>
<td>1872</td>
<td>2,512</td>
<td>2,628</td>
</tr>
<tr>
<td>1873</td>
<td>2,563</td>
<td>2,612</td>
</tr>
<tr>
<td>1874</td>
<td>2,639</td>
<td>2,617</td>
</tr>
<tr>
<td>1875</td>
<td>1,981</td>
<td>2,494</td>
</tr>
<tr>
<td>1876</td>
<td>2,630</td>
<td>2,553</td>
</tr>
<tr>
<td>1877</td>
<td>2,466</td>
<td>2,500</td>
</tr>
</tbody>
</table>

The difference between the extremes in the annual average is 911 quarts, but in the extremes of the general average only 130 quarts. The cows were dry from 49 to 86 days a year, an average of 69 days dry annually for the eight years. The record is complete from 1868 to 1879, inclusive, twelve years, but the first two years there were only four cows, and the last two cover a period of experiment with feeding almost exclusively on corn stover during the winter, which reduced the average product of 11 cows for those years to 2,008 quarts a year. The Ayrshire herd of J. D. W. French, Cochichewick Farm, North Andover, Massachusetts, fed very moderately as breeders, has the following record:

<table>
<thead>
<tr>
<th></th>
<th>1874</th>
<th>1875</th>
<th>1876</th>
<th>1877</th>
<th>1878</th>
<th>1879</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cows</td>
<td>3</td>
<td>11</td>
<td>11</td>
<td>12</td>
<td>10</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>Milk</td>
<td>6,934</td>
<td>6,218</td>
<td>5,310</td>
<td>5,343</td>
<td>5,316</td>
<td>5,222</td>
<td>5,720</td>
</tr>
</tbody>
</table>

This high average, of 2,660 quarts a year for six years, needs modification because the record includes the exceptional production of three selected cows the first year, and reckons two heifers as one cow in some of the later years. The following interesting comparison was made by Mr. Robert McAdam at Rome, New York, in the month of June, 1864, being a test of the milk and cheese production of equal numbers of Ayrshire and Shorthorn cows:

**Ayrshires:** 64 Cows, 65,380 lbs. of Milk; Cheese, 6,424 lbs. Daily average of Milk per Cow, 333 lbs.; Cheese, 13 lbs.

**Shorthorns:** 64 Cows, 52,680 lbs. of Milk; Cheese, 4,797 lbs. Daily average of Milk per Cow, 272 lbs.; Cheese, 29 lbs.

The herds were esteemed first class of their respective breeds, and were pastured in adjoining fields on land of similar quality. The best single yields of Ayrshires are found also in the Waushakum herd. The cow "Georgie" gave 8,596 lbs. or 3,961 quarts of milk in 1870, the only yield of over 8,000 lbs. among seventeen different Ayrshires in the eight years' trial; but the next year this cow gave only 3,288 quarts, and her average for several years was 3,250 quarts. "Georgiana," of the same family, gave one year 3,650 quarts. Several Ayrshires in other American herds are on record as giving averages of from 50 to 58 lbs. of milk a day for one or two weeks, but with incomplete accounts of full year's yield. The Messrs. Sturtevant report in connection with their herd that during the stated trial they had about twenty records in each year of 40 lbs. and over of milk in one day, and but one case during the whole period in which a cow gave over 50 lbs. in a day. No records of the butter-products of Ayrshires in America have been found which are of special interest.

**Jerseys.**—To illustrate the products of American Jerseys, ten herds have been selected, located in New England, New York, and Pennsylvania. These average fourteen cows each, and the records cover from two to seven years. The average annual product shown is 2,288 quarts of milk and 251 lbs. of butter. H. C. Haskell's herd of Deerfield Jerseys (Massachusetts) has a record for seven consecutive years, an average of 8 cows, 2,315 quarts of milk, and 307 lbs. of butter; 16:4 lbs. of milk made one pound of butter, the ratio being from 12:6 in March to 23:5 in June, and the net profit was 60 dollars gold per cow, per annum. The "Deerfoot Herd" of Edward Burnett (Massachusetts) shows a three years' trial, with an average of 25 cows; these gave an annual average of 2,152 quarts of milk and 260 lbs. of butter; and for the one year of 1876, the average was 2,616 quarts of milk and 331 lbs. of butter. A herd of fourteen cows in Connecticut is on record as averaging one year 400 lbs. of butter per cow.
For yields of single Jersey cows several noteworthy cases are recorded. (The figures in brackets indicate the number of the animal in the register of the American Jersey Cattle Club.) "Motley's Flora" (173), in Massachusetts, 1853, made 511 lbs. of butter in fifty weeks. "Pansy" (1019) in Connecticut, calved September 24th, 1871, and before October, 1872, made 574 lbs. of butter. Milk produce not given in these cases. "Snowdrop" (569), in Massachusetts, gave an average of 4,137 quarts (9,918 lbs.) during the years 1875, besides a quantity of cream used; she calved again, April 15th, 1877, and in the month of June following gave 1,406 lbs. of milk. A cow owned by the writer, in Massachusetts, in no sense a fancy or fashionable Jersey, calved in May 1876, and on several trials that year was found to be producing over 20 lbs. of butter a week, even in "fly time;" she was milked steadily for nineteen months, and during the last twelve of these, the year 1877, made 516 lbs. of butter. This cow calved again, February 1st, 1878, and during the 1876, and 1877. "Belle of Newton" (1747), in the one year 1874, gave 4,783 quarts of milk (10,280 lbs.). "Alphea" (171), bred and owned by Colonel R. M. Hoe, of Morrisania, New York, is a cow famous for her own performances and for the reputation of her progeny; she lived (1863-71) before the time of systematic long-continued records, but on several trials was found to produce more than 3 lbs. of butter a day—21 1/2 lbs. in one week—on grass alone. Two non-registered Jerseys are added:—"Abbie," a cow in Massachusetts, calved April 17th, 1876, and prior to the next March, gave 4,620 quarts of milk, from which 486 lbs. of butter were made, autumn of this year gave her own weight (about 800 lbs.) in milk monthly. "The Jersey Belle of Scituate" (7,828), owned by Charles O. Ellms, of Scituate, Massachusetts, presents the best record of any American-bred Jersey up to 1879. She is descended from "Motley's Flora" and "Dick Swiveller" and "Pilot," all famous animals in the early days of Jerseys in the United States. A portrait of this cow, furnished by the owner, is given herewith; it is as she appeared in the spring of 1877, when five years of age. She dropped her third calf, February 25th, 1876, and before the end of that year made 608 lbs. of butter. February 25th, 1877, she calved again, and up to March 5th,
1878, made 705 lbs. of butter; she averaged 19 lbs. a week for over five months, and at times four quarts of her milk gave a pound of butter. Her fifth calf was dropped May 10th, 1878; during one week in June she made 22 lbs. of butter, and in September 7 lbs. were made from the milk of three days. Her fifth calf was dropped June 7th, 1880, and she was tested for the seven days ending June 21st; she gave 45 lbs. of milk a day at the beginning of the test, and 44 lbs. at its close. The total weight of butter made in the week was 25 lbs. 3 ozs., salt having been added before weighing, at the rate of 8 ozs. to 10 lbs. of butter. The record is the more remarkable as the cow was on pasture in the summer, kept up at night, and given two quarts of shorts in the morning, and in winter, besides the best of hay, never fed over 5 lbs. of grain-food a day.

"Jersey Belle" had two rivals that attracted much attention in the United States during the year 1880, and both excelled the record just given. "Jersey Queen," bred by the Messrs. Fairbanks, of Vermont, and owned by J. S. Kenerson, of Barnet, Vermont, is the first. The milk record of this cow was not kept, but she certainly produced in 365 days, ending March 15, 1880, the full weight of 748 lbs. of butter before salting. Besides this, milk and cream were used from her product, by her owner, equivalent to 20 or 30 lbs. of butter, but this quantity being uncertain, is not claimed. In April, 1880, "Jersey Queen" gave in one week 66 quarts of milk, from which 12 lbs. of butter were made; fifteen months after calving, this animal produced butter at the rate of 650 lbs. a year, on pasture and 3 lbs. grain-food daily; and the last week in September, 1880, nineteenth month after calving, she gave 176 lbs. of milk, from which 11 lbs. of butter were made. [This cow will be due with her fourth calf in February, 1881, and will then be seven years old. It is proposed to make a very complete record of her performances during the following year.]

"Eurotas" (2,451), a brown cow with a grey back, dropped August 13, 1871, was bred by Col. Hec, being a grand-daughter of "Alphea," above named. She was by imported "Rioter 2d" (469) out of "Europa" (176), daughter of "Alphea" by her full brother "Jupiter" (93). This cow weighs about 1,000 lbs., is plain-looking, large-bodied, short-legged, and somewhat coarse in pattern. The present owner (1880) is Mr. A. B. Darling, of New York City. The remarkable richness of Eurotas' milk was first noticed with her fifth calf, November, 1878. On trials made single weeks in February and March following, she made 21 lbs. and then 22 lbs. of butter, the latter from 217 lbs. of milk. As late as three months before next calving, she gave on grass alone, 2 lbs. of butter a day. "Eurotas" dropped her sixth calf October 30, 1879. On the 11th of November her record began, the milk being kept by itself, and the cream churned every other day. The butter made during the five months ending April 10th weighed 364 lbs. 15 ozs., no grass meantime. Then came fresh feed, and in the sixth month 73 lbs. 13 oz. butter, while in the seventh, ending June 10th, 91 lbs. 9 oz., or an average of over 3 lbs. of butter a day. The next two months added 162 lbs. 14 ozs., giving a total for nine months of 692 lbs. 10 oz. of butter. From August 10 to 15, 1880, inclusive (the latest report available), "Eurotas" gave 13 lbs. 9 oz. of butter, which made a record of 706 lbs. 3 oz. in nine months and six days, thus exceeding the full year's yield of "Jersey Belle." "Eurotas" should calve November 10, 1880. The detailed record of this cow for the month of June, 1880, the eighth month after calving, is of sufficient interest to insert entire:

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>June 1</td>
<td>2 - 6</td>
<td>1</td>
<td>June 13, 14</td>
<td>6 - 5</td>
<td>June 25, 26</td>
<td>5 - 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;</td>
<td>3 - 4</td>
<td>6 - 4</td>
<td>&quot;</td>
<td>15, 16</td>
<td>6 - 6</td>
<td>&quot;</td>
<td>27, 28</td>
<td>5 - 0</td>
</tr>
<tr>
<td>&quot;</td>
<td>5 - 6</td>
<td>6 - 1</td>
<td>&quot;</td>
<td>17, 18</td>
<td>5 - 15</td>
<td>&quot;</td>
<td>29, 30</td>
<td>5 - 0</td>
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<td>&quot;</td>
<td>7 - 8</td>
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<td>31, 32</td>
<td>5 - 12</td>
</tr>
<tr>
<td>&quot;</td>
<td>9, 10</td>
<td>6 - 5</td>
<td>&quot;</td>
<td>21, 22</td>
<td>5 - 12</td>
<td>&quot;</td>
<td>33, 34</td>
<td>5 - 13</td>
</tr>
<tr>
<td>&quot;</td>
<td>11, 12</td>
<td>6 - 4</td>
<td>&quot;</td>
<td>23, 24</td>
<td>5 - 13</td>
<td>30 days</td>
<td>-</td>
<td>88 - 6</td>
</tr>
</tbody>
</table>

Among the odds and ends are found:--A cow in New Jersey that in four weeks in June, 1876, made 75½ lbs. of butter, and a heifer which calved at twenty-two months old was milked for 811 consecutive days, and produced an average of one pound of butter a day during that time. Yet, in Allen's "American Cattle," doubt is expressed as to the accuracy of Yornitz's statement that Jersey cows have been known to make 19 lbs. of butter a week.

Swiss.—Although no herd products of this breed are to be found yet in the United States, there is a careful record of the butter-yield by one cow which deserves mention. "Swiss Bessie," thoroughbred, was dropped March 15th, 1872, and owned from time of third calving, October, 1877, by Mr. D. G. Roberts, of Pittsfield, Massachusetts.
Her fourth and fifth calves were dropped in August, 1878, and October, 1879, and her sixth was due October, 1880. Her total milk yield for three years—October 1st, 1877, to October 1st, 1880—was 27,729 lbs., and butter made 1,662 lbs.; annual average 9,243 lbs. milk and 554 lbs. butter. The ratio of butter to milk is very high—1 to 16½, or 1 lb. of butter for every 7½ quarts of milk, for the whole period. At times, for a month or more, it required but 13 lbs. of milk to make 1 lb. of butter. The product of "Swiss Bessie" for the calendar year 1879, during which she was dry two months, was 9,291 lbs. milk and 611 lbs. butter.

Mixed Herds.—The only other milk yields to be cited are those of the mixed herds of dairy-cows as they exist in the great cheese-making districts of New York. Natives predominate in these, mixed with many grades of various kinds, and a considerable number of thoroughbreds of different breeds. The figures are taken from the reports of the cheese-factories. In 1864, 125 factories, receiving the milk of 128,528 cows, showed an average yield per cow for “the factory season” (say 200 days) of 1,066 quarts of milk. In 1874 the same factories substantially showed the average yield to be 1,411 quarts. Here is evidence of a marked improvement in the quality of the stock, a gain of 33 per cent. in the product in ten years.

Professor Arnold gave the average of these New York factory herds of mixed stock in 1874 as 1,753 quarts for the best, the poorest 1,027 quarts, and the highest for any one dairy during nine months 2,682 quarts. These estimates practically agree with those of Dr. Sturtevant previously given. But in a review of the census figures made in January, 1879, Professor Arnold expresses the opinion that the quantity of milk consumed by the producers has been under-estimated, and on the new basis he places the average annual milk product of the dairy-cows of New York at 3,655 lbs. or 1,701 quarts of milk. In Massachusetts, twenty-five factories in the year 1864 reported 12,130 cows, averaging 1,400 quarts for 250 days, and the State census for 1875 gives the annual average product 1,900 quarts per cow.

For comparison, a summary of the foregoing is given in tabular form:

<table>
<thead>
<tr>
<th>Breed</th>
<th>General Averages</th>
<th>Best Herds</th>
<th>Best Single Cows</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Milk</td>
<td>Butter</td>
<td>Milk</td>
</tr>
<tr>
<td>&quot;Natives&quot;</td>
<td>4,066</td>
<td>380</td>
<td>4,710</td>
</tr>
<tr>
<td>Mixed Herds</td>
<td>3,656</td>
<td>263</td>
<td>5,870</td>
</tr>
<tr>
<td>and Grades</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shorthorns</td>
<td></td>
<td></td>
<td>6,880</td>
</tr>
<tr>
<td>Holsteins</td>
<td>11,261</td>
<td>908</td>
<td>15,900</td>
</tr>
<tr>
<td>Jersey</td>
<td>5,446</td>
<td>238</td>
<td>5,483</td>
</tr>
<tr>
<td>Swiss</td>
<td>4,987</td>
<td>281</td>
<td>5,017</td>
</tr>
</tbody>
</table>

Value of American Dairy Cattle.

Milk-cows reached their highest average value in the United States about the year 1870, and from that time a sharp decline took place. Mr. Dodge places the average value at 30 dollars in 1870, and at 26 dollars in 1875, these figures being intended for the country at large, and to include all cows except the choicest thoroughbreds. Their nominal prices are so entirely out of proportion to their numbers as to be properly excluded from a general average. A buyer and seller of dairy-cows in Pennsylvania kept a record of prices for forty years, with the following result:—Average price for forty years, 39 dollars; extreme annual averages, 19 dollars in 1861 and 55 dollars in 1867; for twenty-five years prior to 1861 the range was from 18 to 40 dollars, the average 27 dollars, and from 1861 to 1876 the range was from 40 to 100 dollars, average 65 dollars. At three public sales of average dairy-cows held in Pennsylvania and New York in 1877 these prices were obtained—43 dollars each for 20 cows, 53 dollars for 25, and 52 dollars for 55. In 1878 the value of fair cows in the dairy districts averaged about 50 dollars. In New York City good milk-cows sold for from 50 to 60 dollars, and extra ones for 70 or 80 dollars. Mr. Thomas Fitch, of New London, Connecticut, writes: “In giving you prices obtained for the dairy-stock raised by me, thoroughbreds, cross-breds, and grades, I select two years, ten years apart. In 1866 I sold 53 head of all ages at an average price of 118 dollars; highest 350 dollars for a cow, lowest 35 dollars for a grade heifer calf. In 1877 sold 34 head at an average of 144 dollars; highest 515 dollars for a cow, lowest 10 dollars for a heifer calf.” Some idea
of the prices of thoroughbred neat stock in the United States can be obtained from the following statements:

Jerseys: At public sales of about five hundred animals of this breed during the years 1877 and 1878, occurring in widely separated places, the average prices obtained were 233 dollars per head for females and 93 dollars for males. At a large sale of newly-imported Jerseys held at Albany, New York, in May, 1878, an average of over 400 dollars per head was obtained; at another, in New York City, 380 dollars per head for 20 two-year-old heifers; and at a third, in Philadelphia, bulls averaged 265 dollars and cows and heifers 427 dollars. A remarkable sale of Jerseys, largely American-bred and recorded animals, occurred at New York in May, 1880, and is known as the "Kellogg sale." Fifty-one cows and heifers averaged 298 dollars, and 5 bulls 229 dollars. One bull sold for 600 dollars, and two heifers were struck off at 1,400 and 1,425 dollars respectively, these being the highest prices ever realised in the United States at a public sale of this breed. During the year 1880 several private sales were reported at very high rates, bulls at 1,000 dollars, and cows at 2,000 and upwards. Bonâ fide offers of 5,000 dollars were made and refused for a single cow. Colonel Waring, Secretary of the American Jersey Cattle Club and Manager of the Ayrshire Cattle Association, reports among the operations of that famous establishment, covering ten years ending in 1877, purchases of Jerseys, 23 males at an average cost of 47 1/2 dollars and 16 females at 190 dollars; sales, 60 males, average price 99 dollars, and 83 females, average 216 1/2 dollars. In 1885, in New England, a Jersey cow (then generally called Alderney), giving 12 quarts of milk a day, and making 12 lbs. of butter a week, was worth 100 dollars. Guernseys, less fashionable, are lower in price, sales in 1878 giving averages of 176 dollars for females and 103 dollars for males. Ayrshires may be quoted at about the same rates. But as an example of the choicest animals of this breed, the Messrs. Sturtevant report that, in making up the Waushakum herd, the males were purchased at an average cost of 92 1/2 dollars, the females at 100 dollars. Good Ayrshire cows change hands in America at from 100 to 200 dollars. At a sale of Holsteins in Central New York in February, 1880, an average of 238 dollars was obtained. Devon sales are not often reported in the United States. At one of 35 animals in Connecticut in 1875 the prices ranged from 150 to 300 dollars; in 1878 a bull and three good cows sold together for 1,000 dollars. Fifteen American-bred Here-fords, all in the English herd-book, were sold in Maryland, June, 1880, at an average of 225 dollars. Shorthorn sales occurring in all parts of the country in 1877 and 1878, none of them being of very fancy stock, give 287 1/2 dollars as the average price obtained for 577 females, and 181 dollars per head for 185 bulls. The "Shorthorn Herd-Book" reports 834 sales occurring from 1870 to 1876, including 14,816 animals, the general average price being 393 dollars, but this average was largely raised by a few extraordinary sales like that of the Campbell herd in 1876 (see page 13).

The Cultivator and Country Gentleman (Albany) publishes an annual summary of its reports of public Shorthorn sales. For the ten years ending with 1879 the record of this journal includes 22,929 head, sold for an aggregate of 7,218,361 dollars, an average of 315 dollars. In the year 1879 there were 2,65 animals sold averaging 115 dollars; this is a great reduction, but the offerings included a larger number of ordinary creatures. Two examples are these:— First, the Cannon-Cochrane sale, at Dexter Park, Chicago, June 30, 1880, when 32 cows and heifers averaged 93 5/10 dollars, and 11 bulls and calves 662 dollars, all being choice stock; second, a sale of very good animals of the same breed, 38 in number, at the same place, the next day, resulting in an average of 189 dollars. The greater part of these Shorthorns, however, relate to beef-production, and have hardly a perceptible effect upon dairy-stock in America.

H. E. A.
CHAPTER XXVII.

AMERICAN DAIRY PRODUCTS.


REAT as the produce of the dairy in America has been for a number of years, the total production has been much exaggerated. Without data on which to base calculations as to the quantity of milk sold for use while fresh, and consumed by families of producers, the number of cows in the country whose product does not affect the making of butter and cheese is quite uncertain. Likewise the amount of butter consumed by the families of the makers is largely a matter of speculation, and it is upon the annual butter product of the United States that the wildest figures have been given. Cheese manufacture has been more sectional, and the facts in regard to it better known. The amount of cheese made in a year by the average American cow, the number of cows whose milk is made into cheese, and the average quantity of milk required for a pound of cheese, are among the most established facts of the dairy, and furnish a good basis for calculation. A careful study of all the reliable data leads to the conclusion that of the 12,000,000 cows owned in the United States, just about one-half contribute to the annual butter crop; the milk of about 1,000,000 cows is made into cheese; and that of the remainder is consumed as milk. It is probable, however, that 1,500,000 cows are used for breeding rather than the dairy, and their milk does not contribute to the dairy products of the country. As to the gross products, it has been often asserted, and in places where one may expect to find trustworthy dairy information, that 1,500,000,000 lbs. of butter are annually made in the United States. This is simply absurd, for it would require a product of 250 lbs. for every one of the 6,000,000 butter-making cows, which is almost double the general average. The census of New York for 1875, already referred to as specially reliable in dairy statistics, gives the average butter yield for the cows of that State as 133 lbs. a year. Certainly a lower rate must be taken for the country at large. An average of 125 lbs. a year gives a total product of 750,000,000 lbs., and 133 lbs. per year a total of 800,000,000 lbs. of butter. Between these figures the true amount probably stands in 1880, the whole worth about 200,000,000 dollars. There is a general agreement that the United States cheese crop of 1880 is from 300,000,000 to 350,000,000 lbs., or an average of 300 lbs. per annum per cow. Milk consumed, new and skimmed, exceeds the butter in value, and carries the total value of the United States dairy products to 408,000,000 dollars. The following statistics, derived from the United States census, are manifestly far below the truth, the amounts consumed by producers being doubtless often omitted, at least prior to 1870. The figures for 1875 and 1880 are estimated as already explained:

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Cows</th>
<th>Butter made</th>
<th>Cheese made</th>
<th>Milk Sold and Used</th>
<th>Total Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1849</td>
<td>1,537,683</td>
<td>213,345,396</td>
<td>105,553,858</td>
<td>973,568,111</td>
<td>125,956,765</td>
</tr>
<tr>
<td>1850</td>
<td>6,202,914</td>
<td>313,345,396</td>
<td>105,553,858</td>
<td>973,568,111</td>
<td>166,135,111</td>
</tr>
<tr>
<td>1859</td>
<td>8,305,735</td>
<td>493,309,954</td>
<td>105,576,135</td>
<td>1,225,000,000</td>
<td>210,100,500</td>
</tr>
<tr>
<td>1870</td>
<td>8,905,232</td>
<td>314,092,680</td>
<td>102,957,379</td>
<td>200,000,000</td>
<td>230,000,000</td>
</tr>
<tr>
<td>1875</td>
<td>11,000,000</td>
<td>700,000,000</td>
<td>210,000,000</td>
<td>2,000,000,000</td>
<td>400,000,000</td>
</tr>
<tr>
<td>1880</td>
<td>12,000,000</td>
<td>800,000,000</td>
<td>300,000,000</td>
<td>2,000,000,000</td>
<td>400,000,000</td>
</tr>
</tbody>
</table>

The following may be added for the Dominion of Canada:

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Cows</th>
<th>Butter made</th>
<th>Cheese made</th>
<th>Milk Sold and Used</th>
<th>Total Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1871</td>
<td>1,292,839</td>
<td>22,277,747</td>
<td>22,277,747</td>
<td>200,000,000</td>
<td>50,000,000</td>
</tr>
<tr>
<td>1880</td>
<td>1,500,000</td>
<td>75,000,000</td>
<td>75,000,000</td>
<td>200,000,000</td>
<td>50,000,000</td>
</tr>
</tbody>
</table>

The foregoing is as accurate a showing of the gross products of American dairying as can be given from the data available.

As to the disposition made of these products, the home consumption and domestic markets of
America will be first considered. The three
different forms in which dairy products are used
and sold vary so much in the conditions affecting
them as to necessitate separate treatment.

It has already been stated, in describing the
location of dairying in America, that the local
butter markets can be and are, generally, locally
fed, this being true even in the South, excepting
the cities. Of the annual gross butter product of
the United States and Canada, it may be roughly
stated that 30 per cent. is used by the producers
or in neighbourhood exchange, that 50 per cent.
more is disposed of in local markets, delivered
by the maker to village families or handled by
only one trader before reaching the consumer,
and that the remaining 20 per cent. goes to
the great centres of trade, and passes through
the hands of three to five classes of dealers,
between the producers and the consumers. In
the local markets the grocers or dealers in general
merchandise in the towns and country stores
receive the butter from the farmers in exchange
for goods, in the form of printed pound lumps
or rolls varying from 1 to 5 lbs. in weight, and
retail it to the various classes of consumers.
For many years no distinction of grade was made
—a pound of butter was a pound of butter, all
bought and sold at the same price, irrespective
of how or by whom it was made. This remains
the custom in country districts remote from trade
centres, and where dairying is not a specialty;
and in the stores of villages and country towns
in more thickly-populated regions only two grades
are generally known—table butter and cooking
butter. Of course there are exceptions in nearly
every locality, some makers commanding an extra
price for their butter, usually delivered directly
to the consumers, and some whose product is
so poor that the only place it finds in market
is as grease. When the butter is to go into
the wholesale trade it is generally collected from
the producers by village merchants who act as
forwarders to the city commission produce houses.
For this trade the butter is mainly packed in solid
mass in packages of different sizes and kinds,
almost universally of wood. There are round boxes
with covers, holding 10, 12, and 15 lbs.; pails, "re-
turn pails," and tubs, usually holding 40 to 60 lbs.;
and firkins or barrel-shaped packages of 100 lbs.;
also small pails, half-tubs, and half-firkins. This
matter of the size and shape of the package differs
with locality. There are local merchants in
different parts of the country who buy butter of
the producers in lots of different size, of varied
quality and colour, and then, to render it more
saleable in the large markets, they work it all
over together, generally with a machine, wash
it frequently, often purify it in some way, colour
it uniformly, and then pack it in tubs or firkins;
this is usually called "milled butter." In like
manner dairy butter from numerous farms is
collected, re-worked, re-packed, and sold as a factory
product, being known to the trade as "imitation
creaming." In Canada and parts of the United
States a good deal of butter is sent to market
in large cylindrical rolls, each wrapped in cloth,
and these packed in a tight firkin or barrel,
generally in strong brine, sometimes in dry salt.
Many good dairymen in different sections who
have a special line of customers put up their
butter in pound or half-pound prints, or other
attractive forms, and in packages specially
adapted to this method ship directly to con-
sumers or to fancy grocers and marketmen, for
immediate retailing. Another method, first prac-
tised in 1879 and 1880, is to take the butter from
the churn in granular form before it gathers,
wash thoroughly, work not at all, but place loosely
in a tight vessel, which is then filled with strong
pure brine and sealed up. In this form butter
may go to market fresh, be preserved for a long
time, and at pleasure removed from the brine,
slightly worked, salted to taste, and made into
pats or prints as "rosy" as if just from the
churn.

St. Albans, Vermont, furnishes a good ex-
ample of an American dairy market, with butter as
a specialty, and well illustrates the development
and growth of such a market. This place is the
shire town of Franklin County, in the north-west
corner of Vermont, 63 miles south of Montreal,
and about 200 miles from Boston. The sur-
rrounding country in New York as well as in
Vermont is an excellent butter-making region. In
the year 1825, although butter was plentiful and
sold at 10 and 12 cents a pound, there was no
special market and not a great surplus; the accum-
ulations of the season were usually sent overland
in the winter to the Montreal market. About 1840
a larger surplus of butter was noticeable, and the
shipments turned towards New York, water trans-
portation being depended upon, and consignments
made in the autumn only. In 1850 the construction of railroads opened a quick route from St. Albans, created its market, and made Boston the objective point. At that time the town had a population of 3,500, no trade organisation—not has it yet—and no special market day. The dairymen of the surrounding country brought in their butter at pleasure, and it was bought up by jobbers and resident agents of Boston dealers. In 1854 a weekly refrigerator-car began to run from St. Albans to Boston for the butter shipments, and this made Tuesday the butter day, and gave more system to the trade. No material change has since occurred. Every Tuesday, from daylight until noon, the streets of St. Albans, now a town of over 7,000 inhabitants, are filled with vehicles of all descriptions laden with butter and cheese, their contents are sampled and graded by numerous buyers, sales effected, and the packages delivered directly to the railroad agents. For some years the greater part of the buying has been done by local experts, on commission, for the large city operators; the commission was one cent a pound for a long time, but has considerably decreased, and become largely subject to special contracts.

As to quality, but three grades were formerly known—prime, fair, and poor, and the quantity of each ranged just about one-third. Of late years there has been more care in assorting, and a greater proportion of the product has been placed in the higher grades, but very little in the highest. The following table gives the shipments of butter from St. Albans, at intervals since 1850:

<table>
<thead>
<tr>
<th>Years</th>
<th>1850</th>
<th>1855</th>
<th>1860</th>
<th>1865</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lbs. of Butter</td>
<td>1,925,968</td>
<td>1,713,127</td>
<td>2,256,700</td>
<td>3,635,277</td>
</tr>
<tr>
<td>1850</td>
<td>1855</td>
<td>1860</td>
<td>1865</td>
<td></td>
</tr>
<tr>
<td>3,270,182</td>
<td>2,972,431</td>
<td>2,555,325</td>
<td>1,778,700</td>
<td>1,182,050</td>
</tr>
</tbody>
</table>

During twenty years, ending in 1870, the shipments amounted to 50,631,595 lbs., valued at about 15,000,000 dollars, and during the same period cheese to the amount of 21,000,000 lbs., valued at about 3,000,000 dollars. Nearly all the butter passing through the St. Albans market is in tubs of spruce and white oak containing just about 50 lbs. each. The rapid falling-off in the shipments from this point since 1870 has been owing, first, to branch railroads, which take up butter at local stations which formerly went to swell the receipts at St. Albans, and next to Western competition in the Boston market. In the great butter-markets of the country it is found that not over 2 per cent. of the total receipts can be classed as "fancy" or "gilt-edged," and but about 10 per cent. as really first-class, bringing top prices in the wholesale trade. The consumption of butter varies in the United States in different localities, and among different classes of people, from 12 lbs. to 25 lbs. per head per annum. The general average is not far from 15 lbs.

The conditions governing the trade in cheese and butter-markets differ greatly from those relating to butter. Cheese has never been so generally made in America by the owners of dairy-cows as butter, and the rapid substitution of factory cheese-making for private dairying has also made great changes. So now very little cheese is made except in the distinctively cheese regions. The contrast may thus be seen:—The census shows an annual product in thirty-three States and Territories of more than 1,000,000 lbs. of butter each, but only eleven produce more than 1,000,000 lbs. of cheese; twenty-nine States and Territories produce more than 2,000,000 lbs. of butter, but only six produce as much cheese. One of the results of this condition of the cheese production is that the article passes through the hands of several dealers before reaching the consumer, and another is that the cheese trade of the country is very greatly concentrated. So much was this the case that, as late as 1860, one man attempted a "corner" in the American cheese trade; New York and five adjoining States then produced nine-tenths of the whole cheese crop of the country, and the greater part of this was engaged in advance. A disastrous failure resulted, but this illustrates the concentration of the cheese trade; no one would ever have attempted a similar control of the butter product of the country. In retailing it has been quite common for years for the selling price of cut cheese to be double the current wholesale rates, and retailers often received a profit of 50 to 80 and even 100 per centum on cheese sold to consumers, when selling butter for just what they paid for it in groceries, or at a very small profit. This doubtless accounts, in a great measure, for the very low per capita consumption of cheese in America, which is from 1 lbs. to 5 lbs. per annum. There is in progress, however, a rapid increase in the rate of home consumption of cheese; the aggregate increase is estimated
DAIRY FARMING.

by good judges to be from 12,000,000 lbs. to 15,000,000 lbs. per year. Local markets have been created in many places by catering to the popular tastes and prejudices in the matter of size, form, and colour of the cheeses offered for sale, and retailers are beginning to see that the old maxim of "quick sales and small profits" is as true when applied to cheese as to other merchandise. In some places such special efforts have been found to increase the average annual consumption in the community to over 20 lbs. per capita. A case is authenticated where careful investigation showed the per capita consumption to vary in the years 1872 to 1875 from 8 to 11 lbs.; then, by special efforts to make cheese a more attractive and more common article of food, the rate was raised to 14 lbs. in 1876, 17 lbs. in 1877, and about 20 lbs. in 1878.

Little Falls, Herkimer County, New York, is probably the best example of American cheese-markets. The great cheese product of that county and the advantageous location of the town made it at an early date a centre for the sale of dairy products. It is a town of 6,000 inhabitants, situated in a rocky gorge cut through the hills by the Mohawk River, directly upon that stream, on the New York Central Railroad, midway between Albany and Syracuse, and near the Erie Canal. The market character of the place was acquired spontaneously, the dairymen coming there to sell by common consent. At first trade was very irregularly conducted, producers and buyers visiting the town at their convenience, and meeting largely by chance. But the business soon systematised itself, and as early as 1858 Mondays and Wednesdays became regular sale days, sellers from farm dairies in large number coming in with their loaded wagons, and meeting buyers from the Eastern cities, their agents and local dealers. The wagons were scattered along the streets, and these, with the railroad freight house, formed the marketplace. From 1860 to 1864, after the factories became pretty well established, Mondays only were regular market days. In 1864 weekly reports of the Little Falls cheese-market began, and have continued a standard reference from that time; the transactions are specially reported for many of the leading city newspapers, the quotations telegraphed the country over, and the prices there obtained have a marked influence upon the city markets for the week. The business continued to be chiefly done upon the streets until 1871. In the spring of that year a Board of Trade, purely in the dairy interest, was organised at Little Falls, largely through the efforts and under the guidance of X. A. Willard, with whom the idea originated. On the 10th of July, 1871, the commodious trade rooms of the Board were formally opened, and to them the greater part of the transactions were then transferred. Other Boards of Trade were soon organised at different dairy centres, most of them being modelled closely after this original; the locations of several of them have been already named. This Little Falls Board, although a purely local business institution, made the mistake of trying to attach to itself a "New York State Dairymen's Association," with meetings and management controlled by the local Board; this has created jealousies and rivalry, impaired the usefulness of the organisation, and more or less dispersed the business, sending some of it upon the streets again. But as a whole the Little Falls trade continues to grow, and the town remains one of the largest dairy-markets of the world. Not only is the greater part of the Herkimer County cheese product sold there, but much from the neighbouring counties of Fulton, Otsego, Montgomery, &c. Since the factory-made cheese has become nineteen-twentieths or more of the total product, the sales are greatly facilitated. Factory cheese is now so uniform in quality that it is generally sold on Mondays by sample, and shipped the next day from railway stations nearest to the factories. Thus a very large part of the amount sold at Little Falls is never brought to that place, and does not appear in the report of shipments therefrom. The usual method is for each factory agent or seller to take a sample or cylindrical cutting with a tryer from one cheese of every vat of milk for every day of the cheese offered; these cuttings are placed in little glass bottles which fit a pocket-case (Fig. 219), and sales made from them at the market. The reputation of the several factories largely influences the sale of their products, and indeed sales are often made.
This table has little value, however, beyond showing this variation, because the railroad shipments form but about one-half of the season’s sales at this market. It should be added that the prices of cheese at Little Falls generally run as high as anywhere else in the country, being often equal to New York City rates, where the same product is largely re-sold.

As these Dairy Boards of Trade are so numerous in America, prove such a help in business, and have a general resemblance, it may be well to state the leading features embraced in their governing rules:—Membership open to any bond fide producer, factory agent, or dealer, on payment of annual fee from one to five dollars, private dairymen being taxed less than factories; sales-rooms or head-quarters for convenient transaction of business on fixed market days, and only members entitled to the privileges (a small fee in some cases gives privilege of rooms to any one for a single market day); registration on each sales-day of sellers and their offered products, and of buyers; an executive officer, usually the secretary, in the charge of the rooms, of membership of the bulletin, and of the records of the Board and the transactions of the market; a bulletin, and upon it, conspicuously displayed on market days, quotations, telegrams as to exports and business information bearing upon the trade from New York; foreign and domestic markets; a board of arbitration for settlement of all differences between buyers and sellers, &c.; committees to grade products, to facilitate trade and transportation—and minor regulations.

Utica, twenty-two miles west of Little Falls, has become a dairy market of almost equal size and importance. It is a city of over 30,000 inhabitants, with a large general business. The following is a comparative and interesting statement of the cheese trade for three years, at both Utica and Little Falls, taken from the very comprehensive reports of Mr. B. D. Gilbert, Secretary of the Board of Trade at Utica:

<table>
<thead>
<tr>
<th>Month</th>
<th>1876</th>
<th>1877</th>
<th>1878</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>326</td>
<td>15,215</td>
<td>665</td>
</tr>
<tr>
<td>February</td>
<td>1,206</td>
<td>77,909</td>
<td>771</td>
</tr>
<tr>
<td>March</td>
<td>2,236</td>
<td>141,382</td>
<td>1,146</td>
</tr>
<tr>
<td>April</td>
<td>6,868</td>
<td>555,395</td>
<td>3,508</td>
</tr>
<tr>
<td>May</td>
<td>5,623</td>
<td>391,112</td>
<td>10,616</td>
</tr>
<tr>
<td>June</td>
<td>12,517</td>
<td>773,360</td>
<td>43,376</td>
</tr>
<tr>
<td>July</td>
<td>11,301</td>
<td>928,965</td>
<td>18,141</td>
</tr>
<tr>
<td>August</td>
<td>18,987</td>
<td>1,332,720</td>
<td>10,917</td>
</tr>
<tr>
<td>September</td>
<td>12,928</td>
<td>816,028</td>
<td>11,435</td>
</tr>
<tr>
<td>October</td>
<td>12,878</td>
<td>781,635</td>
<td>17,790</td>
</tr>
<tr>
<td>November</td>
<td>7,366</td>
<td>450,899</td>
<td>19,367</td>
</tr>
<tr>
<td>December</td>
<td>2,262</td>
<td>148,378</td>
<td>4,937</td>
</tr>
<tr>
<td>Total</td>
<td>94,730</td>
<td>5,021,563</td>
<td>111,053</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>1877</th>
<th>1878</th>
<th>1879</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utica</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sales of Boxes ...</td>
<td>205,713</td>
<td>322,535</td>
<td>301,559</td>
</tr>
<tr>
<td>Highest price obtained Cents.</td>
<td>15</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Lowest price obtained</td>
<td>8</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>General average for Season</td>
<td>11 1/2</td>
<td>8 1/2</td>
<td>8 1/2</td>
</tr>
<tr>
<td>Value of Total Sales ... Dells.</td>
<td>1,430,991</td>
<td>1,686,923</td>
<td>1,488,553</td>
</tr>
</tbody>
</table>

| Little Falls |      |      |      |
| Sales of Boxes ... | 208,847 | 281,618 | 241,943 |
| Highest price obtained Cents. | 15 | 12 1/2 | 14 |
| Lowest price obtained | 8 1/2 | 6 | 4 |
| General average for Season | 11 1/2 | 8 1/2 | 7 1/2 |
| Value of Total Sales ... Dells. | 1,481,017 | 1,431,013 | 1,149,566 |

Mr. Gilbert, in October, estimated the sales for the season of 1880 at 284,198 boxes for Utica, and 237,277 boxes for Little Falls, with an average price of 12 cents. At these two markets the season usually begins in April and closes early in December; the business of the Boards at both places is so well maintained that it is rare for a single market day to pass without the occurrence of sales.

Sales of milk, for use in families, are made in almost all cases, the country over, by the producer direct to the consumer, the large cities excepted. In many American towns and villages families keep a cow who own no other domestic animal; sometimes two families unite in the ownership of a cow, dividing the product.
often the owner of a single animal supplies a
neighbour or two with milk. The milk supply
of the villages and towns in general is conducted
in a most varied and unsystematic manner; the
owner of one or two cows carries the milk on
foot from door to door—the keeper of a few
animals delivers to his customers with his own
waggon—the milkman "owning a milk-route"
and an "outfit" takes the milk of several farmers
and retails it, or two or three neighbouring farmers
unite in maintaining one milk waggon and route
to dispose of their products. Although one middle-
man may thus be employed in some cases, the
milk for even large towns and small cities is,
for the most part, conveyed by waggons, without
change, from the farm where produced to the
door of the consumer. The maximum distance
regarded practicable for cartage and delivery
is fifteen miles. Under this system the milk is
generally strained into the can, and started for
its destination withoutcooling, thus greatly im-
pairing its keeping qualities. In connection with
the large cities, railroad transportation, the hand-
ling of milk in large quantities, and a regularly
systematised trade are to be found, with com-
mission merchants, wholesale and retail dealers,
milk depôts and retail stalls. Transportation by
rail for over 200 miles is not uncommon. Milk
thus marketed is taxed to support at least three
sets of middlemen, and yields to the producer
from one-third to one-half of the price finally
paid by the consumer. This branch of the sub-
ject will be further noticed under another head.
Nearly all milk for use as food goes to market
in tin cans; these vary in size from 1 to 10
gallons, according to local custom. The average
annual consumption of milk per capita in the
United States cannot be given with any pre-
tence to accuracy; a mean estimate is 100 quarts,
or less than ½ pint a day. Several country ex-
periments have indicated 1 pint a day, one in a
manufacturing town ¾ pint, and the New York
City consumption has been estimated at ¾ pint
daily, per capita.

All the facts and figures of the domestic
markets refer only to the manufactured articles
butter and cheese, and generally as prepared
for the wholesale trade. Butter is usually re-
ported in "packages," and cheese in "boxes." Where weights are not added the former may
be computed at 50 lbs. per package, the latter
at 60 lbs. per box. There is a marked tendency,
however, to forward dairy products in smaller
parcels, in response to the demands of consumers
and the distributing trade. Whereas the ordinary
weight of a cheese prior to 1850 was 100 lbs. or
more, the average at Little Falls in 1878 was 57
or 58 lbs., and 30 lbs. cheese have proved very
acceptable, bringing prices a shade above others
of like quality, because of the size. In butter,
the home markets are drifting toward a fresher
article and less packed, and so small packs, as well
as 1, 2, and 4 lb. packages of different forms,
retailed unbroken from the dairy or creamery,
meet with decided favour.

The transactions of other domestic markets
must be very briefly mentioned. Elgin is to
Illinois and the north-west what Little Falls,
Utica, and St. Albans are to the east, the
centre of dairy interests; and its market largely
influences the trade of that whole section. In
the year 1850 there were not a dozen farms
specially devoted to dairying in the vicinity of
Elgin; in 1878 there were forty butter and cheese
factories within a radius of twelve miles, besides
a very large milk-condensing factory. Previous to
1872 the sales were mostly made through com-
mission merchants, but in that year a Board of
Trade was organised, and its sales during the five
years following amounted to nearly 3,000,000
dollars. The following statistics, furnished by
Mr. R. P. McGlinney, who has been the Secretary
of the Elgin Board from its organisation, exhibit
the rapid increase of sales at that market:

<table>
<thead>
<tr>
<th>Years</th>
<th>Butter</th>
<th>Prices</th>
<th>Cheese</th>
<th>Prices</th>
<th>Value Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>1872</td>
<td>lbs.</td>
<td>81</td>
<td>cents</td>
<td>lbs.</td>
<td>12</td>
</tr>
<tr>
<td>1873</td>
<td>62</td>
<td>28</td>
<td>35</td>
<td>1,766</td>
<td>9</td>
</tr>
<tr>
<td>1874</td>
<td>136</td>
<td>52</td>
<td>40</td>
<td>2,350</td>
<td>10</td>
</tr>
<tr>
<td>1875</td>
<td>235</td>
<td>55</td>
<td>38</td>
<td>3,000</td>
<td>9</td>
</tr>
<tr>
<td>1876</td>
<td>579</td>
<td>55</td>
<td>29</td>
<td>6,000</td>
<td>8</td>
</tr>
<tr>
<td>1877</td>
<td>1,174</td>
<td>42</td>
<td>30</td>
<td>6,350</td>
<td>7</td>
</tr>
<tr>
<td>1878</td>
<td>1,118</td>
<td>42</td>
<td>27</td>
<td>4,240</td>
<td>4</td>
</tr>
<tr>
<td>1879</td>
<td>977</td>
<td>40</td>
<td>31</td>
<td>4,185</td>
<td>3</td>
</tr>
<tr>
<td>1880</td>
<td>2,525</td>
<td>39</td>
<td>10</td>
<td>10,000</td>
<td>7</td>
</tr>
</tbody>
</table>

Milwaukee, Wisconsin, received in 1878 about
5,000,000 lbs. of butter and an equal quantity
of cheese. The receipts of San Francisco for the
same year were 14,000,000 lbs. of butter and
nearly 10,000,000 lbs. of cheese. The markets
thus far named, as well as others previously
mentioned as centres of trade in describing the
dairying districts, indicate the activity of this
interest in their surrounding country. They are receiving and forwarding depôts. The dairy trade for distribution through the most populous Eastern sections, and in connection with exports, centres at the great cities.

New York is, of course, the most important and interesting wholesale market of dairy products in America. The Butter and Cheese Exchange was organised there in 1873, and opened trade rooms in September of that year; the title has since been unfortunately changed to American Exchange, a term so general as to be without significance. The following receipts at New York were reported for the trade:

<table>
<thead>
<tr>
<th>Year</th>
<th>Butter, in Packages</th>
<th>Cheese, Boxes</th>
<th>Year</th>
<th>Butter, in Packages</th>
<th>Cheese, Boxes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1870</td>
<td>559,615</td>
<td>3,111,925</td>
<td>1871</td>
<td>531,302</td>
<td>2,007,063</td>
</tr>
<tr>
<td>1872</td>
<td>690,658</td>
<td>1,714,210</td>
<td>1873</td>
<td>1,675,655</td>
<td>2,335,353</td>
</tr>
</tbody>
</table>

The fluctuations in the market and the activity of the trade at different seasons of the year can be seen from the following tables of monthly receipts and prices at New York, for three selected years:

**Butter in Packages of about 50 lbs. each. Prices in cents per lb. for fine Creamery and New York State Dairy.**

<table>
<thead>
<tr>
<th>Month</th>
<th>1874</th>
<th>1875</th>
<th>1876</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>79.670</td>
<td>39 to 45</td>
<td>79.308</td>
</tr>
<tr>
<td>February</td>
<td>54.602</td>
<td>42 to 46</td>
<td>54.225</td>
</tr>
<tr>
<td>March</td>
<td>15.205</td>
<td>43 to 47</td>
<td>15.104</td>
</tr>
<tr>
<td>April</td>
<td>61.694</td>
<td>36 to 39</td>
<td>60.367</td>
</tr>
<tr>
<td>May</td>
<td>22.853</td>
<td>32 to 34</td>
<td>22.818</td>
</tr>
<tr>
<td>June</td>
<td>107.671</td>
<td>38 to 39</td>
<td>104.311</td>
</tr>
<tr>
<td>July</td>
<td>95.985</td>
<td>29 to 32</td>
<td>95.133</td>
</tr>
<tr>
<td>August</td>
<td>91.692</td>
<td>30 to 33</td>
<td>88.843</td>
</tr>
<tr>
<td>September</td>
<td>90.402</td>
<td>33 to 36</td>
<td>90.176</td>
</tr>
<tr>
<td>October</td>
<td>99.088</td>
<td>30 to 40</td>
<td>104.767</td>
</tr>
<tr>
<td>November</td>
<td>105.138</td>
<td>35 to 38</td>
<td>126.860</td>
</tr>
<tr>
<td>December</td>
<td>102.387</td>
<td>35 to 38</td>
<td>94.149</td>
</tr>
</tbody>
</table>

**Cheese in Boxes of about 60 lbs. each. Prices in cents per lb. for New York State Factory.**

<table>
<thead>
<tr>
<th>Month</th>
<th>1874</th>
<th>1875</th>
<th>1876</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>25.320</td>
<td>11 to 15</td>
<td>13.170</td>
</tr>
<tr>
<td>February</td>
<td>46.045</td>
<td>10 to 17</td>
<td>26.365</td>
</tr>
<tr>
<td>March</td>
<td>26.915</td>
<td>12 to 17</td>
<td>26.724</td>
</tr>
<tr>
<td>April</td>
<td>16.579</td>
<td>12 to 17</td>
<td>21.930</td>
</tr>
<tr>
<td>May</td>
<td>39.082</td>
<td>10 to 16</td>
<td>117.528</td>
</tr>
<tr>
<td>June</td>
<td>160.333</td>
<td>11 to 12</td>
<td>162.533</td>
</tr>
<tr>
<td>July</td>
<td>205.333</td>
<td>11 to 14</td>
<td>201.273</td>
</tr>
<tr>
<td>August</td>
<td>348.591</td>
<td>13 to 18</td>
<td>345.542</td>
</tr>
<tr>
<td>September</td>
<td>211.030</td>
<td>11 to 14</td>
<td>305.801</td>
</tr>
<tr>
<td>October</td>
<td>170.529</td>
<td>15 to 16</td>
<td>275.629</td>
</tr>
<tr>
<td>November</td>
<td>121.017</td>
<td>13 to 16</td>
<td>128.652</td>
</tr>
<tr>
<td>December</td>
<td>70.206</td>
<td>11 to 16</td>
<td>114.333</td>
</tr>
</tbody>
</table>

The commercial years thus selected for illustration were of healthy activity, with satisfactory prices, free from feverishness and unusual fluctuations. The prices given in cents per pound are for Eastern or New York factory products. The average receipts per month were 87,215 packages of butter and 158,831 boxes of cheese. The previous table of yearly receipts shows that more than half of the whole cheese product of the United States is annually received at the New York market.

Chicago ranks next in importance, receiving and forwarding, or distributing, about 50,000,000 lbs. of butter annually and nearly as much cheese. Other late reports of the dairy trade of cities are these, being the number of pounds handled of butter and cheese respectively:

- Boston, 3,000,000 and 1,000,000
- Philadelphia, 6,000,000 and 2,500,000
- Baltimore, 6,000,000, 1,200,000
- Cincinnati, 6,000,000, 5,000,000
- St. Louis, 7,000,000, 5,000,000
- New Orleans, 5,000,000, 3,500,000

**Exports.**

The export of dairy products from America began at an early date, and has rapidly increased with every decade, although there have been periods when the trade has greatly fallen off for a few years. But with the exception of cotton and leather, there are no products of American agriculture which, from 1790 to 1850, show so great a gain in the quantity and value exported as do butter and cheese. Butter became an article of foreign commerce earlier than cheese, and exceeded the latter in the quantity annually exported until 1855. From that time there has been more cheese than butter exported annually. From 1835 to 1865 the values of the butter and cheese exports were about equal; since 1865 that of the cheese has been much greater.

Among the exports of Charleston, South Carolina, in the year 1747, is the item of 130 casks of butter, and in 1770 the American colonies exported 167,000 lbs. of butter and 56,000 lbs. of cheese. All of these products went to the West Indies, and those islands have been the steadiest and among the largest of the consumers of American butter and cheese, especially of the former. Until the interruption of the commerce of the United States by the war of 1812, the West Indies received nearly all the dairy exports. From 1820 the trade became more scattered, the British-American provinces receiving large consignments. In 1830 New York cheese began crossing the
DAIRY FARMING.

No. 7.—Exports of Dairy Products from America.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total from the United States</th>
<th>Total from Canada</th>
<th>Total Export from North America</th>
<th>Total from the United States</th>
<th>Total from Canada</th>
<th>Total Export from North America</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs</td>
<td>lbs</td>
<td>lbs</td>
<td>lbs</td>
<td>lbs</td>
<td>lbs</td>
</tr>
<tr>
<td>1770</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1790</td>
<td>470,440</td>
<td>—</td>
<td>470,440</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1800</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1810</td>
<td>1,822,141</td>
<td>—</td>
<td>1,822,141</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1820</td>
<td>1,679,300</td>
<td>—</td>
<td>1,679,300</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1830</td>
<td>1,788,212</td>
<td>—</td>
<td>1,788,212</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1840</td>
<td>666,621</td>
<td>—</td>
<td>666,621</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1850</td>
<td>849,963</td>
<td>—</td>
<td>849,963</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1860</td>
<td>1,300,949</td>
<td>—</td>
<td>1,300,949</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1870</td>
<td>1,621,177</td>
<td>—</td>
<td>1,621,177</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1880</td>
<td>2,142,367</td>
<td>—</td>
<td>2,142,367</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1890</td>
<td>2,564,094</td>
<td>—</td>
<td>2,564,094</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1880</td>
<td>3,082,117</td>
<td>—</td>
<td>3,082,117</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1890</td>
<td>3,785,963</td>
<td>—</td>
<td>3,785,963</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1850</td>
<td>4,396,690</td>
<td>—</td>
<td>4,396,690</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1860</td>
<td>4,750,912</td>
<td>—</td>
<td>4,750,912</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1870</td>
<td>5,040,914</td>
<td>—</td>
<td>5,040,914</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1880</td>
<td>5,750,914</td>
<td>—</td>
<td>5,750,914</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1890</td>
<td>6,121,367</td>
<td>—</td>
<td>6,121,367</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1850</td>
<td>6,461,367</td>
<td>—</td>
<td>6,461,367</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1860</td>
<td>6,721,367</td>
<td>—</td>
<td>6,721,367</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1870</td>
<td>7,081,367</td>
<td>—</td>
<td>7,081,367</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1880</td>
<td>7,421,367</td>
<td>—</td>
<td>7,421,367</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1890</td>
<td>7,750,914</td>
<td>—</td>
<td>7,750,914</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1850</td>
<td>8,082,117</td>
<td>—</td>
<td>8,082,117</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1860</td>
<td>8,396,690</td>
<td>—</td>
<td>8,396,690</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1870</td>
<td>8,721,367</td>
<td>—</td>
<td>8,721,367</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1880</td>
<td>9,081,367</td>
<td>—</td>
<td>9,081,367</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1890</td>
<td>9,421,367</td>
<td>—</td>
<td>9,421,367</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

* This column includes total exports from United States only.

No. 8.—Destination of the Dairy Products Exported from the United States of America.

<table>
<thead>
<tr>
<th>Year of Export and Name of Article</th>
<th>To Great Britain</th>
<th>To the British Possessions in North America</th>
<th>To the British West Indies and Guiana</th>
<th>To the British Possessions in South America</th>
<th>To Germany</th>
<th>Total Exported from United States During Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs</td>
<td>lbs</td>
<td>lbs</td>
<td>lbs</td>
<td>lbs</td>
<td>lbs</td>
</tr>
<tr>
<td>1850</td>
<td>Butter</td>
<td>91,155</td>
<td>583,350</td>
<td>843,505</td>
<td>300,350</td>
<td>302,350</td>
</tr>
<tr>
<td>1860</td>
<td>Cheese</td>
<td>511,343</td>
<td>1,232,372</td>
<td>1,743,715</td>
<td>723,715</td>
<td>723,715</td>
</tr>
<tr>
<td>1870</td>
<td>Cheese</td>
<td>333,923</td>
<td>1,053,015</td>
<td>1,386,938</td>
<td>586,938</td>
<td>586,938</td>
</tr>
<tr>
<td>1880</td>
<td>Cheese</td>
<td>497,248</td>
<td>729,248</td>
<td>1,207,492</td>
<td>627,492</td>
<td>627,492</td>
</tr>
<tr>
<td>1890</td>
<td>Cheese</td>
<td>333,928</td>
<td>1,053,015</td>
<td>1,386,938</td>
<td>586,938</td>
<td>586,938</td>
</tr>
</tbody>
</table>

Atlantic in small quantities, and by 1840-41 the shipments to England had reached more than 1,000,000 lbs.; this increased to over 5,000,000 lbs. a year before 1845. Still up to 1840 the annual butter export from the United States had never reached 3,000,000 lbs., and cheese had exceeded 2,000,000 lbs. but one year; the total value of the annual dairy exports had never risen to half a
Prices of Dairy Products.

From 1850 to 1850 the average annual export of butter was over 3,000,000 lbs., and during the same decade the cheese export rose from 700,000 lbs. to 17,000,000 lbs. From 1850 to 1855 there was a decline of nearly one-half in the quantity and value of the exports. At this time Great Britain appears to have taken fully two-thirds of the whole export, and much went to Canada. The reciprocity treaty between the United States and Canada, which was proclaimed March 16th, 1855, included butter and cheese in the free list, and Canada, with the more distant provinces, were large purchasers of those articles in "the States" during the ten years the provisions of that treaty were in operation. From 1850 to 1860 the butter exported averaged 2,500,000 lbs. and the cheese over 6,000,000 lbs. annually; from 1860 to 1870 butter 14,000,000 lbs., cheese 40,000,000 lbs. The aggregate weight of cheese exported from the United States from 1790 to 1878, inclusive, was 1,386,736,307 lbs., and one-tenth of the whole (139,249,276 lbs.) is credited to the calendar year of 1878! These facts may be better presented by the accompanying tables of export statistics. Table No. 7 gives the total exports of butter and cheese from the United States and Canada for a number of selected years, sufficient to show the development of this trade and its fluctuations, and the net shipments of dairy products from American shores, in the third column, obtained by deducting from the sum of the first two columns the quantities reported as passing from Canada to the States, and vice versa. Table No. 8 exhibits the disposition of most of the surplus dairy product of the United States during twenty years. The rest has been distributed in comparatively small quantities among about twenty other countries; the largest customers not named are Mexico, the Hawaiian Islands, China, and Japan. It will be seen that Great Britain takes over 70 per cent. of the butter exported, and over 95 per cent. of the cheese. The details of the Canadian exports cannot be so closely given, but the proportion of the surplus butter and cheese of the Dominion which goes to Great Britain is about the same as just named for the United States. The figures of the Tables are generally those of the fiscal years ending, both in Canada and the United States, upon the 30th of June.

The City of New York has controlled nearly the whole foreign trade of the United States in dairy goods from the time it became important. In 1855 more than half the butter and nearly all of the cheese exported from the country was shipped from that port; in 1880 three-fourths of the butter export and more than nine-tenths of the cheese.

The following is a monthly statement of the exports from this port for the years 1877 and 1878:

<table>
<thead>
<tr>
<th>Month</th>
<th>1877</th>
<th>1878</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>835,851</td>
<td>4,092,415</td>
</tr>
<tr>
<td>February</td>
<td>1,580,356</td>
<td>4,577,512</td>
</tr>
<tr>
<td>March</td>
<td>2,207,800</td>
<td>2,006,122</td>
</tr>
<tr>
<td>April</td>
<td>1,660,957</td>
<td>1,590,393</td>
</tr>
<tr>
<td>May</td>
<td>802,574</td>
<td>8,997,982</td>
</tr>
<tr>
<td>June</td>
<td>2,419,135</td>
<td>20,599,781</td>
</tr>
<tr>
<td>July</td>
<td>3,631,881</td>
<td>21,789,294</td>
</tr>
<tr>
<td>August</td>
<td>3,555,706</td>
<td>21,003,433</td>
</tr>
<tr>
<td>September</td>
<td>5,128,106</td>
<td>10,667,094</td>
</tr>
<tr>
<td>October</td>
<td>1,949,765</td>
<td>7,226,190</td>
</tr>
<tr>
<td>November</td>
<td>993,783</td>
<td>8,381,650</td>
</tr>
<tr>
<td>December</td>
<td>718,947</td>
<td>6,861,795</td>
</tr>
</tbody>
</table>

The other ports from which dairy products go abroad in any considerable quantity are Philadelphia, Boston, Baltimore, New Orleans, and San Francisco.

Comparing butter and cheese with other agricultural products exported from the United States, it is found that in value they form 3½ per cent. of the total, and that cotton, wheat, pork products, Indian corn, tobacco, and beef products are the only articles which bear a greater ratio to the whole.

Prices.

The prices of dairy products in the United States vary so much with the location of the sales, the changing rates of transportation, and the general tone of trade and the markets, that the figures available are not of great value. Theoretically, based upon the respective quantity of milk required to produce a pound of each article, the relative price of butter and cheese in the same market is held to be as 2½ is to 1; that is, with butter selling at 25 cents a pound, cheese should be 10 cents. But practically this law has rarely governed sales; cheese, until 1878, sold generally at half the price of butter, and often more, but since that time the cheese average
has ranged from one-third to two-fifths that of butter.

The average prices obtained for butter and cheese at the wholesale market of New York City are given as follows for the month of January in each year for half a century, upon the authority of Professor Willard:—Commencing with January, 1825, the products of the previous year sold in New York City at 74 cents per pound for cheese and 15 cents for butter. In 1826 cheese advanced to 8 cents, and then declined, reaching 6 cents in 1831, 1832, and 1833, advancing to 63 cents in 1834. During this decade the highest price reached for butter was 17 cents in 1827, and the lowest 13½ cents in 1830. In the next decade (1835 to 1845) the range for cheese was from 93 cents, the average for 1837, to 43 in 1841, and for butter from 20 cents in 1838 to 8½ cents in 1843. In 1845 cheese advanced 50 per cent. upon the previous year's rates, or to 63 cents, and varied little till 1851, when it dropped to 5½ cents, the lowest average for this decade; but it then rose steadily till it reached 9½ cents in 1854, the highest point in these thirty years. Butter, from 11½ cents in 1845, went to 19½ cents in 1854. The next decade (1855 to 1865) covers the war period, when gold reached a value of 2·55 in United States currency, this being the average for July, 1864. In 1855 cheese maintained its price of the previous year—9½ cents, declining 1 cent in 1856, and advancing to 9½ cents again in 1857. In 1858 it fell to 6½ cents, and then advanced with rapid strides, 8½ cents in 1859, 11 cents in 1860, and on to 15½ cents in January, 1864. At this time the gold dollar was worth 1·55 dollars currency; or, a pound of cheese brought a little less than 10 cents in gold at New York. Butter started at 22½ cents in 1855, declined to 14 cents in 1861, and rose to 24 cents, or 15½ cents in gold, in 1864. (The quotation of 14 cents immediately preceded the year of greatest butter export from the United States.) Next come the years of inflation—the "flush times"—1865 to 1875. Cheese rose in 1865 to an average price of 20 cents per pound, and butter to 45 cents. These averages were unprecedented, and have never since been realised. At this time the best cheese, New York cheddars, retailed at 40 cents a pound, and the entire butter product of numerous fancy dairies sold at from 1 dollar to 1½ dollars a pound. It must be borne in mind, however, that on a gold basis the wholesale rates last named were really 9½ cents for cheese and 20½ cents for butter. From this point the decline has been almost continuous. Cheese brought from 16 to 18 cents until 1872, then dropped to 13½ cents, rose somewhat above 14 cents in 1873 and 1874, and averaged 15½ cents in 1875; in 1876 the average was 15½ cents, 14½ cents in 1877, and 12½ cents in January, 1878. "Skims" at the same time were quoted at 6 to 8 cents. Butter fell to 30 cents in 1866 and 1867, rose to 45 cents again in 1869, dropped to 20 cents in 1872, and in 1874 stood at 27 cents; in 1875 there was some advance, but still greater decline followed, the average being about 26 cents in 1876 and 1877.

The season of 1878 witnessed a general break and demoralisation in the American dairy market. Cheese steadily declined, choice New York State factory falling below 8 cents at times, averaging 9 cents for the year, and closing at about 8½ cents. Butter during the same time ranged from 33 cents in January to 17 cents in July, closing at 24 cents, this being about the average for the year of choice New York and Western creamery. This depression became still greater during 1879; for the first six months selected lots of cheese at New York averaged not over 8 cents a pound, and in February there were large sales of lower grade, for export, at 5 and 6 cents. The choicest creamery butter, which stood at 30 cents in January, averaged 23 cents for six months, and sold in June at 16 cents, the best New York dairy butter being 2 or 3 cents per pound lower. In July and August the averages were 16 cents for choicest butter, and less than 6 cents for cheese. Early in the autumn a sudden and great advance occurred; in October butter reached 32 cents and cheese 16 cents, 100 per cent. increase within three months, and the year closed with a very slight reaction, butter 30 and cheese 13. During 1880 the market was steadier, but there was a wide range in prices. Creamery butter starting at 30 to 32 cents in January, reached 40 cents in February, fell below 20 in June, and rose to 35 towards the end of the year. Factory cheese touched 15 cents in February, dropped to 13 in July, and rose again to 13 and over as the season closed. The general averages in the New York market for 1879 and 1880 may be placed at 8 and 12 cents respectively.
for cheese, and at 22 and 30 cents for butter. These are gold rates, the currency of the United States having reached par again.

Beginning with the year 1878, Wisconsin factory cheese kept very nearly on an equality with New York State, and Ohio factory products about half a cent below; farm dairy cheese has been seldom quoted. Western and New York creamery butter has been also equal in price, with fine dairy pails quoted at 20 per cent. less.

The Chamber of Commerce of the City of Cincinnati, Ohio, is one of the oldest and best-managed institutions of its kind in America. From its annual reports the following condensed abstract is made, giving the annual receipts of butter and cheese at that city, and the annual average prices of Central Ohio and Western Reserve products, for twenty years:

<table>
<thead>
<tr>
<th>Year</th>
<th>Receipts</th>
<th>Price</th>
<th>Year</th>
<th>Receipts</th>
<th>Price</th>
<th>Year</th>
<th>Receipts</th>
<th>Price</th>
<th>Year</th>
<th>Receipts</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1839</td>
<td>12,653</td>
<td>$1.80</td>
<td>1849</td>
<td>34,465</td>
<td>$1.75</td>
<td>1859</td>
<td>53,328</td>
<td>$2.30</td>
<td>1869</td>
<td>110,105</td>
<td>$1.65</td>
</tr>
<tr>
<td>1841</td>
<td>12,529</td>
<td>$1.75</td>
<td>1851</td>
<td>34,590</td>
<td>$1.75</td>
<td>1861</td>
<td>53,683</td>
<td>$2.30</td>
<td>1871</td>
<td>131,633</td>
<td>$1.73</td>
</tr>
<tr>
<td>1842</td>
<td>25,088</td>
<td>$2.75</td>
<td>1852</td>
<td>34,714</td>
<td>$2.75</td>
<td>1862</td>
<td>53,718</td>
<td>$2.30</td>
<td>1872</td>
<td>136,640</td>
<td>$1.73</td>
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<tr>
<td>1843</td>
<td>26,500</td>
<td>$2.75</td>
<td>1853</td>
<td>36,575</td>
<td>$2.75</td>
<td>1863</td>
<td>53,905</td>
<td>$2.30</td>
<td>1873</td>
<td>137,387</td>
<td>$1.73</td>
</tr>
<tr>
<td>1844</td>
<td>20,000</td>
<td>$2.75</td>
<td>1854</td>
<td>40,000</td>
<td>$2.75</td>
<td>1864</td>
<td>53,805</td>
<td>$2.30</td>
<td>1874</td>
<td>137,658</td>
<td>$1.73</td>
</tr>
<tr>
<td>1845</td>
<td>12,000</td>
<td>$2.75</td>
<td>1855</td>
<td>45,900</td>
<td>$2.75</td>
<td>1865</td>
<td>53,275</td>
<td>$2.30</td>
<td>1875</td>
<td>173,144</td>
<td>$1.73</td>
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<tr>
<td>1846</td>
<td>15,000</td>
<td>$2.75</td>
<td>1856</td>
<td>45,000</td>
<td>$2.75</td>
<td>1866</td>
<td>53,785</td>
<td>$2.30</td>
<td>1876</td>
<td>153,745</td>
<td>$1.73</td>
</tr>
<tr>
<td>1847</td>
<td>22,000</td>
<td>$2.75</td>
<td>1857</td>
<td>41,761</td>
<td>$2.75</td>
<td>1867</td>
<td>53,914</td>
<td>$2.30</td>
<td>1877</td>
<td>143,417</td>
<td>$1.73</td>
</tr>
<tr>
<td>1848</td>
<td>12,000</td>
<td>$2.75</td>
<td>1858</td>
<td>42,000</td>
<td>$2.75</td>
<td>1868</td>
<td>53,744</td>
<td>$2.30</td>
<td>1878</td>
<td>100,569</td>
<td>$1.73</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Butter, in Packages.</th>
<th>Cheese, in Boxes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>Receipts</td>
</tr>
<tr>
<td>------</td>
<td>----------</td>
</tr>
<tr>
<td>1839</td>
<td>12,653</td>
</tr>
<tr>
<td>1841</td>
<td>12,529</td>
</tr>
<tr>
<td>1842</td>
<td>25,088</td>
</tr>
</tbody>
</table>

This amounts altogether to 23/4 cents per pound, and at this stage the cheese has passed from the importer into the hands of dealers and jobbers, and is on the English market in competition with the British product. A rough but fairly approximate method of reckoning the nett proceeds in New York of cheese sales at Liverpool is to deduct one-seventh of the rates quoted at the latter place. This will cover allowance for loss of weight. Of course the charges are less than those given when the price of cheese is very low as in 1879.

11. E. A.
CHAPTER XXVIII.

AMERICAN MILK TRADE AND CITY SUPPLY.

Nough has already been said in regard to the sale and delivery of milk for use as food in the neighbourhood of its production, but the matter of city supply must be further noticed and some examples given. To prepare milk for safe transportation a considerable distance, preserving its sweetness forty-eight hours, as is sometimes necessary, the uniform custom of American producers is to cool it as soon as possible after being drawn from the cow.* Pools of cold water are generally used, in which the milk is set in cans or pails 8 inches in diameter and about 20 inches deep, the aim being to reduce the temperature to 54° or lower within an hour. Sometimes the milk is strained directly.

* Experiments tried in America during the year 1880 disprove the theory, supposed to be well established, that milk must be soon and thoroughly cooled in order to make it "keep" and bear transportation. The parties experimenting have strained the milk into cans as soon as possible after coming from the udder, always before the temperature has fallen below 90° Fahr., then hermetically sealed the cans, usually of glass, and from that time disregarded temperature in handling and shipping the milk. Thus put up, the milk has been found to bear carriage for great distance, and to keep good in all weather, fully as long as when cooled in the usual way. The great point seems to be to seal the milk so soon, as to permit a minimum exposure to the atmosphere. The experiments have been on a large scale, quantities of milk having been thus sent successfully to distant points at different seasons. But although the main features of this process are here stated, there are certain precautionary measures taken between the milking and canning, or in the canning-room, which the parties interested do not yet make public into the cans, and those set into the pool, the covers off. It thus stands until just before the time of starting from the farm; if in pails it is then transferred to the shipping cans. When going to large cities by rail, it in many cases has to be carried two or three miles to the nearest station.

Railroad cans, passing between the country producers and the city dealers, are of varied patterns in different localities in America. The accompanying illustration gives the forms preferred in the principal cities, and as made by the Iron Clad Manufacturing Company of New York. The one in the middle of Fig. 220 with the round top is the pattern customary in and about New York and Saint Louis. That with the smaller top at the left and rear is used at Philadelphia, Baltimore, and Cincinnati. The one at the right and rear is the Chicago pattern, and the little one on the extreme right is the Boston can. The usual size for railway cans is 10 quarts, but the Boston can ranges from 2 to 12 quarts, 8½ being the
favourite size. This is much used for delivery unbroken to families and hotels; it has a wood stopper, while all the others have tin covers. The can on the left of the figure represents the form usual for pedlars' delivery waggons, with hook for the dipper. This, being less subject to rough usage than the railroad cans, has not the extra iron-bound bottom.

The milk remains in the railway cans in which it starts from the dairy until it reaches the retailer or some distributing depot; then it is transferred to a cooler, and ultimately to the delivery cans, which contain from 10 to 20 gallons, 15 being a very common size. These cans have large bowl-shaped mouths, with covers, and are very generally conveyed over the routes in open vehicles, the milk delivered to the consumers by removing the cover at each sale and dipping from the can with a long-handled quart measure. There is thus constant exposure to contamination, especially in wet or dusty weather.

A waggon cooler and delivery can invented by Frank K. Ward, proprietor of "The Alderney Dairy" of the City of Washington, is a great improvement upon the fittings in general use. The engraving shows the cooler complete upon the bench which supports it in the waggon; under the bench the measures are so arranged as to keep their places protected from dust and yet be readily slipped out for use. The cooler consists of a double-walled case of heavy plate tin, with non-conducting air-spaces which extend up around the necks of the enclosed cans. Three cans are inseparably incased in the cooler, two large and one smaller, these being of single thickness; tight covers close these cans. In rear of the small can is an opening into the general interior of the cooler, through which it is filled with water and ice, broken ice and salt, or other refrigerating material, and this, acting upon the entire surface of the cans, is very efficient in keeping the milk, cream, or buttermilk they contain in good condition during the course of delivery. In cold weather the double-walled case and confined air-spaces preserve the contents of the cans from freezing. Tubes with large taps connect with the cans at the bottom, and enable the contents to be quickly drawn without exposure by removing covers. This cooler can be used in any
vehicle over 32 inches in width, but is especially adapted to a covered delivery waggons with sliding side doors. In such the bench is fastened in the fore part of the waggons with the cooler facing the driver; behind him in the back of the waggons is space for the extra 10-gallon railway cans from which the cooler is re-filled. The taps are within reach of a person standing on the ground on either side of the waggons, but are under cover. In the ordinary size of the cooler the large cans hold 50 quarts and the smaller half that quantity. The three taps are removable, and these, with the four covers and three measures, are the only parts or pieces; every part of the appliance is accessible, and the whole can be thoroughly cleaned while in the waggons. There is an opening at the bottom of the cooler to draw off the water and for cleaning. This contrivance is also adapted to use in milk sale depots, in restaurants, and hotels. When not to be used in a vehicle, rods are inserted through the middle of the can tops, with plungers which reach to the bottoms of the cans; by these the contents may be agitated without opening, to thoroughly mix before drawing from the bottom. Fig. 222 shows one of Mr. Ward's delivery waggons complete. Not only these waggons, but all the arrangements of this establishment at Washington are so perfect that it well merits further attention. It is, however, similar to the one at Syracuse which is about to be described. The latter is managed by an association, while "The Aldeney Dairy" is the personal enterprise of its single proprietor.

New York City, in the year 1840, with its population of 312,000, received about 45,000 quarts of milk daily, mainly by waggons transportation; a large quantity was also produced within the city limits. The Erie Railroad soon after began conveying milk to New York, and in 1843 it carried 795,376 gallons. In 1850 the city received by rail alone an average of 91,413 quarts daily, and this was regarded as not more than two-thirds of the whole supply. At this time the Erie and Harlem roads carried over 3,000,000 gallons a year each, the Hudson River, New Haven, and New Jersey roads together 1,000,000 gallons or more, and less quantities reached the city by other routes. In 1860 the estimated daily receipts were 200,000 quarts; in 1870, 300,000, and in 1879 over 400,000 quarts a day. During one week in June, 1879, the actual receipts by public routes, rail and water, averaged 449,150 quarts per day. The returns of the milk shipments over the Erie Railway show the rapid development of the trade at New York;—In 1843, 795,376 gallons; 1850, 3,152,639 gallons; 1860, 6,103,652 gallons, and 1870, 11,733,500 gallons. In 1850 seventy miles was considered the possible limit of milk transportation; ten years later the distance was doubled, and in 1879 milk trains regularly run between New York and points more than 250 miles distant. In 1850 one-third of all the country milk received in New York was from Orange County. In 1879 the city received daily supplies not only from a widely-extended area in the State of New York, but from New Jersey, Connecticut, Western Massachusetts, and Vermont. While New York is the depot for this great supply, the milk is not all consumed there; a large part of the receipts are re-shipped to Brooklyn, Jersey City, Newark, and other neighbouring places.

The principal railway lines centring at New York make the transportation of milk a specialty, and run daily express milk trains. Most of the milk thus carried is in 10-gallon cans, and about 200 cans (or 8,000 quarts) form a car-load. The freight charge, including the return of the cans, is usually the same for all distances on a given section of road. On the Erie road the charge has been for several years 55 cents per can, the extreme distance of shipment being 50 miles. On the Hudson River and Harlem roads, 55 cents for all distances less than 90 miles, 60 cents for those from 90 to 130 miles, and 50 cents for all over 130. Stations in Vermont, from 210 to 250 miles distant from New York City, ship to that point about 400,000 gallons of milk annually, the freight being 2 cents a quart, and the receipts by the farmers averaging between 2 and 2½ cents, the year through. In Orange County, New York, the average receipts on the main lines and branches of the railways are about 120,000 gallons per annum for every mile of road. The months of June, July, and August always show the greatest shipments, April, May, and September coming next. The three summer months carry double the quantity of the same time in winter. The milk trains for New York are nearly all run at night, reaching the city between midnight and three o'clock in the morning. The arrangements are such that morning's milk, after being eight hours in the
cooling tank at Rutland, Vermont, 240 miles from New York, can be transported to the city and delivered at the doors of consumers by daylight the next morning.

The supply of New York City with milk is burdened with an unreasonably wide margin between the price paid by the consumer and the nett receipts of the producer. While 8 cents per quart was the usual retail price in the city for several years preceding 1880, the average return to the farmer during the same period was for 2½ to 3 cents; the producer has to deliver the milk at the railway station and furnish the cans, which get very hard usage, and although "iron-clad" are a large item in the farmer's expenses. It is admitted that the cost of delivering the milk after its arrival in the city is about 2½ cents a quart, and that it cannot be materially lessened; this too is exclusive of the 10 per cent. loss on the quantity delivered, by shrinkage and accidents. But there remain the items of which there is chief complaint—the freight charges by the railways and the profits of the middlemen, together about 3 cents a quart. It is true that special facilities are provided by the railways for safe and rapid transit, but still the rates on milk are exorbitant compared with other produce and merchandise. As above stated, the average rate is from 65 to 70 cents per cwt. for milk and can for 100 miles or less, while two barrels of flour or sugar weighing several times as much are carried twice as far for less money. Nearly all the milk reaching New York by rail is taxed from 1½ to 1½ cents a quart, much of it more. With the market glutted, sound milk has been sold so low that the freight absorbed the whole receipts, the returns to the producer being only the empty cans. Attempts to reduce by legislation the charges on milk to 30 cents per can (¾ cent per quart) have failed because of the great influence of the railroads at Albany. The clear profit to middlemen of 1½ cents and more per quart is even more exasperating, and the cause of constant agitation and endeavour to bring consumers and producers nearer together. Co-operative organisations have been successful to a limited extent, and with railway charges reasonably reduced, milk can be delivered to New York consumers for 7 cents or less, while at the same time it yields a return of over 3 cents to the producer.

This important matter of city milk supply receives much attention in America, and several articles have been patented for conveying milk and cream in small quantities from the dairy to the consumer unopened. While milk delivered in the usual way in New York is sold for 8 cents, there is a steadily increasing sale to private families for 10 cents of milk delivered unbroken from the dairy. This trade began with tin cans holding 1, 2, and 3 quarts, with a simple contrivance for sealing, but these were soon replaced by vessels of porcelain and glass. Of these there are several kinds, in the form of cans, jars, and bottles, holding from 1 pint to 2 quarts, and with or without locks and special fastenings. The "Lester" can, largely used in New York for milk from dairies 100 to 200 miles distant, is a strong glass can and cover, the latter fastened by a metallic clamp which not only hermetically seals the can, but places the milk under slight pressure and prevents motion or churning of the contents. These cans are of sizes containing from 1 to 5 quarts, and are packed in wooden cases for transportation. The crystal jar (Fig. 223) is similar. It has a glass top screwed down upon a rubber ring, and is provided with a bale. The opening is large enough to admit a small dipper to remove the cream. The "Warren" milk-bottle (Fig. 224) is also very popular, and rapidly coming into use in other cities as well as in New York. These bottles are securely and conveniently packed in boxes holding a dozen, as shown by Fig. 225. These contrivances show the great pains which are taken to present milk to consumers in a neat,
secure, and attractive form—a system which pays
the vendor well and satisfies the consumer. Thou-
sands of such are daily sent from dairy-farms many
miles distant from New York to agents in that city
who deliver them to the consumers. The air being
excluded, the milk keeps well in these packages,
milk supply of the city not conveyed by waggon
from producers within a few miles was received by
the steamboats running up and down the River
Delaware. During 1879 scarcely any milk reached
the city by water, and more than four-fifths of the
supply was by rail. The maximum distance run
by the milk trains is 60 miles, and Chester County
furnishes more than any other section, proportion-
ately. Very little now crosses the Delaware, nearly
all being supplied by Pennsylvania farmers. The
total average supply of the city is placed at
100,000 quarts a day, employing 600 vendors in
its delivery, with nearly as many waggons. In the
retail trade a business of 1,600 to 1,800 quarts is
considered very large, the average being about 200
quarts daily to each dealer. The retail price
changes twice a year, the winter rate, which runs
six months, being ordinarily 2 cents more per
quart than the summer price. As elsewhere, the
consumption in summer is found to be much
greater in Philadelphia than in winter, falling
off one-tenth about the 1st of September. The
retail trade feels a great variation in the demand
during every week, at least 10 per cent. more milk
being sold on Fridays and Saturdays than on the
first three week days. This renders the regulation
of the milk supply a difficult matter, and a surplus
often results. Such is disposed of in different
ways; some is re-shipped to the nearest cheese-
factory, and from much the cream is taken and
churned in the city, the skim-milk and butter-
milk being sold at low rates, or given away.
"Schmier-käse," or cottage-cheese, is a favourite
article in the Philadelphia markets, and this
furnishes another means of consuming the sour
milk. The milk trains arrive in Philadelphia at
various times between ten o'clock in the morning
and sunset, necessitating refrigerators until the
delivery early the next day. Philadelphia has a
straight-necked, small-mouthed pattern of carrying
can, the sizes being for 5, 7½, and 10 gallons, with
the medium as the favourite. The railway freight
are 8, 12, and 15 cents per can respectively for
the sizes named, or 3½ cent per quart. Shippers
prepay freight, and cans are returned. In 1872
the retail prices were 8 and 10 cents per quart,
netting producers 3 to 3½ cents. In 1879 these
rates had fallen from 6 to 8 cents and 2 to
3 cents respectively.

The annual milk supply of the City of Chicago
for the year 1880 was placed at upwards of

![Fig. 25.](image-url)
6,000,000 gallons, nearly all conveyed by rail from places within 50 miles.

The business of supplying Boston with milk is managed chiefly by contractors, who, conferring with the producers just before the commencement of each period of six months, fix the price per can at the farmer’s door, and assume the provision of the cans, collection of the milk, and transportation by rail. The contractor leases a car of the railroad at a fixed annual rent, with specifications as to time, route, and stopping-places. The prices paid have been from 5,000 dollars for a car running 20 miles, to 9,000 dollars for about 50 miles. Sixty miles is the extreme distance of regular milk shipments to Boston up to the year 1850. This system has decided advantages in relieving the farmers of the uncertainty as to nett proceeds, and the liability of having milk returned which exists under shipments on commission, and in tending to lessen the difference between prices to first hands and to customers. At the same time it has proved very profitable to contractors, so much so as to cause producers to feel aggrieved, and endeavour by combined action to market their own milk. The Boston trade has its own peculiar style of can, as already stated; this can has a side handle, small opening, and a wooden stopper, and the several sizes hold $\frac{8}{3}$, $\frac{5}{2}$, $\frac{9}{2}$, and $\frac{9}{3}$ quarts, the second being most used. The contractors very generally sell the milk at the can in Boston at an advance of from 8 to 10 cents per can over first cost, thereby obtaining a profit of 3 to 5 cents per can. It is then re-sold by the can at an advance of 10 or 12 cents, and finally retailed at from 5 to 8 cents per quart. Collections and settlements are usually made monthly all round. Milk for which the farmer receives 3 cents can be sold by the contractor at 4 cents, with a profit of about $\frac{1}{2}$ cent per quart; the wholesale dealer and retailer divide 3 cents a quart for their labour and profit. Thus three sets of profits to middlemen. The average daily supply of the city for 1850 was 116,000 quarts; for the year 42,340,000 quarts; for this the consumers paid over 2,500,000 dollars. During the year specified large quantities of skim milk were sold in the city, as such, at 3 cents a quart.

In most American cities there are ordinances regulating the milk trade, providing penalties for adulteration, &c., and the boards of health or officers under them are often charged with the execution of these laws. Adulteration to some extent is found among the dealers in every city, and among producers also. The commonest fraud of all is the addition of water, and next comes the subtraction of cream, or “topping” the cans—removing cream which rises in transit, for sale separately at a high price. Nineteenth of all the cases examined where poor milk is complained of result, if in anything, in finding that one or the other of these frauds has been practised. Although various substances are commonly supposed to be used for adulterating milk, it is very rare for the city chemists and inspectors to find anything added to milk except water, salt, and burnt sugar. Salt is used to preserve milk and to give it solidity; burnt sugar to make up the needed sweetening and to give colour when the milk has been either watered or robbed of its cream.

Under an Act of the Massachusetts Legislature, the City of Boston appointed an inspector of milk, who has been in service since August, 1859. This officer devotes his whole time to acquainting himself with the milk trade of the city, those engaged in it, the sources and methods of supply, testing samples of milk upon application, investigating complaints, and enforcing the laws for the prevention of milk adulteration. He publishes an annual report containing many items of interest. The samples of milk examined during each year range from 1,500 to 2,000, and about one-fourth are found to be more or less watered; from 1 to 40 per cent. of water is found, the average being about 18 per cent. In 1859 Boston had a population of about 175,000, and some 300 milk-dealers. In 1850 the city had a population of over 360,000, and from 700 to 800 wholesale milk-dealers; more than half these dealers sold from waggons, and most of the rest kept a few cows and sold the milk in their neighbourhoods. There were 1,730 cows kept within the city limits, 510 persons owning but one each. The inspector classes all as wholesale dealers who distribute milk to families, stores, hotels, &c., from waggons, or who keep more than one cow. No attempt is made to keep account of the retail dealers, except the registration of registration when entering the business, and examination of their wares on complaint. It was estimated, however, that milk was retailed at 5,000 different places in Boston during the year 1850.

The City of Syracuse, in the State of New
York, which with its environs contains a population of about 70,000, possesses a unique organisation for its milk supply. It is known as the Onondaga County Milk Association, and was chartered and began business in the month of March, 1872. The capital stock of the company was originally 25,000 dollars, but it has been a steadily prosperous concern, and has since increased its capital four-fold. The stock is held by about fifty persons who were formerly milk producers and dealers acting independently, and it is apportioned at the rate of 20 dollars to each cow usually kept in milk by the holder; the stock-book shows that the members own from seven to seventy cows each. The head-quarters of the Association are in the city, where it owns and occupies a large four-storey brick building provided with every accommodation for receiving, keeping, handling and distributing milk, for boarding and lodging the thirty or more employes, and for general business purposes. There are offices, the directors’ room, and a well-arranged hall for meetings and discussions by members of the Association and other dairymen. In the rear are barns and stables for twenty-five horses, sheds for as many waggons, sleighs, harness, &c., also a repair shop, a blacksmith’s shop, and other conveniences. The Association maintains twenty milk routes, with a wagggon and pedlar upon each, supplying about 40,000 people through the year. The management is delegated to a president, vice-president, and nine directors, of whom five form the executive board, and the working force comprises a superintendent, cashier and accountant, milk-receiver, two distributing clerks, cheese-maker, hostler, blacksmith and helper, housekeeper and assistant, and twenty pedlars. All the help is boarded at the building of the company, and one of the most interesting items in connection with the enterprise is the fact that board satisfactory to the employés has been furnished at a cost of less than 8 dollars a month.

The Association originated from a prosaic desire on the part of milk-producers to benefit themselves, and a belief that several persons who were selling milk in Syraucuse, each one by himself, could economise in labour and cost of delivery by co-operation. The object was to establish a central depot where the milk produced by all could be received, thence distributed so far as it could be used as milk, and provision made for working the surplus into butter and cheese on joint account. The great saving expected was in the delivery to consumers; it was thought that instead of half-a-dozen waggons running daily through the same streets to furnish here and there a family, as occurred often under the old system, the customers of the six pedlars might, by union of interests, be supplied from a single wagggon. Next was the expected saving by advantageous use of the surplus milk; that of several pedlars being “pooled” or handled in one mass. Both of these expectations have been so far realised as to give prosperity to the Association. The independent “owners” of milk routes at first looked with suspicion upon the concern, but one by one have found it to their interest to join. The impression of a monopoly, likely to be at first formed, is not sustained by the facts, for the Association has opposition enough from individual sources to force it to keep up the quality of its milk and to keep down its prices. The result has really been to maintain in this city a high standard of quality and very reasonable rates.

The articles of association are very carefully drawn, and these are among the most important features:—Every member is bound to deliver at the rate of 6 quarts of milk daily through the year for every cow represented by the stock he holds; the directors may refuse all milk offered in excess of this ratio, and may reject any milk failing to meet the rules as to quality, condition, &c.; the cows, farm, food, water, and general dairy management of every member are to be subject at all times to inspection by the directors or their agents; no member may in any way interfere with the business of the Association by competition or otherwise, or become at all interested in rival trade; every member on withdrawing from the Association agrees to bond himself to abstain from all such competition for at least five years; members may, upon due notice, cease to deliver milk proportionate to stock, and in lieu be granted a cash dividend, at the rate of 7 per cent. per annum; there are strict provisions as to details, and penalties prescribed for all violation of the rules and regulations; all sales are for cash, and monthly financial statements are made, with monthly dividends for the stock-holding producers.

The business is conducted as follows:—Each milk-producer has two sets of narrow-necked,
large cans to carry his milk from home to the central depot; the rules require that the milk shall be cooled as much as possible before delivery by setting the cans in a cold bath, and in warm weather the cans must be protected by wet blankets, while en route; the milk is to be all delivered before eight o'clock in the morning, and it is upon delivery that the work of co-operation begins. The building of the Association faces north, and at the east end, cutting off a part of the first storey, is a driveway to the yard and buildings in rear, and the long platform at which each stockholder delivers his milk. Every can is marked with its weight and the name of the owner; as fast as received they are weighed by the clerk and the milk credited to the producer, furnishing the basis of his accounts with the Association. After weighing, the cans are placed on a car and run along a track to the cooling-room, where they are put into a tank of ice-water until wanted for distribution. The producer receives his second set of cans, delivered the previous day, now clean and sweet, and returns home. The milk is distributed without being decanted just as brought from the farms to the depot, and the milk of the same dairies passes over the same route day by day. Each pedlar on leaving the depot is charged with the weight of milk placed in his waggon. The consumer, if so inclined, may read the name of the producer daily upon the can from which he is supplied; indeed, by paying a small extra charge, the consumer may not only select any dairy connected with the Association from which he prefers to be supplied, but may go to the farm and select a particular cow; the milk will then be specially strained in a small can, marked and duly delivered. This, in cases of sickness and for food for infants, is a matter of importance. These provisions also enable any complaint on the part of the customers to be at once traced to the producer of the objectionable milk. On the return of the delivery waggons, each pedlar delivers his surplus milk, is credited for it, and it is run through a pipe to the butter and cheese room in the basement. Each pedlar then takes his empty cans, for which he is responsible, to a place provided, where they are rinsed in cold water, scalded with hot water and then steamed, a row of jets being arranged so that by placing cans over them, bottom up, every crevice is reached by the steam, and the metal so heated as to destroy every tainting germ. The cans are then dried, in the air and sun when possible, and await delivery to the farmers. Near the tank and cleaning apartments is a sitting-room for the use of pedlars while waiting, and in this a set of drawers provided with locks, one of which is assigned to each pedlar for keeping the money and ticket-box entrusted to him.

In the basement a six-horse-power engine and a large boiler furnish the heat and steam required. All the milk not taken out by pedlars is set for butter-making, skimmed at twelve hours, and the buttermilk and skim-milk are made into cheese. The milk returned by the pedlars, kept separate, is set twenty-four hours, the cream churned and the milk made into "pot-cheese" or sent to the piggery. The latter is situated outside the city, and there the Association keeps about 100 swine on contract. The customers are furnished upon order with butter, cream-cheese, and "pot-cheese," cream, buttermilk, and sour-milk; 10,000 quarts of sour-milk are often sold in a month at half the price of new milk.

Every member of the Association has a business interest in having everything right and giving the public full satisfaction. This leads them to sustain the management in making and enforcing strict regulations, to ensure cleanliness, purity, and a good quality of product, and to ferret out any fraud and bring offenders to justice. Frequent tests are made of milk received, and close investigation as to causes follow all appearances of inferior quality or any irregularity. The directors often employ inspectors who are strangers to the producing members whose farms they visit, and their reports, covering the most minute particulars, are only made known to the officers of the Association. The general standard is maintained by requiring a change in care, food, or water when found necessary, and sometimes by discarding one or more inferior cows.

The business of the Association is summarised in the table on the following page, the figures being the average result of operations for the years 1876, 1877, and 1878.

These interesting facts are derived from the annual reports of the Association:—There is the greatest consumption at the season of greatest production; this is shown by all experience in the trade. The consumption in winter is undoubtedly reduced somewhat by the increase in price; in
Syracuse the retail rates have been 5 cents a quart in summer and 6 cents in winter. The milk consumed by the customers of this Association is, as nearly as it can be computed, at the rate of 59 quarts per annum per capita, or 1-66 quarts per day. The shrinkage or total loss in measuring, spilling, and cleaning cans seems very large: 283,350 quarts of milk in a year, the whole product of 120 cows! But it has been found that pedlars must always be allowed 10 quarts in 100 for this seeming loss in delivery; much of it is due to the necessity of contrast between this cost of delivery and that in New York and Boston is very striking. Fifty-two dairies contributed to the Association the milk of about 1,600 cows. The actual average product of the cows was 6.52 quarts per day, or 2,380 quarts per year, which is very creditable. The highest average, 3,716 quarts per cow per year, was attained by the owner of ten cows, this yielding 103.5 dollars each; one owning 40 cows averaged 3,339 quarts. The lowest average of any stockholder was 1,843 quarts or 50.5 dollars per cow.

<table>
<thead>
<tr>
<th>Months</th>
<th>Milk I received.</th>
<th>Milk Disposed of.</th>
<th>Monthly Shrinkage.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quarts.</td>
<td>Quarts.</td>
<td>Quarts.</td>
</tr>
<tr>
<td>January</td>
<td>191,934</td>
<td>1,129</td>
<td>193,955</td>
</tr>
<tr>
<td>February</td>
<td>190,891</td>
<td>1,572</td>
<td>192,176</td>
</tr>
<tr>
<td>March</td>
<td>234,529</td>
<td>2,218</td>
<td>233,278</td>
</tr>
<tr>
<td>April</td>
<td>243,329</td>
<td>6,318</td>
<td>241,617</td>
</tr>
<tr>
<td>May</td>
<td>246,829</td>
<td>11,149</td>
<td>231,732</td>
</tr>
<tr>
<td>June</td>
<td>311,369</td>
<td>15,035</td>
<td>307,348</td>
</tr>
<tr>
<td>July</td>
<td>283,222</td>
<td>15,088</td>
<td>288,209</td>
</tr>
<tr>
<td>August</td>
<td>236,347</td>
<td>11,908</td>
<td>250,263</td>
</tr>
<tr>
<td>September</td>
<td>241,167</td>
<td>9,881</td>
<td>236,348</td>
</tr>
<tr>
<td>October</td>
<td>198,914</td>
<td>9,266</td>
<td>198,257</td>
</tr>
<tr>
<td>November</td>
<td>204,320</td>
<td>2,939</td>
<td>206,150</td>
</tr>
<tr>
<td>December</td>
<td>204,310</td>
<td>2,628</td>
<td>206,938</td>
</tr>
<tr>
<td>Total</td>
<td>2,790,502</td>
<td>93,855</td>
<td>2,884,417</td>
</tr>
</tbody>
</table>

**CASH RECEIPTS.**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk sold</td>
<td>$101,756.88</td>
</tr>
<tr>
<td>111 lbs. Butter sold</td>
<td>3,122.81</td>
</tr>
<tr>
<td>85,534 lbs. Cheese sold</td>
<td>8,188.33</td>
</tr>
<tr>
<td>4,999 quarts Cream sold</td>
<td>1,296.69</td>
</tr>
<tr>
<td>91,514 lbs. Sour Milk &amp; c.</td>
<td>2,355.13</td>
</tr>
<tr>
<td>Receipts from Sales</td>
<td>$118,070.44</td>
</tr>
</tbody>
</table>

**CASH PAYMENTS.**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Divided among Producing Members</td>
<td>$80,102.68</td>
</tr>
<tr>
<td>93,855 quarts Milk purchased</td>
<td>3,015.55</td>
</tr>
<tr>
<td>Expenses—Salaries, Labour, Taxes, &amp;c.</td>
<td>24,623.57</td>
</tr>
<tr>
<td>Surplus—To balance</td>
<td>538.34</td>
</tr>
<tr>
<td>Total Cash Payments</td>
<td>$118,070.44</td>
</tr>
</tbody>
</table>

"giving good measure," really over-weight at each delivery. The shrinkage on routes has often reached 13 per cent., and at the retail delivery department of the office it has been just about 8 per cent. The exact shrinkage in the sales of 1877 was 12.68 per cent., and in the whole business of the year S8 per cent. upon the gross amount of milk handled. The average receipt for milk sold was 4.5 cents per quart, for the surplus milk 2.7 cents, for all a little over 3.2 cents. The producers received in dividends per quart 2.5 cents for milk delivered at the depot by them. The total expenses divided averaged 1 cent a quart on the milk sold, and 84 cents for every 100 quarts of all the milk handled. The full description given of this organisation seems to be justified by its peculiarities and its excellency as a model. The problem which the Onondaga Milk Association had to solve was:—Would the savings arising from co-operation be sufficient to enable them to sell only pure, unskinned, unwatered milk at such prices as to give them a fair profit, at the same time meeting any legitimate competition that might enter the market? The experiment appears to be a success; and the Association has by its own honesty, and by insisting upon the honesty of those who supply the milk, acquired the confidence of its customers, the people of Syracuse.

H. E. A.
CHAPTER XXIX.

AMERICAN FARM DAIRYING—METHODS AND PROCESSES.

DAIRY methods and processes in America necessarily vary much because of the diversity of climate, of systems of farming, of the origin, habits, and condition of the people. So great is the variation in matters of detail, that a minute description of all is impracticable, but by classification and the selection of examples a fair idea of the facts may be conveyed. As to general management and the treatment of cattle, enough has been written in preceding sections. It remains to describe different methods of dairy detail practised in the United States, with some reference incidentally to farm arrangements and buildings, and the processes of manufacturing butter and cheese in private dairies and by co-operation at factories on what has been named "the American system."

The pail is, then, the place at which to begin. Nearly all the milking is done by men in America, and although the simple requirements of good milking—quietly, quickly, cleanly, completely—are well understood, in very many cases they are not observed. It has been often and truly said that good cows are much more common than good milkers, and many a good cow has been ruined, or her development prevented, by an ignorant or careless milker. It must be confessed that, as a general rule, there is a lamentable degree of negligence at this all-important point. More than half the dairy-cows in America are stalled half the year, and many more placed in stalls at milking-time habitually at all seasons. A very common practice is to give food just at milking; this is partly a matter of convenience and partly to keep the animal occupied and quiet. But some thoughtful dairymen claim, with a show of reason certainly, that so important an operation as milking should receive the undivided attention of the cow as well as that of the milker. Very generally, therefore, cows are milked in their stalls, and the condition of the stalls and the atmosphere of the shed or stable is often such as to injure the quality of the milk every moment it remains exposed in the apartment. Worse yet, the cleanliness of the cows and of the milkers is inexcessably neglected. It very often happens, also, that the other farm duties are such as to throw the milking into hours very early and very late, when the light is insufficient to ensure proper care, and when the milkers are but half-awake, benumbed with cold, or, when tired and perspiring, they hurry carelessly through this final "chore" at the end of a long day's work. Washing or otherwise cleaning the udder before milking is the exception rather than the rule. In those sections where a mild climate or the want of buildings makes open shedding or the lee-side of a haystack the customary shelter, and the cows are consequently milked in the open air, even with equal negligence on the part of the keeper, the process of milking is far more cleanly than in most close stables. Yet many cow-stables are to be found well cleaned and ventilated, the air always pure and sweet, where straw, leaves, sand, and sawdust are used for bedding, and absorbents, whitewash, and plaster frequently and freely applied, sufficient attendance provided, the cows carded daily, and every precaution taken to ensure cleanly milking. And it is encouraging to observe that the importance of cleanliness in connection with cows and their milk is being more and more recognised in the States. An open tin pail, sides somewhat
flaring, is the usual receptacle for milk as drawn from the cow, but utensils affording more protection are coming into use.

The milking done, the product is carried, usually in the open pails, regardless of the weather, to the dairy or milk-room. On small farms where the quantity of milk is never large, no special apartment is devoted to it, but the pans into which it is strained will be often found set upon shelves in the open cellar near barrels of vinegar and pork, or bins of apples, turnips, or potatoes, or in the family pantry alongside cold meats and vegetables, pies, pickles, and preserves. It is astonishing how good butter and cheese, or articles so considered, are ever made under such conditions, and yet this is a true sketch of the circumstances under which the greater part of the dairy products of America were made not many years ago, and of the treatment of milk in many instances still. In other cases milk-rooms are, and for generations have been, fitted up in the cellar, wholly or partly underground, or on the ground-floor in some well-shaded part of the house. Separate buildings are not general, but are numerous in the best dairying sections, built in connection with well, ice-house, spring, or independently, as described in the examples to follow. Small quantities of milk are sometimes placed in large tin pails or cans, lowered by cords into a well, and there suspended, partly immersed. It is at this point of the treatment of the milk that great variations occur, depending chiefly upon its after-use, whether to be shipped to the city for sale, taken to a factory, or made into butter or cheese upon the farm. Therefore classification should begin here, presenting first examples of management where the specialty is production of milk for town and city supply.

The Secretary of the Board of Agriculture of the State of Connecticut, Mr. T. Sedgwick Gold, is a practical farmer, owning, living upon, and conducting a farm of 600 acres located in West Cornwall upon the southern slope of one of those very stony hills so numerous in Litchfield County, and some 600 feet above the bed of the Housatonic River. From the north side of the farm, which extends to the top of the hill, there is a fine view of the Berkshire hills in Massachusetts, and looking over and beyond the Taconic spur of the Green Mountain range the Catskills can be seen stretching along the west side of the Hudson River. Originally rocks large enough and numerous enough to try the strength and patience of the most energetic were the chief feature of this property. Most of these were in the form of boulders, this section lying in one of the most apparent glacier paths in the country. The smaller stones have been drawn together and worked into massive walls, constituting the boundary and division lines of the farm, and many of those too large to move have been buried out of sight, in holes dug beside them, the soil thus removed being used for grading, filling hollows where smaller stones were removed. In this way good grass lots have been so cleared that the mower and tedder find few obstructions, and the pastures have been improved. The walls, of course, prevent an economical working of the farm; it is not pleasant when one mounts a horse-take to be stopped by a fence and obliged to turn around every 30 or 40 rods, but there was no other possible disposition of the stone. Many of the best grazing and dairy farms of New England are similar to that here described.

Grass is the staple product of "Cream Hill Farm," and the crop averages 250 tons. Indian corn, wheat, rye, barley, oats, and roots are also cultivated, so far as these crops may be needed for home consumption. A maslin crop of oats and barley is a favourite with Mr. Gold, securing a large yield and making excellent feed for horses and swine. Ground grain is preferred for the stock, and water-power being abundant, there is a mill on the place which does the work not only of this farm but of several others of the neighbourhood. All the hay and grain raised is fed out on the farm, mainly to cows, the specialty being milk-production; but other cattle and sheep are also fed, and considerable beef and mutton sold. The farm-buildings are commodious and convenient. The new barn has all the modern conveniences for a dairy-herd; it stands upon the hill-side, with sheds and yard open to the south, the basement for manure accessible to teams, and so ventilated that no fumes ascend to the cattle floor above; back of this are cellars for roots and fruit. The main floor is well lighted and well ventilated, with stalls on the sunny side and bays for hay on the north, while a stone wharf at either end gives access to the capacious second floor, on which three or four loads of hay can stand at a time. The foundation of the building is substantial masonry, and the massive oak and chestnut frame, the timber all grown on the farm,
looks as though it might last for centuries. From 50 to 60 cows are kept in milk, and the daily average product is generally kept above 10 quarts, so that the usual shipment is 15 cans of 40 quarts each, besides ample reserves for a large household. Mr. Gold had native cattle originally, and began to improve by introducing Durham blood, but found Shorthorns too large and clumsy for his stony hills, and changed to Ayrshire; this change resulted in an increased milk-product and a diminished expense in feeding. The present herd are, with a few exceptions, Ayrshires or high grades of this breed, and at the pail the grades are about as valuable as the full bloods. Milking begins in summer about sunrise and ends about sunset; in winter it begins before sunrise and ends after sunset. The milk is strained into railway cans in a clean room at the end of the barn, and then carried directly to a cooling room near the house. There are tanks of running water from a hill-side spring, with a constant temperature of 46° Fahr.; the cans are placed in the cold bath, uncovered, and not quite filled, leaving the surface of the milk the full size of the can and at or below the level of the water; thus the cans remain several hours. Under the same roof there is a supply of ice for use when the weather necessitates reducing the temperature of the water in tanks and for transportation. The night’s milk always goes to the lath, and is cooled till the next afternoon. The morning’s milk is treated in the same way, and remains in the bath at least nine hours. Between three and four o’clock every afternoon the cans are lifted from the water, filled quite full, closed tightly, and then started in a suitable conveyance for the railroad. The fifteen cans of milk make a load of almost a ton, but fortunately the route is down hill all the way, three miles, to the West Cornwall station on the Housatonic railroad. There the milk train is met, which reaches New York City, 120 miles distant, just before midnight. The waggon takes back to the farm the empty cans of the shipment the third day preceding; five sets of cans are thus necessary, and a sixth set is always held in reserve in case of loss or detention. Thus an “outfit” of railway cans for this farm costs about 400 dollars. Mr. Gold uses mules for his teams, finding them well adapted to his work, hardy, docile, and ready to carry the load to railway or mill without fretting, although at the end of a long day of labour. At times the milk of this farm, instead of being shipped in tin directly to a commission merchant in New York, is taken soon after the morning’s milking to a creamery near the West Cornwall depot, where it is all cooled, then put in the glass cans of the Lester Milk Co., and by the creamery manager forwarded to the city the same afternoon, and delivered to consumers the next morning. It may be stated in passing that fruit, in great variety and abundance, is a leading feature of this highland farm, and that Mr. Gold has near his house an acre which is always the model farm garden of the State of Connecticut.

Public attention was called in America to the deep-setting of milk in the summer of 1871, and the subject has been agitated ever since, constantly gaining friends, and the practice steadily extending. The first article published was a description of some Swedish dairy-farms, among them that of Mr. G. Swartz, which appeared in the American Agriculturist in May, 1871; this was soon followed by several letters in the same periodical by George E. Waring, jun., announcing the adoption of the Swedish deep-setting method at “Ogden Farm,” in Rhode Island, and reciting the satisfactory results. Professor Willard mentioned this method in some of his dairy lectures about the same time. But the claim that “the Swartz system” was thus first introduced into America is absurd; it has been practised in this country, in all its essential features, for more than a century. The writer of this read the articles above mentioned, in the year of their publication, upon a farm in Virginia, where deep stone crocks, of just about the dimensions recommended by Colonel Waring, were used for setting milk for butter-making, in the cold pool of the spring-house; and the negro dairy-woman pointed out one such crock which she had used thus in the same spring for over fifty years! The only variation from the “Swartz system” was in the material of the vessel and in not using ice; the water in the spring remained between 44° and 48° Fahr. during the year.

Between 1860 and 1870 a number of contrivances for setting milk were introduced, most of them being large, shallow pans, in a fixed standard or frame, usually about as high as a table, and each holding a whole milking. The sizes varied
Each cow has her own place, with name, age, and pedigree over the manger, and they are arranged in the order in which they usually come in from pasture. The milking is done by women, the same one always attending the same cows, and it is done quietly and quickly. Near by is the spring-house, the dairy institution of this region, built of stone, 24 feet by 18, the walls 10 feet high, its foundations set deeply in the hill-side, so the floor is 4 feet below the level of the ground at the lower end. A plentiful spring enters directly from the earth at the back end of the building, and flows over the entire floor, at a depth of about 3 inches; the floor is of oak plank laid upon sand and gravel. At one place is a pool a foot deep, in which the cream-pails stand. There are platforms raised a few inches above the water, on which to move about the room, but three-fourths of the area is occupied by the slowly-moving spring-water. At the top of the walls, on each side, are long, low windows, covered with fine wire cloth, which gives a free circulation of air in the upper part of the room. The milk is strained into rather small pans pointed on the outside, and provided with handles; the milk stands about 3 inches deep, so that its surface is just below that of the water in which the pans are placed. The cream is removed after twenty-four hours, with a cone shaped tin scoop perforated with many small holes, separating the milk thoroughly. The cream-pails hold several gallons, and stand in cold water till churning. The temperature of the water as it flows about the milk-pans is 52° Fahr., and that of the air of the spring-house, when closed, about 56°; thus the year round. It is the intention in this establishment to keep milk, cream, and butter at a temperature within the limits of 52° and 62° from the time of setting, to the table. The churning is rarely done more than twice a week. The churn is of the Philadelphia barrel pattern (described on page 433), hung upon its axis with a journal or bearing at each head and revolved by horse-power. The churning lasts about an hour, at the end of which time a little cold water is added to cause the butter to gather. The buttermilk is then drawn off, cold water added twice, a few turns given to the churn, and when the last water comes off it is nearly clear. The horse-power is then thrown out of gear, and the churn gently rocked by hand to collect the butter near the opening, and at a vent from which the remaining
water escapes. It is thus left for an hour or two. Then the butter is taken from the churn and worked upon an Embree rotary butter-worker, 20 lbs. at a time; this is in one corner of the spring-house. At the last of the working the maker throws the butter backward with the left hand, and as it comes from under the roller presses upon every part of it, with the right hand, a cloth wrung out pretty dry from cold spring-water; the cloth is frequently washed and wrung. This is continued till not a particle of water can be seen as the butter comes from the roller; when thus well dried the butter begins to adhere to the roller. It is then salted, on the "worker," with the roller, 1 oz. to 3 lbs., removed to a table, weighed and at once put up in pound prints. The working, wiping, salting, weighing, and printing of 100 lbs. of butter is done by one person in little more than two hours, the whole process, from the beginning of churning, being usually completed before noon. The beautiful "Philadelphia prints," fragrant as new-mown hay and as yellow as gold, such as only pure Jerseys will make, are then deposited in large tin trays and set in the water to harden. The next morning each print is wrapped in a damp cloth, put in a tin case, each layer on its own wooden shelf, with ice compartment filled if needed, and in a sweet cedar tub (the Koehler) sent to the city consumers in perfect condition.

"The Darlington butter" is among the best known and most highly esteemed of all the famous brands of Philadelphia prints. It is the product of the dairy-farm of Jesse and Jared Darlington, 350 acres, in Delaware County, Pennsylvania. The herd consists of 170 cows, largely natives, selected for their butter qualities, and 140 to 150 are usually in milk. There are two spring-houses, the principal one built of stone, 46 feet by 32, one and one-half storeys high, with a never-failing spring discharging about 8 gallons of cool water per minute. The milk-room is 24 by 25 feet, temperature 55° to 60°, and the milk is strained into large pans, the largest holding 500 quarts, being set 5 or 6 inches in depth. It usually remains thirty-six hours before skimming, by which time a slight acid has been developed; in winter a little sour milk is put in the pans to hasten the process. When taken off, the cream is put into tin pails holding 5 gallons each, and hoisted to the upper room; there the pails are put into a cold-water bath until churning. The churning is done twice a week in two large horizontal revolving-barrel churns, run by power; time usually over an hour. When the cream is put into the churn, a suitable quantity of annatto, dissolved in milk, is added to produce a colour resembling the highest natural colour of the best Guernsey butter in June. The butter, when taken from the churn, is carried to working tables in the upper room; it is not washed, but the buttermilk is extracted by absorbing it in a moist cloth, which is frequently wrung out in clear water. It is thus thoroughly worked over in masses of 10 or 12 lbs. each, is salted at the same time, and then passed to the weigher at an adjoining table. This operator forms it into rough cones of the desired weight, and transfers it to the moulder at her left. This workman, with pound and half-pound wooden "prints," turns out very rapidly the nicely-finished and attractive lumps, each bearing the name "Darlington," with a neat device. The lumps are regularly arranged in square zinc trays, several inches deep, which float in a cold-water vat. The owners devote much time to personal supervision or execution of the dairy details, and have maintained such a standard in their butter, that it has sold at from 75 cents to 1 dollar a pound for several years in the cities of Baltimore, Philadelphia, New York, and Boston. (The milk and buttermilk are fed to swine, these about equaling the cows in number.)

The following sketch and description of the private dairy of Mr. Eastburn Reeder, of Bucks County, Pennsylvania, which combines ice-house and dairy-rooms, were furnished by the owner to the American Agriculturist, and published therein May, 1875:—

The building is shown in Fig. 226. It is 34 feet long and 15 feet wide, and stands at a distance from any other building or any contaminating influence. It is divided into five apartments, the ice-house (seen at a, Fig. 227), the milk-room (b), the vestibule (c), with stairs leading to the winter milk-room below, and an attic above for the storage of sawdust for the ice. The ice-house is 12 feet square and 14 feet deep, holding 36 loads of ice, or over 2,000 cubic feet. It is 6 feet below ground and 8 feet above. The walls are of stone, 18 inches thick. The frame building above the wall is 8 feet high. The lining boards of the ice-house extend down the face of the wall to the
bottom, making an air space of 18 inches, which is filled with sawdust. The ice-house is filled through three doors, one above the other, at the rear end. There is perfect drainage at the bottom of the ice-house, ample ventilation above, and no currents of air can reach the ice.

The milk-room \((\theta)\) is 12 feet square, and is 1 foot lower than the ice-room. It is divided into two storeys of 7\(\frac{1}{2}\) feet each, for winter and summer use. A ventilator enters the ceiling of the lower room and leads to the cupola at the top, furnishing complete ventilation for both rooms. The vestibule \((c)\) is 4 feet wide and 8 feet long. Here the milk is strained and skimmed, the butter is worked, and pans are stored. The floor is of flagging laid in cement, as is that of the winter or lower dairy. The pool \((d)\), which contains iced-water, is 36 inches long, 16 inches wide, and 20 inches deep, and in this the deep pans and cream-kettles are immersed. The waste from the ice-box \((e)\) can be turned into this pool. If the deep-can system of setting milk should be practiced, this pool can be lengthened to 12 feet.

A drain \((f)\) carries off all the waste water from the room. At \(g\), Figs. 227 and 228, is a cooling cupboard, located in the wall between the ice-house and the milk-room, 6 feet high, 4 feet wide, and 18 inches deep. This is lined with galvanised sheet-iron, has a stone slab at the bottom, and two slate shelves 15 inches wide, on which the cakes of butter are hardened before they are packed for market. A current of cold air can circulate around the shelves, as they are 3 inches narrower than the depth of the cupboard. There are latticed blinds in the doors of the cupboard, shown at \(i\), Figs. 228 and 229, where the doors are shown as open and closed. A current of cold air can pass through the lower lattices, and this causes an equal current of warmer air to pass through the upper ones. This warmer air, cooled by contact with the ice-box \((e)\), passes down and out into the milk-room, where a temperature of \(60^\circ\) is easily maintained. By closing or opening these lattices, the change of temperature is regulated as may be desirable. At \(h\), Fig. 227, are ventilating pipes, which are provided with registers, seen at \(x\), Figs. 228 and 229. These communicate with the air-chamber beneath the ice-box, and also with air-flues at each end of it; thus two additional currents of cold air can be created when they may be needed. The windows of the lower milk-room are close to the ceiling, and above the surface of the ground outside. They are 3 feet wide and 18 inches high. They are made with outer wire cloth screens, glazed sashes, and inner shutters or blinds. The milk-room can thus be aired and darkened at the same time, if this is desired. In operating this dairy it has been found necessary to use 10 to 15 bushels of ice weekly in the hottest weather of the summer, the ice-box then requiring filling two or three times each week. The air within the milk-room has always been dry, so that the floor will not remain damp after it is washed longer than a few hours. (The dairy has been examined, when in operation, by a committee of the Solesbury Farmers' Club, who reported that it was the best dairy-house they had ever seen.)

"Spring Hill," in Fairfax County, Virginia, is situated upon the second tier of hills rising from the Potomac River, and is 12 miles due west from the city of Washington. The farm contains about 100 acres in forest, two-thirds being primeval hard wood, the other third pine of 30 years' growth, and 150 acres of arable land, divided into seven fenced fields, each having a living spring or spring stream within its limits; 10 or 15 acres more are occupied by buildings, garden, lawn, and roads. The soil is the heavy, deep, red clay, characteristic of the Piedmont region of Virginia, the home of maize and clover. The principal crops, Indian corn, wheat, rye, oats, grasses, and leguminous plants. Fruit and butter the specialties, the cities of Georgetown and Washington the markets. The cows, Jerseys and Jersey grades, 15 to 20 being kept in milk, are at pasture seven months, semi-soiled during one-third of this time, the dryest season, and fed in stables, tied with short chains the rest of the year, with several hours daily in a warm yard. The winter-feeding has no unusual feature. The milking is done by negroes, under an open shed in favourable weather, and begins just about sunrise and sunset. The milk is at once taken in the tin milking-pails to the spring-house, several rods distant. This building is in a forest-lined ravine, between two hills, upon one side of a small stream, stone walls enclosing a space of 8 feet by 12, covered by a wooden frame and roof with ventilating windows in the gables. Large white oaks shade the building in summer, admitting for a few hours in mid-day stray beams enough for health and purity. In winter the sun shines upon it a short time daily. The air
passing through the little vale is always fresh and sweet. A platform occupies the middle of the spring-house, extending from the door at one end; a double spring issues from the hill-side upon either side of the platform, just inside the doorway, and the water, flowing along the sides, meets at the farther end and passes out to the adjacent stream. The temperature of the water remains between 44° and 48° Fahr. during the year, and that of the air in the room is seldom above 55°. Upon reaching the spring-house, the milk is strained into earthenware crocks of rather greater depth than diameter, holding from 3 to 8 quarts, and these are set into the spring, so the milk surface will be just below the water level, and clean wooden covers put on them. In the water are flat stones of different sizes, which can be shifted easily so as to give any desired depth to the water flowing over them; thus milk-vessels of all sizes can be accommodated. A large stone jar for cream stands in the deepest part of the pool. The flow of water is unfailing, and sufficient to change the whole every twelve or fifteen minutes. Along each side of the building, 2 feet above the water, are slatted shelves to which the milk-vessels can be transferred in case of an occasional overflow of the springs in an unusual storm, for storage of extra milk-vessels and similar uses. The milk is skimmed uniformly at the end of twenty-four hours, one morning’s milk being removed from the spring before the next is set. The skimming is done with a metallic ladle, care being taken to dip out as little milk as possible. The churning is done when the cream is sweet, usually every other morning, and sometimes every day. The churn is of wood, a horizontal cylinder with a simple rotary dash, turned with a crank by hand. Temperature of the cream at churning, 60° to 62°; time in churning averages twenty minutes. The butter is gathered in the churn, removed to an oak table with an inclined top, washed thoroughly with cold spring-water, and lightly worked with a lever; then salted, about ½ oz. to a pound, and set away till evening. It is then carefully worked with a lever, moisture removed with sponge, covered with muslin, and packed in small stone jars in quantities to suit customers. The butter, in jars, remains in the spring-house, but never near warm or cooling milk, till sent away. Once or twice a week the product is delivered to families in the city, generally under contract, at a fixed price the year round. Price for some years, 40, 45, and 50 cents. Weekly products from 80 to 100 lbs.
In the Southern States where springs are not available for spring-house dairies, milk-rooms or cellars are sometimes constructed alongside the well, from which a supply of cold air may be obtained, and sometimes as independent apartments. The American Agriculturist gave the following description of a private dairy of this class, seen in North Carolina in 1868:

"It was built in connection with a very pleasant and comfortable although an old mansion. The entrance to the cellar was from the porch which ran around the house, and adjoining the rear or kitchen door. A handsome shade-tree and a grape-vine protected the entrance, which had lattice-work on three sides, with a door, also partly of lattice-work, in the front. A few steps led down into a very cool apartment about 6 feet below the ground, well lighted from a glazed cupola in the roof, and built of brick, and whitewashed. From a trap-door at one side a stairway led to a lower cellar, which was the milk-room. The upper apartment was used as a store-room for kitchen utensils, churn, and other similar articles. The lower cellar, when the hatchway was open, was well lighted. It was also of brick, and cleanly whitewashed. The floor was of brick, not cemented together. Shelves ran around this cellar at a convenient height, on which were kept milk, cream, butter, and other things proper to a milk-room. Although it is now five years since we saw this cellar, its coolness, perfect cleanliness, and sweetness was so impressive that the remembrance of it is still perfectly distinct. The cellar was about 10 feet square, and in all about 14 feet deep. The lower apartment was ceiled over with wooden beams and a tight floor. The cost of the whole would not be beyond the means of almost every farmer."

The writer knows of a similar room in Virginia, built right against the wall of a deep, cold well. It has an opening from the well into the lower apartment, and a small ventilating flue in one corner. It makes a very convenient and satisfactory arrangement for managing the milk of a few cows, from which butter is made.

"Deerfoot Farm," in Southborough, Worcester County, Massachusetts, owned and managed by Mr. Edward Burnett, has already been mentioned as having one of the best herds of Jersey cattle in America, and it is one of the most successful butter-farms in New England. About 75 head of Jerseys are kept, including calves and heifers, the cows in milk numbering from 45 to 60. The average yield being 5 lbs. of butter a week to each cow for the year, the butter product of the farm ranges from 200 to 300 lbs. a week. Systematic management, and the closest attention to care and feed of the stock, as well as to dairy details, characterise the establishment. The cows are always milked in their stables, where everything is scrupulously clean. The dairy-rooms are in one wing of a frame building, which in part serves for employees' quarters, and is situated on a hill-side, rather higher than the barns, although near. There are four apartments, a refrigerating room, a milk-room, a churning and working room, and storage. The dairyman receives the milk from the milkers and attends to all the subsequent work, from straining the milk to shipment of the butter. Mr. Burnett began, in the year 1870, with the small old-fashioned tin pans; these he discarded within twelve months, and put in large Orange County pans, effecting a great saving of time. A year later he changed to setting in deep pails in a tank of cold water, and after two years adopted the Hardin method of refrigerating, still using the deep pails set dry in a compartment, the air of which was cooled with ice. The room arranged for this purpose is now used for keeping cream and butter while in store. The next step onward—for he makes only such changes as he considers advancements—was a contrivance designed by..."
Mr. Burnett himself, cooling with ice-water about one-third of the can, the upper part, while the rest was exposed to the air of the milk-room, 60° to 70°. The setting vessels are cylindrical, of tin, 20 inches deep and 8 inches diameter, with covers, and holding 17 quarts each. These are placed in a wooden trough 9 inches deep, which has holes cut in the bottom to let the cans through till they rest upon an iron flange soldered on to outside of each pail; under the flanges are rubber washers, and these, with clamps, make all water-tight. Thus the pails or cans have about 8 inches of their length within the tank, the rest projecting below.

In this position the cans are filled, the milk strained a second time as it enters them. The tank or trough is then filled with water, in which is placed broken ice enough to reduce the temperature to about 45°. The tank is made in two sections, each large enough for pails to hold one milking at the maximum. An ice-chest, the size of one section, is fixed on rollers so as to move and fit closely over either half of the tank, and when in position may be let down upon a rubber washer running all round the section by a simple lever which displaces the wheels from the rails. This leaves an air-tight compartment between ice-chest and water of tank. The chest holds 200 or 300 lbs. of ice, and needs filling but once daily. Its drip falls into the tank, but not upon the cans. After thus setting ten hours the milk is carefully skimmed with a metallic dipper, in the form of an inverted cone, with a long handle. Of course the cream thus obtained is fully double the bulk of that gathered in most other methods, being thin and watery, and it is more trouble to churn it. But Mr. Burnett has satisfied himself by repeated experiment that he produces a higher quality of butter, and more uniform at all seasons, than by his former open-pan system; moreover, in some instances where by the new method he obtained 1 lb. of butter for every 17 lbs. of milk, the ratio with shallow pans tried at the same time, milk standing forty-eight hours, was 1 to 18. He also found it much easier to control the temperature of his milk by water than by air, no matter how small the room used. Skimmed as stated, one section of the tank is always emptied, although perhaps not cleaned up, before the milk for the other comes in. The cream is put into large tin pails, which stand in refrigerating-room, temperature 50°, until the faintest acidity is developed. The cream-pails are then moved to the churning-room, and temperature gradually raised to 56° in summer and to 62° in winter. Four or five days in each week the churning is done, usually two churnings of about 30 lbs. of butter each, from 20 gallons, or thereabouts, of the thin cream. The Philadelphia barrel-churn is used, revolved horizontally by steam-power, about forty turns per minute; three-quarters of an hour to an hour is generally occupied in churning. When the butter breaks and the pieces are about the size of peas, the buttermilk is drawn off. Then the butter is rinsed three or four times in the churn, with pure water of the temperature at which it is desired to work the butter. After this it is gathered as much as possible in the churn and removed to a wooden working table, similar to the Eureka worker (hereafter described). Upon this the butter is rolled out thin, usually three times, and each time wiped, or rather "sopped," free from all moisture; then, while spread thin like pastry, it is salted, only 3 oz. to 10 lbs., the salt sprinkled on evenly with a fine sieve. The butter is rolled out twice more, to incorporate the salt, and then sent into the refrigerating-room, where it remains from about 10 o'clock a.m. till 4 p.m. It is then reworked, simply to throw off any brine formed and to render it more flexible, and made up with spats—no hand contact—into regular triangular prisms about 5 inches long and weighing 1 lb. each. These rolls, each wrapped in muslin, are packed on end in tin boxes, all 18 inches wide and 6 inches deep, and differing in length according to quantity of contents. The tin boxes are in turn placed in wooden ones, with ice-packing when necessary, and thus sent by rail to Boston. The prices obtained for several years have ranged from 45 to 75 cents, being usually about double the market quotations for best butter in lumps. Mr. Burnett has at times purchased considerable milk of neighbouring farmers having Jerseys or Jersey grades, and thus increased his weekly production to 400 lbs. of butter, sometimes more; but he has invariably been obliged to discontinue this because it lowered the average quality of his butter and so injured his business. The buttermilk goes to pigs, a choice article of pork being another specialty of the farm. The skim-milk is shipped every day to Boston, 25 miles distant, and is one of the important matters in the economy of the farm management. Treated as described, the milk is always sweet.
when skimmed, and with a fair percentage of fat remaining, so it sells readily in the city at half the price of whole milk.

Distinct from his butter-making, Mr. Burnett sent to the Boston market, during the years 1878 and 1879, a limited quantity of clotted cream in glass jars, which he prepared as follows:—In his milk-room two large shallow pans were set in double jackets, so their contents could be heated by steam or hot-water circulation, or similarly cooled. A cooling-chest, like that described for the other milk-setting apparatus, was arranged to fit over these pans alternately. The milk, strained into a pan, was heated by steam to 160° Fahr., and then by replacing the steam with cold water and with cooling-chest over it, in which ice and salt were used, it was cooled rapidly, almost to freezing. This gave the stiff clotted cream, which was removed in about ten hours. The skim-milk, as in the other case, was sent to Boston.

Not content with the improvements cited, Mr. Burnett experimented, during the season of 1879, with centrifugal cream-separators, and finally had one made after modifications of his own suggestion and under American patents, which he proposes to use henceforth. It operates continuously, and with it he is enabled (1880) to send milk and cream, separately canned, for delivery in Boston the same day it is taken from the cow, and can place butter daily on the dinner-tables of his customers made from the morning's milk. He has also adapted the centrifugal principle for extracting the buttermilk and brine from his butter, the apparatus being devised by himself, a centrifugal "worker."

Hon. Harris Lewis is one of the best-known dairymen in the United States. He has been President of the New York State Agricultural Society, the State Dairymen's Association, and the Farmers' Alliance. His farm, of 140 acres, is at Frankfort, in Herkimer County, New York, about midway between Utica and Little Falls; it lies upon the north side of the Mohawk River, and extends from that stream back into the wooded hills. About 30 acres are on the Mohawk flat, overflowed every spring, receiving a deposit which accounts for the famous crops of hay cut from this meadow year after year. Upon the upland stand the two dwellings of Mr. Lewis and his son, modest buildings in no way remarkable.

The dairy barn is in many respects a model. It is a large frame building on four heavy walls, the top of the east-side wall being level with the ground, making easy access to the main door for the loads of orchard-grass, which grows abundantly near by. On the cattle-floor below are two rows of stanchions running the length of the building, with passage-way in the centre 10 feet wide.

Forty animals stand facing this passage, into which the hay is thrown from above, and from which ventilators lead to the roof. A patent manger is in use; when opened into the passage these make convenient troughs for hay, and when shut down, a square box for meal or roots is before each animal. On each side, in rear of each row of cows, is space wide enough for a team to pass through with sled or wagon, and doors to match at the ends. Yet, when closed, the stable is warm enough in winter to keep roots without freezing, and a supply of these is always to be seen at one end, in their season, with a root-cutter at hand. Mr. Lewis is famous for his root crops for winter feeding; he relies for feed mainly on roots and hay while in stable, and pasturage supplemented with a regular ration of dry forage in the summer. There is running water in the barn-yard, and the pastures and lanes to them are well furnished with watering troughs in different places, so the cows need never walk far to drink. And near each of these many watering-places a few shade-trees have been provided. Mr. Lewis believes that all these accommodations are economical, as the easier he makes everything for his cows, the more comfortable and contented they are, and the better return they make at the milk-pail.

The herd numbers about 30 cows, nearly all full-blooded Shorthorns, and about 25 are usually in milk. It is remarkable as being one of the few noted dairy-farms in America where Shorthorns are preferred to other breeds for dairy purposes.

The dairy-house, a little west of the barn towards the highway, and between the two houses, is a neat wooden structure, raised a little above the ground, and divided into two rooms. The one first entered is for churning and cleaning, and has an outer door at each end; a door on one side of this work-room opens into the milk-room. Four Jewett pans are used, each large enough to hold the milk of a single milking of 30 cows. In one end of the room is an open tank, supplied with spring-water by a ram, the overflow going to the
troughs in the barn-yard. Ice is used in the tank as needed. From this tank water is carried under and around the pans, and the room, receiving no other cooling, is by this means kept at about 60° in hot weather. The milk is allowed to stand from thirty-six to forty-eight hours in the pans, according to the weather; the aim is to skim as soon as coagulation appears at the bottom of the pan. The churning is done every day in a Bullard oscillating churn, by dog-power standing on north side of work-room. As soon as the butter begins to come, the temperature of the contents of the churn is reduced to 55° by pouring in cold water. When the butter has separated from the milk and before it is gathered into a mass, being in lumps like small peas, the buttermilk is drawn off and water poured in. This process is repeated until the water that runs off is quite clear. The butter is then carefully spread so as not to adhere in a mass, salt gently stirred in at the rate of 3 oz. to the pound, and the butter then placed in a bowl and set in a cool place until the next day. The incorporation of salt is then completed, and the butter packed in jars or other packages. All of Mr. Lewis's butter is taken in the home market, and always at an extra price.

W. V. S. Beekman, of Saugerties, New York, one of the prize butter makers of that State, gives the following description of his procedure:—He feeds his animals all they will eat of the very best food. Average daily ration in winter 20 lbs. bright, early-cut clover hay, 4 quarts of fine corn-meal, and one peck of roots, carrots, parsnips, sugar-beets, &c.; in summer he gives an abundance of forage crops in addition to pasture. While pasture is poorest, feeds fodder corn, 2 quarts corn-meal, and a little hay. He uses stamping, being led to prefer these after considerable experimenting; the cows stand on an elevated platform, with an 18-inch wide gutter at the rear. Before each milking the stables are cleaned, and absorbents put in the gutter and fresh straw in the stalls. The cows are then brushed off, and their udders sponged with tepid water. He prefers deep cans for setting, and uses the pool in his spring-house. The latter is a rough board building, 8 feet square and 6 feet high; the temperature of the spring ranges from 40° to 50° during the year. Before churning, he sets the can of cream into a tub containing water at about 70°, and stirs the cream till the latter is brought to 62°, as shown by a floating dairy thermometer. The cream is churned sweet, three times a week, in an old-fashioned dash churn. After churning, the butter is taken out, 8 lbs. or 10 lbs. at a time, into a bowl, and washed at once rapidly, most of the buttermilk being removed in this washing. Half an ounce of finely-sifted salt is used for each pound of butter. The working is finished on a low oaken table having its upper surface an inclined plane, and the butter is carefully pressed, all the moisture being absorbed by applications of thin muslin cloth, which is found preferable to a sponge. Mr. Beekman packs in earthen jars in summer and in oaken tubs in winter. By his management he was able to make butter of superior quality in August, 1872, a month famous for its intense heat and violent thunder showers, and as firm as his product of June and October. He ships to private customers in New York, and by night boat, in summer, not using ice, as he thinks it injurious to flavour. His is a small, private dairy; he keeps but six cows in milk, feeds and milks them himself, and personally churns, works, and packs his butter.

The following are condensed descriptions of the processes of making butter in private dairies, as given by winners of some of the highest prizes awarded at dairy exhibitions in America:—

**Premium Dairy Butter at North-Western Dairy Fair, Chicago, December, 1877.**

Statement of C. C. Buell, of Rock Falls, Illinois:—Cows mostly common stock, a few grades of Durham and Jersey, 40 in all. Fed (November) by running in corn-fields during daytime, where stalks are standing, and at night in stable, on timothy and clover, with two messes of meal daily, two parts corn and one oats, by measure; also fed greater part of the sour-milk and buttermilk from dairy. Milk strained through wire strainer into deep pails as soon as drawn; pails stand in the open air till milking is finished. Then strained again, into same pails, through double cloth strainer. Milk set in a room without fire, temperature 40° to 50°. During part of the time, temperature of room being above 50°, the pails were set in cold water for twelve hours. Milk skimmed twice within forty-eight hours, it being considered desirable to mix the newer and older cream, for sake of flavour. All the cream mixed after last skimming and allowed to stand four hours before churning, during which time it was
slowly brought to a temperature of 62°. Two different churns are used, dependent somewhat upon the weather and condition of cream; one is a vertical dash churn, with solid dasher, its lower side concave, and the other an empty box with ten sides, which revolves about forty times per minute. From a half-hour to an hour and a half is occupied in churning, often the latter with revolving churn. As buttermilk begins to appear, a couple of gallons of strong brine is added, at a temperature of 58°, and the churn stopped a moment later, as with this addition of the brine, at a proper temperature, the butter separates rapidly. As much brine as necessary is then used in washing down the sides of churn, cover and dasher. The butter is then dipped from the churn into a bath of 2 gallons of brine, 10 or 12 lbs. at a time being thus washed, and four or five such parts, constituting the churning, may be washed in the same brine. Removed to a worker with a rolling lever, the butter thus washed but once is worked as little as possible, just enough to mix in a little more salt and to make all compact. Sometimes, instead of working in salt, the butter after the slightest working is laid into a tub of brine for four hours, then worked enough to expel the brine, and packed for market. Chemical colouring matter is used in the churn. Neatness, scrupulous neatness, at all points. The two premium tubs were made up of three different churnings.

**Premium Dairy Butter at International Dairy Fair, New York, December, 1878.**

Statement by John S. Murray, Delhi, New York, whose butter also received prize at the exhibition of the Royal Agricultural Society of England, at Kilburn, 1879:—Butter made from a dairy of 30 cows, principally natives with a sprinkling of Alderneys (Jerseys), by the Cooley or submerged process. The milk remained in the vat twenty-four hours, at a temperature of 48°, when the milk was drawn off and the cream taken into a warm room to prepare it for the churn. Endeavour to have the temperature and ripeness come as near together as possible, just before churning, so as to save sudden heating, as at this stage cream is very sensitive and easily injured. We churn when the cream is slightly acid; we churn about a quarter of the milk, including cream; churn by water-power at a temperature of 59° to 62°; use the old dash churn; churn every day except Sundays, some days twice; when it begins to come in small particles, wash it down with cold water, then take it out into the butter bowl and sprinkle on a little salt, add a few quarts of water, stir a little, and let it remain a short time; then let it drain off through a hole in bottom of bowl; then wash in two waters, at second washing press solid. Weigh and salt with ¾ oz. of Higgins’ Eureka salt to 1 lb. butter, work it carefully and let stand in a cool cellar about four hours, covering it with a cloth; then work again slightly on an inclined plane, in order to let brine run off, and pack. When the firkin is filled, a cloth is put on wet with brine and covered with about an inch of fine salt, damp. A flat stone is placed on top till time for closing the package and sending away. The working is all done with a hand-paddle or ladle, by pressing carefully so as not to injure the grain; have tried several patent workers, but have nothing that would replace the ladle. No artificial colouring.

Hiram Smith, of Sheboygan Falls, Wisconsin, for some years the President of the North-Western Dairymen’s Association, made the butter which took the sweepstake special prize for the best made by any farmer, creamery, or dairymen in the United States, salted with Higgins’ Eureka salt (New York, December, 1878). Statement:—This butter was made from a dairy of 50 cows, in the month of November, 1878; the cows were fed during the time on hay cut in June, also about 4 quarts of shelled yellow-globe mangel-wurzel with 4 quarts of wheat middlings to each cow per day. The cows were regularly salted three times a week, and had free access to water pumped from a well. Milking done about six o’clock morning and evening; the milk immediately strained and submerged in ice-water, at a temperature of 45° in the coolery cans, and allowed to remain about eleven hours, or between milkings. Then the milk is drawn off, and the cream all mixed together and brought to a temperature of 62°, and stirred at intervals for twenty-four to thirty-six hours, or until it becomes a little acid and commences to thicken, at which time colouring matter is added at the rate of a tea-spoonful to 8 gallons of cream; temperature of the cream at the commencement of churning never below 60° nor above 62°, and moderate churning until the cream breaks, or until globules of butter appear the size of wheat kernels. Churning should then cease, and
a gallon of cold brine to every 8 gallons of cream be added, mainly for the purpose of decanting the butter, so that the buttermilk can be drawn off free from the butter. Then add as much more cold brine to work and harden the butter, allowing it to remain ten minutes, with a few turns of the churn. After the brine is drained off, the butter can be salted in the churn, or upon the butter-worker, at the rate of \( \frac{3}{4} \) to 1 oz. to a pound of butter, according to the dryness of the butter, and worked but slightly at this time. Cover with a cloth and let it stand four or five hours, then work it to the consistency of conveniently packing, which should be immediately done, pressing firmly down until the package is well filled. Cover with a clean muslin cloth, cut the shape of the package, wet with brine, and keep in a cool place until used.

With all the progress that has been made and the means provided for facilitating dairy operations, there can still be found in practice, in some parts of the United States, the most primitive methods, especially in butter-making. There are doubtless a good many families who keep one or two cows, and make all the butter they use, yet never use a churn. The writer has three such in mind, as examples, where all the butter is made by stirring the cream with a spoon or wooden paddle, in a large earthen bowl.

In Texas and New Mexico, making butter is a rare occurrence. Many owners of cows by the thousand seldom use milk, but there are times and places at which scenes like the following can be witnessed:—A portion of soured cream, or of the whole milk (for in this climate the milk usually thickens before the cream separates), is placed in a stout leather bag, that is tightly closed and fastened to one end of a long raw-hide rope, or lariat, the other end being attached to the pommel of a Mexican saddle, on the back of a half-wild mustang pony, with a rider quite equal to the occasion. All being in readiness, the rider puts spurs to his steed, which goes off with a bound. The lariat, suddenly straightened out behind, jerks the bag violently forward, so that it falls beside the horse, or, perhaps, hits him upon rump or heels, or strikes the rider's back, and then falls to the ground only to be the next moment jerked into the air again. Thus the mustang careers over the prairie, with its fantastic appendage, until the practised ear of the rider detects the rattling sound in the contents of the sack—as, perchance, it deals him a sound blow on the head—and knows that the butter has come. Then, reining in his horse-power, he draws his churn up before him on the saddle, and canters back to the _rauche_.

A modification of this rather violent mode of churning was customary for years among emigrants, freighters, and detachments of troops when crossing the Western plains. These canvans, or trains, moved so slowly that it was an easy matter, while grazing was good, to take along "an American cow" to add comfort to the meagre domestic provisions for "the outfit." The milk not used while sweet was put into bottles, or small stone jugs, corked up; these, partly filled, were hung under wagons, and there swung and jolted, as the train moved over the roadless prairies through the day's march. Halted for the night, the bottles were buried in the earth to cool, and in the morning little lumps of firm fresh butter were ready for breakfast.

Among the Cherokee and Muskogee Indians, who were moved in the year 1838 from the Gulf States to the Indian territory (west of Arkansas), an old and peculiar mode of making butter may yet be found in practice to some extent. The cream is not removed from the milk until the latter has fully lopped, and then care is taken to get only the cream. A quantity of this is kept until thick and stiff; it is then poured into a coarse linen cloth, the mass wrapped up in several successive coverings of any porous material, and the whole bundle then buried in the ground, preferably 3 feet deep, in a clean, loamy soil. Exhumed after twenty-four hours, the inner cloth is found to contain butterm, generally dry, firm, and in good condition, all whey and water having been absorbed by the earth. Butter thus made has little colour, but is excellent, provided the other dairy processes are done in a cleanly and judicious manner.

Home-made cheese in the United States is becoming more and more rare. The factories have so generally superseded farm cheese-making, that the latter receives very little attention in the consideration of dairy interests in America. And where cheese-making continues in small quantity in private dairies, there is nothing peculiar to the processes employed which calls for special comment or description.

H. E. A.
CHAPTER XXX.
Dairy Implements and Machinery.


Obliging is more noticeable in connection with American dairying than the great attention paid to improving the dairy appliances. And this fact in turn is evidence of the development and importance of the dairy interest itself. The Americans are famous for their ingenuity, and no sooner does any branch of industry become prominent than many brains and hands are directed towards providing labour-saving apparatus and improving the processes at all points. The inventions in aid of dairying are very numerous, and the progress made is quite as marked as in the mechanical advancement in other departments of agriculture. Indeed, new devices for the dairy appear so fast that a close watch of the United States Patent Office is necessary to keep up with them. As a single example of this activity, from the time of the enactment of the patent law there have been on an average thirty applications a year for new or improved churns; and although about one-fourth have been rejected, 1,811 patents on churns have been issued, or a new churn every seventeen days (average) for more than eighty years!

This chapter will be devoted to an account of American dairy apparatus, and especially to describing and illustrating those articles which have borne the test of practical application, and are recognised as valuable acquisitions. Of the multitude of appliances produced, of course only a few of the fittest survive and come into general use. As far as it is possible, the utensils will be described in the order of the process of dairy manipulation.

Milking-machines therefore come first. Considering all the trouble that arises from poor milking, injury to the cow and spoiling of milk, it is no wonder that reform in the matter of milking is so loudly called for. And then the time consumed: it is within bounds to say that for the cows in milk in the United States, this is equal to the whole labour of 200,000 men every day in the year. It is therefore not surprising that for thirty years inventors have been trying to produce a machine to do this work. There have been between forty and fifty patents issued in the United States for cow-milkers, beginning in 1849, and they may be classed according to their action, as tappers, squeezers, and suckers. The first class, or tube-milkers, as they are commonly called, are illustrated and described on page 58, to which the reader is referred. While these tube-milkers are of occasional service in cases of sore, obstructed, and malformed teats, their continued use has generally been found injurious, in causing inflammation, loss of milk by "leakage," and premature drying. So far is it from being true, as sometimes asserted, that these milking appliances have been generally adopted in America, that not a single well-known dairyman in the country has adopted or endorsed them. Yet they continue to be manufactured and advertised, and must find buyers.

The next system of milkers patented attempted to imitate hand-milking, in squeezing and stripping; but the difficulty of making a mechanical substitute for the human hand has not been surmounted, and no success has thus far attended the inventions on this basis, although it is unquestionably the direction in which success is most to be desired.
More than half the American patents for milkers have been upon machines which have aimed to imitate the natural motion of the calf in suckling. Ten of these patents were issued to L. O. Colvin, beginning in 1860, and it is upon the general plan of his inventions that the greatest hope now lies for perfecting a practically satisfactory cow-milker. The latest machine of this kind, which has attained the highest mechanical merit and the most complete theoretical action, is that of Albert A. Durand, made at Auburn, New York.

**Straining, Cooling, and Aerating Milk.**

Straining milk before "setting" it for cream or canning it for shipment is very essential, and too often neglected, coarse cloth make-shifts or other utensils being relied upon that do not answer the purpose. In most metal strainers the surface has been flat or concave, so it has not been possible to use wire cloth fine enough to remove all impurities without filling the meshes and clogging the strainer. To do the work quickly, the cloth or wire used is often so coarse as to make the operation of little effect. The best American article of this kind is More's pyramidal strainer, illustrated in Figs. 231 and 232. Its special advantage is the form of the strainer: the milk falls upon the sloping sides of the pyramid, and the sediment is the constantly carried to the base, leaving a clean surface through which the milk rapidly passes. This permits wire cloth of 100 mesh (10,000 perforations to the square inch), which is finer than any cloth strainer used, and cleans the milk perfectly. As it never clogs, it works very fast. The bowl is seamless, of Britannia or copper, of fine form and finish, and of great strength. The strainer is attached by a coarse screw, and can be easily removed and cleaned. Strainers of different meshes are furnished for the same bowl, for various domestic uses. In the first figure a portion of the bowl is cut away to show the position of the strainer, and the whole rests upon a circular metallic support used in straining into small pans; the second figure shows the parts separated. For use with large factory-carrying casks, deep-setting pails and pans, a simple bent-wire attachment is furnished, which gives complete support. This excellent utensil is sold in several sizes, the strainer surface having from 60,000 to 150,000 perforations, at from 1½ to 2½ dollars, with attachments complete. It is exclusively manufactured by Moseley and Stoddard, of the New England Dairymen's Supply Depot, at Poultney, Rutland County, Vermont.

The subject of cooling milk before transportation has received much attention in America during the last twenty years, and in that time patents for a hundred and fifty devices for the purpose have been issued, twenty-one of them in the year 1875, and twenty-four in 1876. Many combine the cooling with cream-raising, and these will be mentioned later. The simplest and most common provision is the tank or bath of running spring-water, cooled by ice when necessary, and tin pails about 8 inches in diameter, and from 18 to 25 inches deep, with heavy bottom (Fig. 233).

A clever contrivance for expelling the animal heat in a quicker way, but requiring more labour, is represented in Fig. 234. By this milk aerator and cooler, a hand-lever below draws air through an ice-box and forces it down a tin tube to a perforated base, where it is expelled through the milk. The air may be drawn through
cotton-wool, and so be purified from germs of ferments. A valve at the base of the tube prevents
the milk from being drawn into the bellows. All the parts are detachable for cleaning. The figure
shows the apparatus by itself, and also as attached to a can by the extension bracket, but without the
ice-box. This aerator is sold, complete, for 4 dollars, and fitted to cans of all sizes.

Milk-cans.

Milk-cans, for conveying the article to factories by railway, to city dealers in milk-waggons,
and for delivery in small, unbroken parcels to consumers, are very numerous, differing widely in
patterns and in size. Over a hundred patents on milk-cans have been issued in the United
States since 1860.

The "factory" carrying can has been shown in Fig. 132, page 274. It is usually a
cylinder with diameter two-thirds of height, holding from 50 to 60 gallons; when well made
the sides are of a single piece of tin, and with top and bottom hoops and a midway band. Bottoms
and bands are often of wrought-iron, tinned; the covers in several patterns have ventilators attached.
The side handles may be quite plain or of the Whitney pattern, which is that used by the Iron-
Clad Can Company of New York, and shown in the engraving. Another improved form of can-
handles is Millar's patent; these are a combination for convenience in ordinary handling and
for raising and tipping, when cranes are used at a factory. Some cranes have curved hooks,
and some hooks square bent which require a socket perpendicular to the side of the can;
these handles provide for both. They are made of malleable iron, japanned or tinned, and cost
half a dollar a pair.

Milk Setting.

For setting milk to let the cream gather, almost the only article used in the Northern States
for many years was the shallow tin pan, circular, with sides slightly flaring; and the counterpart of
this in the South and those regions where spring-houses prevailed was the pan, often approaching
a jar in form, of earthenware, generally called a crock. A dairy of much size, fitted with small pans
in the days when milk was allowed to stand forty-eight or sixty hours before skimming, presented a
formidable array of tin-ware; the labour connected therewith, devolving upon the women-folk, was
simply killing. The tiers of bright pans upon a bench, drying and sweetening in the sun, is still a
characteristic of the homestead of the American general farmer, who keeps a few cows and makes
butter to use and sell at the country store. But in the active dairying districts the small pans have
almost disappeared.

Patents for improved milk pans and coolers began to be taken out in 1859, although few were
issued prior to 1865; during the next fourteen years, over one hundred and fifty devices of this
class were patented in the United States. Most of them were for large, shallow setting, holding from
10 to 200 gallons, the depth from 5 to 8 inches, sometimes 10, and the pans sold in sets of four.
Nearly all these pans have arrangements for a circulation of cold or warm water around them for
regulating the temperature of the milk. Illustrations and descriptions of several of these systems of cream-raising have already been given.

All these appliances for deep-setting depend upon the use of ice, and involve much labour in
handling and cleaning the cans. There are good American dairymen, however, who wish sometimes to apply heat to their milk, to vary the depth of setting it, and to set deep without so many cans. The judges on apparatus at the International Dairy Fair at New York, in 1878, decided that the best creamer was one that would accommodate methods and processes based upon different theories, not restricted to one, and awarded the diploma for "the best creamer" accordingly.

The refrigerating creamery-vat of Whitman and Burrell, of Little Falls, New York, shown in Figs. 236, 237, received the award. The general utility of this vat is one of its chief merits. In it the milk may be set at any depth up to 20 inches, and the narrow compartments, and these conduct cold water through the mass of milk; if it is desired to prevent cream rising, these attachments, by a simple device (not shown in the engraving) may be put in motion as agitators. A light cover, adjusted by balance pulleys, may be let down upon the vat, and having a jambed edge with india-rubber packing, all dust and air are shut out. The cover is of roofing tin, double, with an air-space of one inch, the top painted and the inside dressed with shellac or paraffin. Ventilators are made in the cover when wanted. To expedite the cooling, there are ice-pans which may be placed under the cover, directly over the milk, with drip-tubes which pass to the outside of the vat. With a very economical use of ice, and perhaps a little salt, a body of 5,000 lbs. of fresh milk may by this apparatus be reduced to a temperature of 40° Fahr. in a remarkably short time. The provisions for water circulation answer also for steam, and by its application the contents of the vat may be soon heated to any degree. Hot water may, of course, be used instead of steam. And to suit different notions in cream-raising, the apparatus admits of the application of heat at the bottom only, of cold at the bottom or the top alone, or of heat below and cold above. The milk receptacle is of heavy tin, substantial but plain; the vat-frame is thoroughly made, put together with screw-bolts, well finished, and the panels covered with a non-conducting coat to economise heat and cold. The whole is simple, every part accessible for cleaning, and it is easily managed. The milk may be drawn off with faucet and spout, and there is the usual tipping contrivance to facilitate emptying. The cream which forms under these air-tight covers is very tender and of even consistency, having none of the objectionable skin or crust so common when exposed to the air, and so it may readily be drawn through the large faucet, after the milk, and conducted directly to the churn. These various attributes make this vat a convenient and economical appliance for either butter-making or a cheese-factory, and particularly for an establishment where both articles are produced at different times, or made from the same milk. Six sizes of these vats are in the market, capacity from 75 to 700 gallons, and they range in price from 35 to 75 dollars for vat alone, and from 50 to 140 dollars when complete, with cover, ice-pans, and partitions.
The Ancient cooler and cream-raiser is a still simpler apparatus for deep-setting in quantity, the invention of R. Ancient, the superintendent of one of the famous Stewart creameries in Iowa, the result of experience there, and introduced in 1879. A strong tank holds a set of ten deep oblong cans, each with capacity for 100 lbs. of milk; they may be connected, thus receiving and discharging 1,000 lbs. at once, or any number of the compartments may be separately used. There is ample space between the cans to facilitate cleaning, and the arrangement presents the greatest possible cooling surface. The tank is made to use cold running water, or for a still bath, adding ice as required. It stands above the floor like a cheesecloth, and has the usual dumping device. The gang of cans, strong and durable, is easily handled and removed by one person. A discharge-pipe allows the milk to be drawn off from under the cream, and the can-bottoms are so shaped that should there be any sediment it will be carried away by the current of milk at the first flow on opening the outlet.

The Fairlamb milk-can, patented in 1878, is an appliance specially adapted to a new system of creamery practice introduced at the North-west by C. C. Fairlamb, of Arena, Wisconsin. The method consists in gathering the cream only from the producing dairies instead of the whole milk. Instead of paying for milk by the pound, with no allowance for difference in quality, in this system the payment is according to the butter value, the cream being taken by the factory agent from cans of uniform size and construction, and credit given according to the glass gauge in the side of the can. Loss of cream by too much shaking of milk in hauling is thus avoided, and all the skim-milk is left sweet upon the farm. The Fairlamb can is an essential part of this system; a very good idea of it may be got from Figs. 238, 239. The can is 19 1/2 inches high, 12 inches in diameter at the top, and 10 1/2 at the bottom, and provided with an air-tube in the centre for air in cooling the milk; this is shown in the sectional view. The cover is of tin, with a rubber band covering the edges, and making the can air-tight, when in place. A glass gauge is fixed in the side for measuring the depth of the cream. The can may be used in water or open air; cooled air is recommended as the best by the inventor. A specially-contrived carrying can is provided for the cream gatherer, under this system, with follower-heads to prevent churning in the waggon, and this can is made of any size above 20 gallons; it is also arranged for regulation of temperature of the cream during transit.

Baker's excelsior cream-strainer is very convenient for reducing a mass of cream to even consistency, either before churning or for sale for table use. The cream is forced gently through perforations at the point of the cone-shaped tin, by means of a peculiarly-shaped wooden knob, turned with a crank. This utensil, price 4 dollars, is made by Jones, Faulkner, and Co., of Utica, New York.

Up to the separation of the cream from the milk, the various kinds of apparatus cannot be well sub-divided, they are all used in connection with the raw materials. But beyond this point dairy appliances are naturally placed in two great classes, as they are intended to facilitate butter-making and cheese-making.

Churns.

There were issued in the United States, prior to the year 1879, upwards of 2,000 patents for tools and implements used in making butter. Churns were the first dairy utensils patented in America (1802), and have exceeded all others combined in number and variety. The grand aggregate of over 1,500 patents of this kind includes not only entirely new patterns or principles, but changes and improvements in the barrel or body of the churn itself, in dashers, in combinations, attachments, and operating devices.
In 1803 a “rocking churn” was invented, in 1813 and 1831 “pendulum” churns, with others termed “reciprocating,” “self-acting,” “oscillating,” and “rotary.” Churns and butter-workers combined were first patented in 1851 and 1852. As a matter of curiosity, these churn patents are divided in time as follows:—Prior to the year 1850, 71; during the twenty-five years ending with 1850, 131; during the decade ending in 1800, 117; during the next decade, 80; from 1871 to 1875, inclusive, 361; in 1876, 86; in 1877, 109; in 1878, 98. The greater part of the whole number, therefore, have originated within twenty years. Some of the best and most popular forms of American churns will now be described.

The Davis oscillating churn of the Vermont Farm Machine Company received the first honours at the International Dairy Fair, New York, 1878. It is a box with rounded ends, free from dashers or other obstructions, hung in a portable frame by four hinged rods, and given its swinging motion by a handle at either end. Figs. 241 and 242 show the general appearance of the churn, and the motion given to its contents by the oscillation. It is very well made, but three pieces of wood in the body, except the cover; and having no sharp angles and corners, it is easily cleaned. It is very efficient, easily managed, and quite cheap. Several sizes are made.

The pendulum churn, John Campbell’s patents, sold by the Dairy Supply Company of New York City, is on the same principle as the preceding one, but differs in details and in material, this being of tin. It is suspended by two cords with snap hooks, and moved back and forth horizontally by a handle at one end. Figs. 243 and 244 show the exterior of the churn and the motion given to it as it swings; Fig. 245 the action of the cream in the churn. The latter is perfect, including the entire contents, so that no “dead cream” can collect anywhere, and the peculiar shape of the interior causes sufficient concussion without any dashing over; but for very active
agitation a close cover is provided, and this has two vent tubes which may be kept corked or left open for aeration while churning. The effect upon the cream is so thorough and uniform in this churn that the butter "comes" all at once. It is especially adapted to prevent over-churning, and to facilitate the method of washing and salting the butter in its granular form. When the butter passes the mustard-seed condition and begins to form larger granules, the tendency in this churn is for the heavier buttermilk to be thrown into the cone-ends, while the butter is buoyed off and does not, as a rule, come in contact with the tin. At this stage, when the particles become the size of wheat-grains, the churning ceases, and some cold water or clear brine is poured in; then, after a gentle motion to wash and harden the butter grains, a large cork which during the churning closes an opening in the end opposite the handle is removed, and a metallic tubular strainer inserted, through which the buttermilk is drawn off, by tilting the churn and taking a half-hitch around the handle with the nearest swing cord. The operator replaces the churn, adds water, washes the butter by shaking the churn, and draws it off as before, repeating until the water comes off clear. The butter may be finally removed with a wire dip-strainer while floating upon water in the churn, salted and set away for final manipulation while still in the granular form. The large opening to the churn, its form, general simplicity, and material enable it to be very easily handled and cleaned, and it is one of the cheapest of good churns. When not in use it occupies no floor room, but it is readily hung up out of the way.

Whipple's rectangular churn, made only by Cornish and Curtis, of Fort Atkinson, Wisconsin, is a great favourite in the North-west, received the highest prize at the Chicago Dairy Fair of 1877, and has won many other honours. It is easily understood from the illustration in Fig. 246. A rectangular or cubical box, quite plain but strong, with circular opening and close cover on one face, is suspended from diagonal corners upon a light frame turned with a crank handle, and as it revolves the cream falls from corner to corner, giving it a diversified and rapid concussion. Nothing could be simpler, and it is very effective in its work. The same pattern is made in large sizes and fitted with pulley for operating by power.

Bullard's oscillating churn, manufactured by Bullard and Ellsworth, of Barre, Massachusetts, is another of the same general class of churns without paddles or dashers, was one of the first introduced on this principle, is used by many of the best butter-makers in New England and New York, and is deservedly popular. It received the highest award at the United States Centennial Exposition. The body (Fig. 247) is a plain box, the length about twice the other dimensions, opening and cover on the top, with vent. By a simple fastening the box is held in place on a seat or frame with two upright rocking standards, and moved back and forth by a handle at one end. At the other end are two heavy balance wheels which overcome the resistance of the cream and continue and regulate the movement. By these wheels, also, power may be applied. But although contributing much to the ease and action of the churn,
the wheels add to its cost and make it a heavy and roomy implement to handle and store.

The Blanchard is unquestionably the best, as it is the most widely known and used, of American dash churns. It is well represented in Fig. 248, with its parts. These are some of its conspicuous merits: perfection of material, excellence and thoroughness of manufacture, simplicity of construction, and ease of operation. The form exposes every part of the interior upon the removal of the cover, and the dasher can be detached by a single motion. The action of the dasher, with its self-adjusting floats, is to give four motions to the cream at every revolution of the crank, and the agitation is in the form of currents, instead of friction and blows. A reverse motion of the dasher after the butter forms gives it a cam pressure, by which the buttermilk may be mainly worked out. Porter Blanchard and his sons have been making churns at Concord, New Hampshire, for more than fifty years, with a constantly increasing reputation, and are still the sole manufacturers of the wares which bear their name.

The Blanchard cylindrical factory churn is one of the newest of the power churns, and has been very successful in many of the largest butter-making establishments in the United States. These churns possess all the excellent qualities of the smaller hand-machines already mentioned, and are of great capacity.

The size shown in the engraving (Fig. 249) will make from 375 lbs. to 425 lbs. of butter at a churning, according to the quality of the cream. Price for this size, 50 dollars.

The horizontal barrel churn, constructed for either hand or power, has usually three dashers running the length of its interior, projecting 3 or 4 inches from the staves towards the axis, and permanently placed equidistant. This churn (Fig. 250) is in general use in Pennsylvania, particularly near Philadelphia, and is often called the Philadelphia revolving churn. It is used more or less all over the country, especially in small factories or dairies having light power, and is made by several of the best-known American manufacturers of dairy apparatus.

The “Queen of the Dairy” is the name given a revolving box churn (Fig. 251) made by Gardner B. Weeks, of Syracuse, New York. It is made for factory use, in gangs of two, three, and four, which may be used separately or all thrown into one compartment. The churn is admirably balanced, and even the large sizes may be turned by the hand-crank. This three-gang size will make 400 lbs. of butter at once. Price complete, 75 dollars.

The butter-makers of Orange County, New York, still largely use the old-time barrel churn with the vertical dasher. In large dairies and factories two or more of these are made into a gang, to which any convenient power is attached,
as shown in Fig. 253. Singly and in gangs, these old-fashioned churns continued to be favoured by good dairymen in different parts of the United States. The set here represented is as put up by Jones, Faulkner, and Co., of Utica, New York.

From among the great number of churns patented and offered for sale in America, but never in general use, a few of peculiar construction may be mentioned. C. H. Carver, of Taunton, Massachusetts, has made a propeller-dasher, a large wooden spiral, which operated vertically, by gearing, in any cylindrical vessel, carries the cream to its centre and bottom with a force commensurate to the speed. It operates very easily and well, is quick in its work, and especially effective when the butter comes, in gathering all the particles into one compact ball.

made by the W. H. Silver Manufacturing Company, of New York City.

In our notice of English churns we omitted the mention of Thomas and Taylor’s patent “Eccentric” churn, of which we give an engraving in Fig. 252. In this churn the agitation of the cream is accomplished chiefly by the alternate rising and falling of the opposite ends of the churn. The inventor claims that it is an easy churn to work, and many people speak highly of it. It has received a leading first prize in one of the Royal Agricultural Society’s competitions.

It is hardly desirable to describe in detail here the various devices for operating churns which are to be found in America. Sundry combinations of gearing, with cranks and treadles, are provided to ease human labour on the small churns, and there are arrangements of weights and springs which only need a little winding-up to do all the turning. Light animal powers are made, circular and with endless chain, in which a dog, goat, sheep, or calf can be...
utilized; and one patent is for an attachment between a lady’s rocking-chair and a strong coiled spring, whereby her leisurely oscillation while conversing, reading, or putting the baby to sleep, will store up sufficient power to do the day’s churning!

Butter-workers.

Butter-workers seem to have originated in America. These implements, as distinct from “gathering and working churns,” were first invented in the year 1842 in Connecticut, and next appeared in Pennsylvania in 1853. Up to 1860 twenty-one United States patents had been issued for this class of appliance, but it was some years later before they became at all popular in any form. Between 1860 and 1870 forty-five patents for butter-workers were taken out, and up to 1879 over one hundred and fifty in all, the recent average being ten a year. Such of these utensils as have proved practicable are applications of the lever and the roller in different forms. In nearly all of them the pressure is applied by operating the worker with one hand, while the other with a wooden paddle or “ladle” moves the butter and brings it into position for working. Points deemed essential are that the butter shall come in contact with neither the hand nor the metallic parts of the implement, and that the moisture should be entirely extracted with the least possible labour, and without injury to the grain of the butter. Workers made wholly of close-grained wood are preferred. One of the earliest and simplest forms is a triangular tray open at its base and inclined towards the apex, where there is fixed in a loose socket one end of a large wooden lever which can be moved to reach every part of the tray. This is made to use upon any table, or placed upon a permanent frame or set of legs. The pressure exerted by the lever is entirely at the judgment of the operator. The expressed buttermilk or water used in washing runs off into a pail set below the lowest point. Fig. 254 represents this kind of butter-worker as made by Jones, Faulkner, and Co., of Utica, New York, and Cornish and Curtis, of Fort Atkinson, Wisconsin.

The Howe butter-worker is another pattern of the same class. A rectangular tray has a sliding frame fitted to its longer sides which carries a pressing bar the width of the tray, operated by a lever handle. The frame slides off at the end, leaving a plain butter tray. It is all of wood, simple, cheap, convenient, and efficient (Fig. 255).
The Eureka butter-worker, made by the Vermont Farm Machine Company before mentioned, combines the lever with roller. The butter can be rolled with any degree of pressure. Fig. 256 well represents the implement, and shows how the roller may be carried to any part of the inclined table. This worker has great capacity, as from 10 to 70 lbs. of butter can be easily managed upon it at one time. It has an advantage over the ordinary lever, in giving an even pressure to all parts of the butter without any drawing or sliding motion, and over the fixed rollers in the ability to change the pressure to suit the condition of the butter. There is no metal about this implement, and none could be simpler in its parts or easier to manage. In the hands of a discreet butter-maker this is the most satisfactory American worker. It received a special diploma at the New York Dairy Fair of 1878.

Several butter-workers have been patented in the United States depending upon the roller operated by a crank. The best of these is the Cunningham butter-worker (Fig. 257), made and sold by Whitman and Burrell, of Little Falls, New York. A rectangular frame on strong legs carries a traverse which is moved back and forth the length of the frame, by sliding it with the hand, or by turning the crank. The crank also turns a fluted roller. Within the frame is placed a wooden tray, fitted to it and holding the butter; this remains in place during the working, but can be at once removed. The crank and roller do the work, and compensating springs at the ends of the roller regulate its pressure according to the consistency of the butter. This implement received a diploma at the first International Dairy Fair at New York. The price for one with capacity of 30 lbs. is 8 dollars.

Lilly's patent (Fig. 258) is the best of the American rotary butter-workers. By simple gearing the crank revolves the butter-bowl and also the ladle or grooved roller. The shape of the latter is peculiar, pressing the butter into ridges as it passes under, which on the next turn of the bowl are crossed diagonally by the roller. There is no metal which can possibly come into contact with the butter. The bowl is concave, so the butter-milk all tends towards the centre, where it passes down through a hollow spindle to a vessel placed below. The machine can be taken apart in a minute and thoroughly cleaned with ease. On detaching the roller, the bowl can be removed from the frame and set away with the butter. This worker is made by C. H. R. Triebels, of Philadelphia, in three sizes; capacity from 5 lbs. to 60 lbs.; prices from 12 to 20 dollars.
The only power butter-worker which has borne severe practical tests in America is that manufactured by Porter Blanchard's Sons, of Concord, New Hampshire. The accompanying engraving (Fig. 259) answers every purpose of description of this simple but efficient utensil. With it large quantities of butter are worked at the factories, easily, quickly, and thoroughly, without injuring the grain. The butter is subjected to direct pressure between surfaces of wood, and without rubbing or drawing. It costs 20 dollars. This is a great acquisition to the labour-saving apparatus of large butter-makers.

A butter-worker of an entirely different character was patented in the United States in May, 1877, by Charles A. Sands, of Burlington, Kansas. It resembles the English machine of Hancock & Co. A wooden tub (Fig. 260) has within it a metallic cylindrical screen with a few perforations; the tub is two-thirds filled with clear water, and outside the screen broken ice is placed, in warm weather. The butter, taken right from the churn, is placed in a strong metallic cylinder, the lower part of which is finely perforated, and this cylinder is placed in the water, in the middle of the tub, being kept in position by radial braces. To the top of the cylinder is fitted a follower which is moved downward by a large screw with hand-wheel, attached to a frame on top of the tub. The screw pressure of the follower forces the butter through the perforations of the inner cylinder, and it rises in vermicelli form through the water within the screen, being washed and cooled thereby. This machine is, by the patentee, urged upon those who prepare re-packed or "milled" butter, but the fewer facilities such are given the better. It has not yet (1879) been manufactured for sale.

A very handy butter-worker for small dairies consists of a common wooden bowl, placed securely on a light stool and held firmly against a rest, which prevents it from breaking or springing down. The ladle or paddle is similar to that used by hand, but larger, attached to a lever, and adjusted so as to reach all parts of the bowl. The latter may be revolved either way at will, as readily removed as from a table, and bowls of different sizes may be used.

Of a number of American contrivances for pressing and printing butter, the simplest and best, all considered, is Nesbitt's patent. This is a hand-lever press, made of hard wood, with brass
hinges and screws, few in number, and the parts secured by wedges, so as to be easily taken to pieces for cleaning. It is plain, but of fine workmanship, and capable of heavy pressure if needed. With this press butter can be very rapidly and easily formed into cubical lumps or "prints," pounds or half-pounds, and at the same time imprinted with a trade mark or any little device. These little implements, very convenient in preparing butter for the retail trade, are sold for from 5 to 7 dollars, according to size, by the New York Dairy Supply Company.

A more elaborate and expensive machine is in use by some makers of fancy or "gilt-edged" butter, which presses a previously weighed ball or lump of butter into a six-faced "print" of any proportions, leaving devices in relief upon five of its faces, which is a pretty sure preventive of imitation.

**Butter Packages.**

Butter packages are to be found in the United States in great variety as to material, form, size, and purpose. Over one hundred patents have been issued for such articles, half of them subsequent to the year 1874. Wood is the favourite material, and its cheapness and lightness, rather than any other quality, render it almost the one thing used in the wholesale trade. For carrying butter in bulk, 50 lbs. or more in a body, the aim is to secure a package which shall be strong, to withstand the dangers of breakage in transportation, easily handled, conveniently opened and closed, and in material and construction suited to preserve its contents from deteriorating in quality.

The "Optimus" butter-tub, made by James B. Gilberds, of James-town, New York, received the diploma as the best package for the wholesale trade at the International Dairy Fair at New York, 1878. This is a white oak tub with three hoops and a white ash cover, of excellent workmanship. The latter is attached by a fastener of a very simple but clever device, which leaves no case to be knocked off, is very efficient, and can be removed in an instant. The trade find it of decided advantage, as it admits of repeatedly showing the contents, when the cover is replaced the package has no appearance of having been opened. The tubs of this pattern are sold at about 4 dollars per dozen. The "Optimus" return butter-pail is substantially the same article, but better finished, and painted with galvanised iron hoops, and sells at about 10 dollars a dozen.

The firkins and half-firkins, tubs, pails and half-pails of many other manufacturers differ in details from the above, but not enough to call for any special description.

A much greater variety exists in the packages intended for shipping butter directly to the consumer, or for retail in unbroken parcels of from 1 to 20 lbs., or in pound lumps and smaller prints. An air-tight glass butter-jar is made by N. Halsted, of Scranton, Pennsylvania, which is an excellent article. The jars, of clear glass, are strong, hold 16 lbs., and made air-tight by special fastenings. The carrying-case, of wood, may be made to hold one, two, four, or six jars, and is ingeniously contrived to ensure safe transportation. It forms a return package superior to any of wood, and is reasonable in price.

Perkins' refrigerating butter package consists of a stone jar, light but strong, encased in a durable wooden jacket provided with a bail and a double cover. The jar is surrounded, as may be seen in Fig. 262, with an air-space as a non-conductor. There can be no leak, no absorption, no waste; so the weight is uniform and there is no reason for tare. This is a safe, clean, durable, and cheap return package of decided merit. Jones and Perkins, of Minneapolis, Minnesota, the makers, use glass as well as stoneware. In both cases the wooden hoop at the rim of the jar is shrunk on, and the wood-casing attached thereby.

The improved butter-tub made by J. G. Kochler, of Philadelphia, is one of the nicest contrivances for carrying print or lump butter from dairy or factory to be delivered to the consumer or retailed from the package. This tub is oval in shape, of white cedar, bound with metallic hoops, and provided with handles. The lid has hinges and fastenings so that it may be locked,
opened half at a time, or wholly removed. Within is a removable tin case, with small air-space surrounding. At each end of the case is a detachable ice-chamber, which can be emptied and filled without disturbing the butter; and the spaces occupied by these chambers are available for additional butter, when ice is not needed. On the inside of the tin case are ledges to support wooden shelves holding prints of butter, and these may be left out for packing in rolls or large lumps. These tubs, with capacity for 25 lbs. of butter in prints, are sold at 5 dollars for those with iron trimmings, and 10 dollars for those extra finished and full brass trimmed; with capacity for 100 lbs., 13 dollars and 25 dollars respectively.

A very handy form of preparing butter for the retail trade, in small packages, and of preserving it well, is that of D. C. Perrin, of Boston. The butter is made up (by press or otherwise) into equal-sized pound lumps, and each wrapped in a piece of transparent paraffined paper. Four of these lumps closely fit into a box of very thin wood, which has received an odourless and waterproof coating. A strip of paper pasted around the cover hermetically seals the package. The butter is admirably protected, and the retailer saves all labour in cutting out and weighing, and all loss by waste and shrinkage, whether the customer takes the little four-pound box or a single lump, in its clean, impervious wrapper. The package may be varied in size of lumps, and the whole, wrappers included, can be furnished at a less cost than the common five and ten pound round wooden boxes, with covers.

N. Waterbury, of Baltimore, Maryland, makes a one-pound butter-box, with packing-tools to match, also intended for use in the retail trade. The boxes are thin bands of wood, bent round, lapped, and sewed together with a machine, with loose circular wooden guards for top and bottom, all to be well soaked in brine before using. Four bands, after being filled, with eight guards, and two stiff circular head-blocks at the ends, are placed in a little frame, and tied up in a cylindrical package. Each of the bands or skeleton boxes holds a circular pound lump of butter. For transportation a double-walled case is provided, in which twelve of the four-pound packages are placed, and if distance makes it expedient the interstices are filled with dry salt. The tools for putting up butter in this form are convenient, making the labour light, and the whole expense need not exceed one cent a pound.

**Cheese-making Appliances.**

Cheese-making apparatus has not received in America the amount of attention which has been given to appliances for the manufacture of butter, although the progress made has been as great. In this class the United States patents number just about three hundred, and these include agitators, bandages, boxes, curd-cutters, curd-mills, curd-sinks, hoops, modes or processes of manufacture, presses, and vats.

At the factories, as the milk is received from the different patrons, each lot is weighed in the weighing-can, and often several small lots in the same receiver, before its contents are run off to the vat. The weigh-cans generally used range in size from 40 to 90 gallons; one of the best is shown in Fig. 133 on p. 274, and is made by Childs and Jones, of Utica, New York. It is of heavy tin, iron-bound, with an iron bottom, inclined toward the outlet to hasten emptying. The same firm offer a great improvement over the old style of discharge-gates, such as shown in this weigh-can, which require frequent re-packing, and often leak at that.

Jones' patent weighing-can gates are all metal, opened and closed by a lever operating a rack and pinion, which moves one metal surface upon another, so accurately fitted as to avoid all packing and absolutely prevent leakage. With
these gates of three-inch diameter, and with or without nozzles, the contents of the largest receiving-can may soon be discharged. Great improvements have been made in the

conveniences for weighing the receipts from several successive patrons. Fairbanks and Co. make a special cheese-factory scale, with a compound beam, by which several different lots of milk, not exceeding 2000 lbs. each, poured into the same receiver, can be successively weighed, the weight of each being shown on a separate beam. Each sliding poise is usually provided with a clamp, to hold it in place. There are different forms of spouts and conductors for conveying the milk from weigh-can to vat, but these do not need description.

Cheese-vats and improvements therein have received fifty United States patents, and although the first was in the year 1810, only four were issued before the era of cheese-factories. The covered refrigerator vat of Whitman and Burrell, previously described among milk coolers and creamers, page 149, received the prize for the best vat at the International Dairy Fair of 1878. Its special merits are its thoroughness of construction, the arrangements for agitating and cooling the milk, for quick and uniform application of heat by water or steam, and its special adaptation to the Arnold patent process of cheese-making.

Of the "self-heating vats" there have been few improvements upon the "Union Dairyman," patented in 1862, and made by Thomas B. O'Neill, of Utica, New York, and it continues to be a favourite with the cheese-makers of New York. A cylindrical copper heat or fire box extends along the bottom of the vat about half its length, and a cut-off is provided by which the hot water can be kept wholly in a tank at one end or turned on to the vat, to circulate under and around the milk. The milk-pan can be easily lifted out of the tank by the handles of its wooden frame, for cleaning, &c.; the whey is drawn off with a syphon. These vats are made in sixteen sizes, with capacity of from 100 to 800 gallons, and sold for from $20 to $300 dollars (Fig. 268).

Ralph's "Oneida" cheese-vat, made by Childs and Jones, of Utica, is another of the self-heaters which is very popular. In this the heater runs the entire length of the vat, and its patent equaliser distributes the heat with great evenness, at the top as well as at the bottom. These vats, in sizes corresponding to the "Union Dairyman," are sold at prices about one-fourth less.

The agitators and the curd-knives made by Whitman and Burrell, of Little Falls, New York, are considered the best in America. Their curd-cutters have metallic heads, which add greatly to the utensils in neatness, lightness, and ease of cleaning. The blades are of the best steel, not over half as thick as the old-style knives, and pass through tender curd with a clean cut, squeezing out no oil. The thin blades are prevented from spreading by one or more cross-
CURD-DRAINER AND GANG-PRESS. 461

stays, and these have cutting edges, or are blades themselves. These curd-cutters are shown in Figs. 135 and 136, pages 275 and 276.

Jones, Faulkner, and Company's curd-drainer is of most approved pattern. The light wooden sink, from 8 to 15 feet long, is placed upon two wheel-trucks provided with strong rollers. It has a false bottom of wooden seats, easily removed in three sections. Below is the drop bottom, inclined to allow the whey to run off, and permitting a free circulation of air under the curd. Price, two dollars per foot of length (Fig. 269).

The curd-mill was hardly known among American cheese-makers up to as late a period as 1866, and not usually found at dairy supply stores till still later. It has since been not only generally introduced but greatly improved in its construction. The best American curd-mill is undoubtedly the patent of Whitman and Burrell, made with knives on the cylinder, as shown in Fig. 93, page 207. The knives are set spirally, so as to cut the curd and carry it through rapidly. The grate is also a set of knives. The advantage of knives over pegs is very great, cutting the curd instead of tearing it, and entirely preventing "white whey." The engraving shows its peculiarities, and how easily it must work. The price is about 20 dollars.

Cheese-presses have been invented and improved in the United States, at the rate of one or two patents a year, from the beginning of the century, forty-five prior to 1850, five during the year 1876, and a total of over a hundred up to 1881. Despite the later inventions, the old-fashioned vertical press with a wooden screw to each cheese is still much in use. The Frazer gang-press was a long step forward, but better ones soon followed.

The Hubbell gang-press, as in Fig. 270, is one of the best, if not the best of all; it received first honours at the great Dairy Fairs of 1877 and 1878 (Chicago and New York). This was originally Beach's Patent, 1876, transferred to J. G. Hubbell & Co., and then to Whitman and Burrell, who are the sole manufacturers. The machine presses a horizontal gang of cheese, with capacity for fifteen, each of seven inches thick. A strong, well-finished frame, standing at a convenient height from the floor, has the pressing apparatus attached, which is easily operated by a hand-lever, with ratchet and palls. This moves a double set of plain spur gearing, the smaller wheels turning two screw shafts which run the whole length of the frame, and passing through solid nuts on either side of the platen or follower, draw that toward the head block with a perfectly even motion. This insures uniform pressure upon the cheese, resulting in good form and avoiding all tendency to strain parts of the machine and to bulge the gang of cheese. The lower part of the frame is a liquid-tight box in which all whey pressed from the cheese is collected, and from which it may be drawn in any manner desired; this is great security towards cleanliness in the press room. This press is sold for 60 dollars without hoops.

The Wilson self-bandaging cheese hoops are usually sold with the Hubbell press, and are shown with it in the illustration, also more fully in Fig. 275. This hoop has many advantages also. It is wholly of metal, and entirely dispenses with rubber rings and wooden followers. It is
in four parts; a closed wide hoop, an open hoop or split cylinder, to fit within the first, and bottom and top rimmed covers, stamped from solid metal; at one end of the outer hoop is a narrow, inwardly-projecting rim or flange. The open and closed cylinders make what is called a telescopic hoop. In use, the cover with widest rim is placed on the ways in the bottom of the press, rim upward; the cap cloth, as large as this bottom cover, is placed upon it. Within the rim of the bottom cover is set the open hoop, its cut edges touching; this is the bandager. The bandage, a little longer than the hoop, is fitted within it, the upper end wet and turned over the top of the hoop. The solid hoop is then put on top of the open one, and slipped down over it about an inch; the rim of the bottom cover and the closed hoop at the top keep the split hoop from springing open and hold the bandage in place. The outer hoop is held in its position by little hooks, attached for the purpose. The cheese curd is then put in for any desired thickness of cheese, but always enough to prevent the outer hoop when slipping over the inner one, while pressing, from being forced quite down to meet the rim of the lower cover. The cap cloth and cover are then put on, the cheese turned on its side on the ways, and the top cover placed close against the head of the press. In the same manner a number of hoops may be filled, the top cover of one against the bottom of the preceding, until all are in place. The hooks mentioned are then unfastened and the pressure is applied. After pressing, the outer hoop, which has handles, may be easily drawn off the inner, and that may be sprung open enough to release the cheese pressed in its bandage.

Coming from these Wilson hoops the cheese is always found moulded in perfect form. These hoops, 15 inches in diameter and 10 deep, or thereabouts, are sold for 8 dollars each, half of this being the heavy royalty for pressing any cheese in a bandage, controlled by the Andrews and Orjen patents.

The Freeman hoop is another excellent one, which is also made by Whitman and Burrell. The hoop itself is one piece of galvanised iron, with a perforated bottom, stamped out and turned up on the hoop. The bandager, an open or spring hoop, is made wedge-shaped, its lower part being drawn very thin, almost to an edge. Similarly, the upper part of the hoop itself is bevelled, so the bandager enters it perpendicularly, and the two thicknesses of metal then overlapping equal the single thickness of the hoop below. This preserves the exact cylindrical form of the interior, the bandager being in place; the latter is held by metal hoops on its edge, which catch upon the top of the hoop. The follower is of wood, perforated and grooved, with rubber ring. The bandager and hoop "telescope" about 7 inches, and the follower does not enter the bandage band till it has settled to its place, and the bottom of the next cheese in the gang presses upon it; it is thus possible to make in the one hoop cheeses varying from 7 to 11 inches in thickness. This is the chief merit of the Freeman hoop, and it is a great one.

The Naylor press is another made by the same firm as the Hubbell, and differing from it mainly in being so constructed as to enable a gang of cheese to be instantaneously released from pressure, instead of the slow process of withdrawing the
platen by turning a screw. This convenience, and its being 10 dollars cheaper, constitute its only advantages. The general form is the same, but in place of the two long screws in the Hubbell press, the Naylor has two bars with teeth upon which fall two sets of pawls successively, as the platen is moved by turning a crank. So by simply throwing out the pawls with a lever, pressure is removed, and the follower, then playing loosely upon the bars, can be pushed to any point.

The upright presses made by Charles Miller and Son, of Utica, New York, are an entirely different form of the gang-press. Two of these presses are illustrated, one for a single gang of cheese, the other for a triple gang. Other patterns made allow a double gang or one in sets of four, sixteen hoops. The principles are the same in all. In the first figure there is a series of levers connected with weights by means of rope and pulley, in such manner that the pressure is continued and followed up by the weights, and the screw is arranged so that it can be raised or lowered to accommodate any height of cheese. In the second figure the levers and weights are omitted, but the length of the screw is adjustable as in the other. The general construction is fully shown. The presses represented cost 50 dollars and 40 dollars respectively, and others of the same kind from 30 dollars to 90 dollars, according to capacity (Fig. 271).

Millar's patent cheese-hoops, used with these presses, are shown in Fig. 272. They are made of heavy galvanised iron, with a perforated bottom and loose open rim, and are suitable for any ordinary screw-press. Over the inner spring hoop, which is raised to the height of the curd, the press-board shown in Fig. 273 is placed, and follower and rubber ring are needless. As pressure is applied, the loose ring sinks into the hoop with the cheese. Price 5 dollars each.

The seamless cheese-bandage (Fig. 274), patented Feb. 19th, 1878, by E. V. Lapham, of Morrison, Illinois, although a very simple thing, is one of the most valuable contributions lately made to American cheese-making appliances. It is sold in the bolt, usually fifty yards, like any bandage cloth, of different qualities and sizes, but is a continuous seamless cylinder. Cut the right length and the bandage is ready. It costs just the same as the material alone for the ordinary unbleached bandage. Thus it saves the labour of making, the waste in the cutting and in seams, and the thread. The bandage is better, too, for it is always certain to fit the hoop of given size for which it is made, and there is no seam to rip open or to mark the cheese in pressing. In ordering, the size of the hoop is given, that of the bandage corresponding. Whitman and Burrell are the sole proprietors of this bandage, and so popular did it become during its second season that thirty looms built expressly for its manufac-
The annoyance and expense of making shipping-boxes by hand-labour, in the cheese-making districts, led to the invention of Harris's cheese-box bending machine. This has proved its practical value. With it more than twice as many boxes can be made, and more uniformly, in the same time, than in the ordinary way. In making large quantities the cost of the labour has been reduced, by the use of this machine, from 2½ cents and over, to 1 cent per box. It is made by Whitman and Burrell. The machine with one cylinder, which makes two sizes of boxes, costs 35 dollars; and with two cylinders, to make five sizes, 45 dollars (Fig. 276).

In this chapter the records of the United States Patent Office have been frequently referred to, as giving the best available data as to the number of dairy appliances of various kinds produced in America. But this is far from the truth, as many improvements are made and new articles devised, of different degrees of importance, and which get more or less into general use, for which no patent is ever sought. Some of those herein described are of the number. Calculating from the known relations between patented and unpatented articles in other branches of mechanical ingenuity, it is estimated that prior to the year 1880 the number of different dairy appliances produced in the United States exceeded eight thousand.

And such is the progress in this department of the dairy industry, that before these pages are in type there will probably be some valuable additions to the long list of American dairy implements and machinery.

H. E. A.
CHAPTER XXXI.

THE AMERICAN FACTORY SYSTEM.


The commencement of the era of associated dairying, distinctly known as the American or Factory system, is assigned by common consent to Jesse Williams, of Rome, in the County of Oneida, and State of New York, A.D. 1851.

Co-operation in dairying had unquestionably been practised at a much earlier date, not only in Switzerland, but in several well-authenticated instances in different parts of America. These trials were all in connection with cheese-production, and in most cases the curd, drained and sometimes partly pressed, was gathered from several dairies to some central point to be made into cheese.

In a paper read before the Wisconsin Dairymen's Association, Mr. J. G. Pickett, of Winnebago County, described what is probably the first recorded instance of co-operative cheese-making in the United States. In 1840, his father, Mr. A. Pickett, removed from Ohio, and settled in Jefferson County, Wisconsin, taking with him 10 cows. The little pioneer settlement at Rock Lake, consisting of eighteen families, and others similar in the same region, had arrived at that stage of civilisation when cheese was longed for. Mr. Pickett proposed, in the spring of 1841, to meet the demand. He desired to make cheese from more cows than he had, but was unable to purchase more. Four neighbours, however, owned among them 10 cows, and Mrs. Pickett suggested the idea of co-operating with these neighbours in cheese-making. Although an entirely original idea with her, it was deemed a good one, and at once carried out. An agreement was made, and about the same time two other settlers, not far distant, rented 10 cows more to Mr. Pickett for two years. On the first day of June, 1841, Mrs. A. Pickett, assisted by her son, who relates the story, made from the milk of 30 cows, owned by six "patrons," the first cheese ever manufactured in Jefferson County, Wisconsin, and doubtless the first made on the associated plan in that State, if not in America. The little kitchen factory in the log house was operated on precisely the same general principles as the large establishments of later years in the same county. The milk was delivered in a very convenient way, safe from injury or adulteration, for all the cows belonging to the settlement grazed in common, and were driven to Mr. Pickett's yard, and milked by their respective owners. The milk was weighed in the pails with old-fashioned steel-yards, the quantity credited to each patron daily, and in the autumn the cheese was apportioned according to the milk contributed. No one in those days thought of cutting a cheese less than five months old, so when the work of the season closed, the cow-owners took their respective shares in cheese instead of money. Rude as were the implements and the methods employed, the quality of the cheese was fair, and the fact established that a good article could be made from the wild grasses which covered the country. The experiment was so satisfactory that the next year, 1842, five more cows were added by the arrival of two new families, and Pickett's cheese soon became known and in good demand, at a shilling a pound, from Milwaukee to Madison.

In the year 1844, Lewis M. Norton built a cheese-factory at Goshen, Connecticut, which is still owned and used by his descendants. The cheese made there was from curd collected at the factory
from numerous farms in the vicinity. Like enterprises in the same decade are recorded in different parts of the country.

The following appeared in The Albany Cultivator in November, 1849:— "In the Western Reserve of Ohio, where the making of cheese has been largely carried on for several years, a change of system has lately taken place to some extent. Certain men, who are well acquainted with the manufacture of cheese, purchase the curd, unsalted, of their neighbours, and make it into that kind of cheese for which they find the readiest sale and best price. A single manufacturer sometimes uses the curd produced from the milk of several hundred cows. It is gathered every morning by men who call at the different farms for that purpose. These large establishments are called 'factories.'"

None of these efforts seem to have become permanent business enterprises, to have reached the dignity of a system, or to have had more than a local influence. And even in New York, where the Williams family inaugurated the associated system, the beginning appears almost accidental, and years elapsed before others, in any number, adopted the co-operative methods. To Jesse Williams is, however, recorded the honour of being the first to establish a permanently successful cheese-factory in New York, and from him and his neighbourhood the American Factory system has spread and attained its present proportions.

Jesse Williams was born on his father's farm, in the town of Rome, Oneida County, New York, the 21st day of February, 1798. His father, David Williams, had been a soldier at Fort Stanwix during the revolutionary war, and, attracted by the fertility of that region, he eventually settled, with two brothers, near the town of Rome, which occupies the site of the old garrison. Jesse was the youngest son, lived upon the homestead with his parents until the death of both, at the ripe ages of eighty-six and eighty-seven, and continued to reside there until his own sudden death from paralysis, December 20th, 1864. He married Amanda Wells in February, 1822, and this widow still lives (1880) at the old home, which is now owned by one of the sons.

It was in 1831 that Jesse Williams took the management of the farm. It had then become exhausted by continual grain cropping, and he determined to try the recuperative effect of dairying. He began with 14 cows, making the milk into cheese, and within three years increased the dairy herd to 40. As was usual in those days, the wife bore the main burden of the dairy labour; at first she took charge of the milk from the time it reached the dairy, and with her own hands made all the cheese, and cared for it until sold. As the cows were increased in number the dairy required the time, strength, and thought of both husband and wife. By unceasing assiduity they succeeded in making an article which not only found ready sale, but gained a reputation, until Williams' cheese was sought in New York and Philadelphia, sold at an extra price, and was shipped to England to some extent.

In the month of February, 1851, Jesse Williams contracted his cheese of the following season to merchants at Rome, at 7 cents per pound, the cheese to be held until autumn, with a view to sending it to Liverpool. As the average price in the neighbourhood was then less than 6 cents, Mr. Williams regarded his bargain as very advantageous, and, with a father's thoughtfulness, induced the buyers to consent to include the season's cheese of his eldest son, George, whom he had just established upon a farm in the vicinity. This was agreed to upon the guaranty of the father that the quality of the son's cheese should equal that of his own. Upon communicating the facts to his son, the latter at once doubted the ability of himself and his young wife, but with one year's experience, to make cheese equal to that of the parents, who had devoted twenty years to this work. The family consultation which ensued led to George and his wife being instructed in cheese-making at the old homestead, but without resulting in the cheese of the new farm coming up to the father's standard; and then Jesse Williams said:— "Well, if you and Anna cannot make your cheese what it should be at home, bring your milk here, and your mother will make it up with ours. The cheese will then surely be all the same." Made as a suggestion, to obviate a lack of uniformity, and to secure a higher average quality, it was acted upon, found practicable, and proved successful, although the farm of George Williams was at least two miles distant from his father's. Here was the beginning of the Williams co-operative dairying, June, 1851.

The next step was natural: the question arose, 'Why cannot we do this with more milk, getting
it from our neighbours? Mr. Williams found that the products of milk in the neighbourhood averaged about 5 cents a pound for cheese fresh from the hoop, or an equivalent in butter, no allowance being made for the labour involved. Here was a fair margin for business, providing the milk could be obtained on this basis, and also Mrs. Williams made up at the farm the milk of 160 cows, and before the summer closed pledges enough for the next year were secured to warrant the erection of buildings suitable to handle the milk of 300 or 400 cows. A co-partnership was at once formed between Jesse Williams and his sons George and De Witt;

providing he could sell all the cheese he could make under the contract at 7 cents. The project being submitted to the contractors, they assented, stipulating that all should be of "the Williams standard." The neighbours were next negotiated with, and a number found willing to sell and deliver the milk upon the basis above named, being glad enough to be rid of the labour and vexations of the dairy work at home and the uncertainties of sales.

Thus, during the season of 1851, Mr. and springs near the homestead were leased, buildings erected, and at the opening of the season of 1852, the original Williams Factory commenced operations. De Witt managed the general farming, while Jesse Williams and George, with their wives, devoted themselves to the factory and its work. That season the family held 70 cows, and they purchased the milk of 290 more. From its start the factory proved a success, and this was largely due to the high quality of its product. That, in turn, is attributed by the family to the
scrupulous care, good judgment, and ceaseless labours of Mrs. Amanda Williams, who for several years was really the cheese-maker, personally supervising all the details of manufacture. The original make-house, calculated for operations untried on so large a scale, proved unsuitable, and has been degraded to a pig-pen; but the curing-room, made upon plans resulting from home experience of many years, still performs its work, and may be regarded as a model. The site of the Jesse Williams Factory is now occupied by the Rome Cheese-Manufacturing Association.

It was a characteristic of Jesse Williams that he was always ready to receive suggestions, to seek advice, and avail himself of every opportunity to progress and improve in his work. Correspondingly, he never sought to hide or make mysterious the causes of his own success; the Williams Dairy from the first, and the Williams Factory to the last, were always open to whoever came to learn, and to strangers and neighbours alike were freely given the fruits of experience there gathered by the open-hearted proprietors. As a good citizen, Jesse Williams identified himself with the interests of his town and county, and whenever a worthy object could be promoted by his assistance, earnest and active co-operation on his part was not wanting. His indomitable will and energy overcame obstacles that seemed formidable to other men, and he was almost certain to accomplish whatever he undertook. Just, kind, charitable, loved and respected by those who knew him, he passed away universally mourned. Not an aspirant for fame or public honours, seeking only to ennoble his life-work of farming, he lived to see his native county raised to the head of the great dairy interest of the greatest dairy State through the adoption of the system he had introduced, and, indeed, to see the whole land dotted with cheese-factories, all of them founded upon the success of his own modest work.

Yet it required several years, at the outset, of actual demonstration to satisfy the dairymen of Oneida County that the principle of co-operation or association, in distinction to domestic labour, was adapted to their industry in general. It was not until May, 1851, that the second cheese-factory was opened in Oneida County. That year four were built at different places in the State of New York, two more the next year, and the number gradually increased, till in 1861 there were about forty in operation in that State. Ten years elapsed from the time the Williams Factory commenced its full operations in special buildings before similar establishments became at all numerous. Then they multiplied with great rapidity. A final realisation of the merits and success of the system in the heart of the great cheese-making district of America was one cause; a second was the rapid increase in the foreign demand; another was the organisation of the first Dairymen's Association in the country in 1863; and a great incentive was "the war period," with its rise in the price of cheese from 10 cents and less in 1860 to 15 cents in 1863, and to 20 cents and over in 1865.

During the season of 1862, between twenty and thirty cheese-factories were in operation in Oneida County. They had already spread to Herkimer and other neighbouring counties, and in 1863 there were nearly one hundred reported in New York, besides some in Ohio and other States. About this time the American Dairymen's Association began to keep a list of the cheese-factories in operation, and the number from which it succeeded in getting reports for several years shows the rapid extension of the system:

<table>
<thead>
<tr>
<th>Year</th>
<th>Factory in U.S.</th>
<th>Factory in Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1861</td>
<td>1863</td>
</tr>
<tr>
<td></td>
<td>232</td>
<td>231</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>Factory in U.S.</td>
<td>Factory in Canada</td>
</tr>
<tr>
<td>------</td>
<td>----------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>1870</td>
<td>1,234</td>
<td>1,316</td>
</tr>
<tr>
<td>1871</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1872</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1873</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1874</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>35</td>
</tr>
</tbody>
</table>

The location of the factories upon the last list published by the Association (1874) was as follows:—In 44 different counties in New York, 1,018; in Ohio, 108; Indiana, 3; Illinois, 45; Michigan, 26; Wisconsin, 45; Iowa, 7; Minnesota, 6; Pennsylvania, 21; Vermont, 32; Massachusetts, 26; Virginia, Tennessee, and Missouri, each 2; and Connecticut, Kansas, and North Carolina, each 1. Factories for the manufacture of butter alone, and those for making both butter and cheese, have also become very numerous, and a good many originally full-cream cheese-factories changed their plan, so that it is now difficult to
HO W FACTORIES ARE CONDUCTED.

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determine the number of cheese-factories proper. During the recent period of great depression in dairying, a large number of factories in the east were closed, but the extension of the system in the north-west has caused a steady increase in the whole number of factories and creameries in the country. There is a decided tendency to make the factories of smaller size as they multiply, the better to accommodate the delivery of milk. The minimum for economy in a factory for butter alone is regarded as 150 cows, while for cheese alone it hardly "pays" to handle the milk of less than 250 cows. The total number of establishments in America which employed the factory system in dairying was estimated by several authorities in 1876 and 1877 as 4,000, and it is believed the United States Census for 1880 will record at least 5,000.

The statistics of the new Census regarding these establishments will be of special interest, because it is proposed for the first time to systematically classify them, according to their work, as cheese-factories, butter-factories, combined butter and cheese-factories, and milk-condensing factories. The schedule of inquiry contains fifteen distinct items applicable to the industry in general, and from five to ten additional bearing upon the different branches. At the present writing the data have been obtained, but not yet compiled; it is hoped to present the results in the appendix to this work.

There are three general methods under which these establishments are conducted in America. First, the purely co-operative plan, by which the system is naturally introduced in new places, but which is generally soon supplanted by one of the others. On this plan the farmers of a neighbourhood unite, contributing to the original expense of the enterprise in proportion to the number of cows they keep, owning the property in common, and conducting it by a committee or committees, selected from their own number from time to time, and dividing the products or the net proceeds thereof in proportion to the milk they severally supply. To be strictly co-operative, the dairy, factory, or creamery should be wholly managed, and the work there performed, by one or more of the "patrons." Secondly, associated dairying on the plan of a joint-stock company. In this, the organisation and management is similar to that of a joint-stock concern established for any mercantile or manufacturing enterprise, except that care is usually taken to have most of the stock held by dairymen who will send milk to the factory, and thus have a direct interest in its operations. The stock capital is usually sufficient to cover the original plant, real estate, and equipment, and leave a margin for operating expenses. In some cases a certain dividend is guaranteed to the stock, and this charged as a part of the expenses of the factory; the net proceeds are then divided upon the basis of the milk contributed by the patrons; this is semi-co-operation. In other cases, the factory once established contracts for milk at a price fixed periodically, often buys it largely from others than the stock-holders, and then the net proceeds are applied to dividends upon the stock. In all these joint-stock concerns the control is usually vested in a Board of Directors, chosen by the stock-holders, and the directors employ their agent, or business manager, and labourers on salary. The third method makes the business one of individual or corporate enterprise, removing it practically from the realm of agriculture to that of manufacture, the dairy-farmers becoming simply the producers of the raw material, milk, which they sell to the manufacturer at rates fixed by contract. Or, the latter receives the milk, charges a fixed rate for manufacturing, furnishings, and sales, and makes returns to the milk-producers according to the market. On this plan the land is purchased, buildings erected, and the factory or creamery operated by some person who devotes his entire time to this business. Factories of this last-named character are, as a rule, more successful, and give better satisfaction, than those managed in any other way. Jealousies and the danger of too much management are avoided, the business is more likely to be conducted on business principles, and have the benefit of business experience. The factory manager has better control over his product, being able to accept, criticise, or absolutely reject the milk offered, without danger of losing his place as a result, and the dairymen know just exactly the standard they must attain in their milk.

The factories have generally been open to inspection by all interested, employers have continually examined one another's work, and there have been competing exhibitions of products, with meetings, publications, and other aids, which have resulted in developing a knowledge of the most profitable methods of producing good milk, the
best and most economical processes of manufacture, and systematic provisions for storage, transportation, and sale.

The following facts are selected because of their reliability and interest from the mass of published statistics and reports regarding the cheese-factories in the United States and their operations.

From the 435 factories found in New York in 1865, the superintendent of the State Census selected 133 from which the most complete returns had been obtained, and published the same in full. These facts are taken from that table as to three factories, the smallest, the largest, and one of medium size; also the average of the whole number:—

<table>
<thead>
<tr>
<th>Season of 1864</th>
<th>Capital Costs of Building and Apparatus</th>
<th>Persons Employed</th>
<th>Cow’s Length of Season</th>
<th>Milk Used</th>
<th>Cheese Made</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cost of Building and Apparatus</td>
<td>State</td>
<td>&amp;</td>
<td>Factory Opened</td>
<td>Factory Closed</td>
</tr>
<tr>
<td>Smallest</td>
<td>$3,200</td>
<td>2</td>
<td>2 280</td>
<td>April 19</td>
<td>Oct. 31</td>
</tr>
<tr>
<td>Medium</td>
<td>$3,000</td>
<td>4</td>
<td>4 500</td>
<td>May 1</td>
<td>Nov. 18</td>
</tr>
<tr>
<td>Largest</td>
<td>$4,000</td>
<td>5</td>
<td>5 1,200</td>
<td>April 18</td>
<td>Nov. 9</td>
</tr>
<tr>
<td>Average</td>
<td>$2,843</td>
<td>2</td>
<td>2 500</td>
<td>April 20</td>
<td>Nov. 12</td>
</tr>
</tbody>
</table>

The cost of buildings ranged from 700 dollars, where the milk of 300 cows was managed, to 5,500 dollars, where the cows contributing numbered 475. The average ratio of made cheese to milk was 1 to 9.915 lbs.; average pounds of milk to a cow, 2,802; pounds of cheese per cow, 283; average price of cheese, 20 cents; average value of cheese per cow, 56.52 dollars.

During the decade between the publication of these official figures, the Secretary of the American Dairymen’s Association collected returns from as many factories as possible annually, not only in New York, but in other States. He succeeded in getting returns from thirty-three cheese-factories, complete in each case for the ten years, 1865-1874, and they furnish these results, more valuable than any single year’s exhibit can be, because of the length of time covered by the averages:

<table>
<thead>
<tr>
<th>Thirty-three Factories</th>
<th>Cows per Factory</th>
<th>Length of Season in Days</th>
<th>Lbs. of Cheese made per Cow</th>
<th>Lbs. of Milk to 1 lb. of made Cheese</th>
<th>Annual Average Selling Price</th>
<th>Extreme Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest...</td>
<td>601</td>
<td>235</td>
<td>lbs. 366</td>
<td>9.90</td>
<td>Cents 17.62</td>
<td>Cents 25</td>
</tr>
<tr>
<td>Lowest...</td>
<td>280</td>
<td>175</td>
<td>lbs. 255</td>
<td>9.30</td>
<td>13.12</td>
<td>11</td>
</tr>
<tr>
<td>Average...</td>
<td>521</td>
<td>201</td>
<td>lbs. 300</td>
<td>9.76</td>
<td>14.52</td>
<td>—</td>
</tr>
</tbody>
</table>

In regard to special statistics for a single season, the Assistant-Secretary, Edward J. Wickson, made this statement, which shows such a contrast between the work of different factories and the productiveness of different dairies as to be worthy of repetition entire:—“I have authentic reports from ninety cheese-factories, widely separated in location, giving the average net return per cow to patrons, the highest average per cow to a single patron, and the lowest average. The figures are drawn from the actual records of more than 36,000 cows. During the season of 1874, the value of the highest average yield per cow for a single factory was 55.07 dollars, the lowest, running the same length of time, 31.22 dollars, and the average for the ninety factories, 39.57 dollars. These are factory averages, not records of separate herds. It appears from these reports that the average net return to patrons per 100 lbs. of milk has been 1.22 dollars (about 2½ cents a quart); the highest net yield was 1.38 dollars, the lowest 99 cents. I have been much interested in comparing the average returns per cow with the average selling price of the factory, and the quantity of milk required for a pound of cheese, in order to determine how much the large yield per cow is due to the dairymen, how much to the cheese-maker and salesman. In the factory reporting the highest average per cow (55.07 dollars) the selling price for the season averaged 14.11 cents, and the ratio of cheese to milk was 1 to 9.76 lbs. Comparing this with the lowest average (31.22 dollars), I find the latter sold cheese for one quarter of a cent less per pound through the season, and used nearly half a pound more of milk to a pound of cheese. Yet this difference in manufacture and price forms but a small part of the wide range between highest and lowest average returns. The profits of dairies depend mainly on the farm, not on the factory; the difference between profit and loss is in the quality of the cows and their management. This is strikingly illustrated by further figures derived from these returns. In the whole ninety factories, the best record for a single dairy is an average of 82.17 dollars per cow for the ordinary season, and the poorest is 14.50 dollars per cow; the average of the best dairies reported by the ninety factories is 50.04 dollars per cow, and of the poorest dairies in each of the ninety factories, 29.34 dollars.” Here is a very wide margin, for which the dairymen himself
FACTORY REPORTS.

is mainly responsible, but which is developed by
the factory and its records. It is not the least of
the merits of the factory system that it presents
such facts as these, previously neither proved nor
The average annual results of a single factory
in Chatauque County, New York, whose reports
are available for fourteen consecutive years, are
as follows:—No. of cows, 917; No. of patrons,

**King Settlement Cheese Factory.**

*Season of 1863. Opened May 14th; Closed November 10th. Length, 191 days.*

<table>
<thead>
<tr>
<th>Month</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk received</td>
<td>90,568</td>
<td>202,847</td>
<td>212,314</td>
<td>182,049</td>
<td>154,440</td>
<td>122,360</td>
<td>17,731</td>
</tr>
<tr>
<td>Cured Cheese</td>
<td>3,148</td>
<td>15,328</td>
<td>20,456</td>
<td>17,278</td>
<td>16,708</td>
<td>15,305</td>
<td>2,193</td>
</tr>
<tr>
<td>Milk for 1 lb. Cheese</td>
<td>10,344</td>
<td>10,960</td>
<td>10,406</td>
<td>10,500</td>
<td>9,228</td>
<td>8,875</td>
<td>8,331</td>
</tr>
</tbody>
</table>

Totals:—Milk received, 983,331 lbs.; Cured Cheese, 98,474 lbs.; Cheese to Milk, 1 to 9.68 lbs.
Greatest number of Cows, 315; average number, 290.
Cheese sold at different prices, 11.50 to 13.50 per cwt.; total for 98,474 lbs., 10,385.89 dols.

**Expense Account:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing, at 1 cent per lb.</td>
<td>984.74</td>
</tr>
<tr>
<td>Bandaging, 0.90; Colouring, 1.00</td>
<td>200.64</td>
</tr>
<tr>
<td>Rennets (550), Salt, 3.00</td>
<td>64.25</td>
</tr>
<tr>
<td>Boxing, 224.12; Cartage to R.R., 234.48</td>
<td>456.60</td>
</tr>
<tr>
<td>Net proceeds (being 88) cents per 100 lbs. Of Milk</td>
<td>8,690.66</td>
</tr>
</tbody>
</table>

**Schuyler's Factory, Westmoreland, Oneida County, N.Y.**

*Season commenced May 11th; Closed October 31st. Working days, 174.*

Totals:—Milk received, 830,493 lbs.; Green Cheese, 82,580 lbs.; Cured Cheese, 78,644 lbs.
Shrinkage, 4.75 per cent.; Milk to 1 lb. Green Cheese, 10.06 lbs.; to Cured Cheese, 10.56 lbs.
No. of Cows, 307; No. of Cheese (6 small), 697; average weight (20 inches long), 114 lbs.

<table>
<thead>
<tr>
<th>RECEIPTS ON SALES.</th>
<th>EXPENSES.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>No. of Cheese</td>
</tr>
<tr>
<td>-------</td>
<td>----------------</td>
</tr>
<tr>
<td>June 23</td>
<td>60</td>
</tr>
<tr>
<td>July 23</td>
<td>100</td>
</tr>
<tr>
<td>Aug. 17</td>
<td>100</td>
</tr>
<tr>
<td>Sept. 7</td>
<td>100</td>
</tr>
<tr>
<td>Sept. 17</td>
<td>86</td>
</tr>
<tr>
<td>Oct. 9</td>
<td>50</td>
</tr>
<tr>
<td>Dec. 13</td>
<td>197</td>
</tr>
<tr>
<td>At Factory</td>
<td>4</td>
</tr>
<tr>
<td>Totals</td>
<td>697</td>
</tr>
</tbody>
</table>

Cost per cwt. of Cured Cheese, excepting manufacturing, and also deducting labour performed by patrons (boxing and cartage) | 49.55 cents. |
Average price per lb. gross, 12.95; net, 11.26; net returns per lb. of Milk | 1.07 |

appreciated, to those who ought to know and to heed them.

The accompanying abstracts are given as good examples, complete and condensed, of annual reports of American factories, as made up for the patrons and furnished to the dairymen's associations. 66; length of season, 218 days; milk received, 2,350,536 lbs.; milk to 1 lb. of cheese, 9.63 lbs.; average price of cheese sold, 13.23 cents; returns per 100 lbs. of milk, after deducting all expenses, 1.33 dols.

A few statistics are now added, for comparison,
DAIRY FARMING.

derived from factories in States other than New York. Wisconsin cheese ranks with the best, and some of her factories give the following. In the list for 1874, this State is credited with forty-five factories; the Secretary of the Board of Trade at Sheboygan Falls collected reports in the year 1877, from sixty-two factories, all in the county of Sheboygan. The totals reported by these were 9,870 cows, 31,958,524 lbs. of milk, and 8,185,275 lbs. of cheese, and these averages:—Cows per factory, 159; cheese per cow, 323 lbs.; ratio of cheese to milk, 1 to 10.93 lbs.; price of cheese, 10.85 cents per lb.; value of cheese per cow, 35 dollars. Eleven factories in Massachusetts, with a total product of 81,254 lbs. of cheese, reported the same season the ratio of cheese to milk, 1 to 10.27 lbs.; cost of making and furnishing, 2 cents a pound; net returns to patrons, 2 cents per quart for milk delivered.

A cheese-factory in the town of Winthrop, Maine, was in operation eighty days in the months of July, August, and September of the year 1874, and 110 days during the season of 1875; the milk used was from about 200 cows, a large part of them full-blooded Jerseys, and the rest high-grade Jerseys. In 1874, 1 lb. of cheese was obtained for every 8.7 lbs. of milk, and the next year the ratio was 1 to 8.9 lbs. This was Jersey cheese, and was pronounced by a competent judge to be "extraordinary for its rich fatness, equal to a Stilton."

The remarkable results at Gwillem's Factory, in Colorado, in 1878 were noted on page 377; later records of factories in that section, situated 7,000 to 7,300 feet above sea-level, give the productive ratio for an entire season as 8.555 lbs. of milk to 1 lb. of cured cheese. The average yield of milk per cow, although not exactly ascertained, is not as correspondingly small as might be supposed from this high cheese quality. Extreme dryness of the atmosphere is the characteristic of the climate there, and so well is milk preserved that no acidity whatever is perceptible at any stage of the cheesemaking in the factories of Colorado.

It is impossible to determine exactly how and when American factories, organised and established with the sole idea of making whole-milk cheese, began to manufacture skim-cheese, and to add butter-making to their other work. It seems, however, to have resulted gradually, from a combination of natural and economic causes, beginning very soon after the factories became numerous. Thus, late in the season, when milk diminished in quantity, but grew richer and kept good longer, patrons at a distance from a factory would deliver only every other day, and, the cream having separated on the earlier messes, they would remove it, to make butter for home use, and so send to the factory milk with but half or a third of its cream. And yet the factory cheese, from this milk, would be apparently equal in quality to the average of the season. Again, factories receiving a part of their milk in the evening, and failing to prevent a separation at night, would try removing and churning the cream of that part, and still make good cheese. There were good cheese-makers, too, who noticed a large percentage of butter in the whey, and claimed that this might be saved by taking more or less cream from the milk for butter before making into cheese, and without detriment to the latter product. And frugal factory managers discovered that they could turn out as many or more pounds of both butter and cheese from a given quantity of milk as of cheese alone, and could sell the double product for a good deal more than the single one. Facts like these, and the results of such experiments, were soon heard in meetings of dairymen, and became arguments for more or less skimming.

Professor X. A. Willard, perhaps the closest student of American cheese-factory practice, as he certainly was its most active and prominent advocate in the early years of the system, favoured skimming within bounds, as may be seen from this extract from an address delivered by him at the Annual Meeting of the American Dairymen's Association, in January, 1866, and repeated before the Ohio State Cheese Manufacturers' Association the same year:—"Now take these facts together:—First, our cheese is richer in butter than it need be; second, we cannot, if we would, retain all the butter in the curds; third, the price of butter is greatly in excess of cheese. These propositions prove that we are annually throwing away millions of dollars, without benefiting anybody or anything, except perhaps the pigs. It is a waste which all of us have been aware of for a long time, but in our blindness were unable to see clearly how to remedy. It can be done by the adoption of butter-making in connection with cheese manufac-
ture. This modification of our system promises to be a leading feature in future operations of the dairy. The plan admits of various modifications in the manufacture of cheese. Some can turn their attention to purely skim-milk cheese, and others only partially so. The question will occur, of course, to what extent the cream may be removed from the milk, and yet a nice, mellow, palatable cheese be made. It is my belief that a portion of the milk may be kept twelve hours, if not longer, then skimmed and added to a fresh mess, and from this mixture as nice an article of cheese made as under our present mode of letting cream pass to the whey tubs. To many of our factories the addition of a spring or cooling-room, a churning-room, and the necessary implements of butter-making, need cost but little; the additional labour, with an ordinary factory, would be covered by one person, and in some instances no addition would be needed to the usual force employed. The public necessities demand that in every cheese-producing county several factories should make butter, at least enough for local consumption. As the quantity of skim-cheese increases new markets will be opened, and these, while they have a tendency to continue remunerative rates, must also operate advantageously on other styles of cheese, by reducing the quantity of these kinds and making them more scarce. I do not advise every factory rushing at once into the manufacture of skim-cheese. That would over-do the business and cause a failure, by throwing upon the market too much of this kind. But it would be safe for those factories that have nice water, and locations suitable for erecting pool-rooms, to add them to the factory, and commence a series of experiments to determine what proportion of the butter may be removed from the milk, and yet retain a quantity sufficient to produce a rich, mellow, and high-priced cheese. The whole matter at this time is crude and undeveloped, and must be worked out in the future.” Professor Willard adhered to this position, for in a public address, some years later than the foregoing, this passage occurred:—“Cheese-men come here, fearful of the establishment of butter factories. They insist that every particle of cream must go into the curds, when they know it cannot all be retained, while it has been proved over and over again that the night’s milk may be skimmed at certain seasons of the year, and when thus treated and mingled with the morning’s milk, the expert cannot detect loss of cream in the cheese.” Still later, in a similar address, Professor L. B. Arnold said this:—“The practice of skimming is gaining ground year by year, and is likely to continue, be the consequences what they may to our national reputation. So long as skimming gives a better return on a hundred pounds of milk than can be done by making cheese alone, it will be of little avail to attempt to check its progress. It will go on until by natural results there becomes an equilibrium in profits, so I have no disposition either to urge on or retard its progress, for it will regulate itself in time.”

With such teachers and teaching, and with the balance-sheets of factories adopting this advice showing better returns than those adhering to their whole-milk principles, it is not surprising that skimming became common; factories produced more or less butter, and changed their plans accordingly. From the outset, however, there were stout opponents to all skimming in connection with cheese manufacture, conspicuous among them being makers whose “marks” had won a high reputation, and merchants who prided themselves on keeping a high standard in the markets. The “full cream” men and the “creamery” men still have frequent warm discussions over the effects, and also the ethics, of their respective operations.

This explains, in a measure, the existing variety in the establishments connected with American dairying which come under the general head of “the factory system.” Some make cheese and nothing else. Others, with cheese as the main product, make more or less butter; they vary with the season and the market, taking from one to three pounds of butter from a hundred pounds of milk; and these, in some cases, hold on to their original name of cheese-factory, while others have changed to “creamery.” Others, again, known as creameries, make both butter and cheese at all times, or butter mainly, with cheese only at times, or butter alone. Then there are those called butter-factories, but even among them more or less cheese is made. It is impossible longer to tell from the name alone the nature of the work done in the establishment. “Creamery” is the most common name applied in the United
States to any factory where the article cream is separated from milk or handled separately.

Creameries came into existence earlier than is perhaps implied by the foregoing, and soon followed the cheese-factories, wherever the latter were established. Thus, placing the real start of cheese-factories as a system in New York at 1861, the first creamery was opened in 1864; in Illinois the first cheese-factory was built in 1862, the first creamery in 1867; in Iowa, the first cheese-factory in 1866, the first creamery in 1871, and so on.

The methods of conducting creameries differ more than those of cheese-factories, just as there is greater variety in the details of butter-making than in cheese-making in private dairies. In most cases, the whole milk being received, and the first object being to cool it and cream it, the prevailing methods are known as the pool and pail system, the large shallow-pan practice, and the use of creamery vats, in which the milk can be "set," and then made into cheese after the skimming. Two of these methods have been already explained in Chapter XIX., and other examples will be hereafter given. There is another method which, because of its practical success, deserves to be fully described, and which is here alluded to because its peculiarities relate more to the cheese part than to the butter.

H. E. A.
CHAPTER XXXII.

DAIRY WORK IN AMERICAN FACTORIES.

General Factory Arrangements—Examples and Details of Construction—Cheese-vats and Heating Apparatus—Curd-cutting—Pressing—Curing-rooms—The Whey—Creameries, or Butter Factories—Methods and Apparatus.

In describing the arrangement of the buildings, their rooms and fittings, we may divide them into two classes. The first includes the oldest factories. We take, as an example of these, the Whitesboro' Factory, Oneida County, N.Y., the property of Dr. L. L. Wight, who holds a high place among American dairymen.

Doubtless, establishments more complete and convenient in some respects exist, but we have selected this because it is a very good representative of the better class of American factories, and happens to possess the best curing-house we remember to have seen in the United States.

The delivery window (Fig. 277) is but a few feet above the road which rises in front of it, so that while the milk can be poured into cans on the weigh-scale (1) without the aid of a hoist, the weighing platform is still somewhat higher than the vats (2), allowing the milk a good fall when discharged into the latter through a conductor pipe from the weigh-can. The milk vats (2) are four in number, contain about 500 gals. each, and are heated by steam, and cooled by a good supply of water. Opposite these are laid two iron-capped track-rails (6), extending from the making-room over a low plank bridge into the curing-house, which is a separate building. A sink (7), in which the curd is placed for drying, runs on this track, on the other side of which are two "Fraser" presses (5), and over it a McAdam curd-mill (4), driven by a 2 horse-power oscillating engine (3), which also pumps water for the boiler. By the arrangement shown the sink can be run under the mill for curd-grinding, and drawn back to the end of the track when its contents are to be put in press. The boiler (8), set in brickwork, is placed in a partially detached building, so that it cannot affect the temperature of the making-room.

The curing-house is 104 ft. long by 30 ft. wide, and two storeys high. The cheese-tables (9) are of the type shown in Fig. 290, and raised about 3 ft. above the floor. When the presses are to be emptied, a table (11) on wheels is run over the track into the making-room, on it some half-dozen cheeses are placed, it is then

![Fig. 277.—Ground-plan of Whitesboro' Factory.](image)

1, Weighing-machine; 2, milk-vats; 3, engine; 4, curd-mill; 5, presses; 6, rails for sink; 7, sink; 8, boiler; 9, cheese-tables; 10, stairs to upper room; 11, cheese-waggon.

...
this house are provided with louver shutters, which can be made to exclude the rays of the sun. During the summer months, when the days are often intensely hot and the nights cool, the windows are closed during the former and opened during the latter, an equable temperature being thus procured and preserved. We well remember the coolness of the building during one of the hottest of American summers, the thermometer standing at about 70°, when the air in the open was between 80° and 90° Fahr.

As another instance of the convenient arrangement of the different parts of a factory on the same principle, we give a portion of the ground-plan of Truxton Factory, in Cortland County, N.Y. It was built for manufacturing and storing the cheese from the milk of 1,500 cows. It will be seen in the plan that the making, press, and curing-rooms are all in a line, and so situated that when the curd is removed from the vats (3) to the sink (4) it can be run into the press-room between the lines of presses (6), and from them carried as cheese, on a table similar to that before described, into the curing-room, without exposure to the open air. The truck is run between the racks (7) the whole length of this room, thus rendering any carrying of the cheese in the hands unnecessary. The making-room for this factory is furnished with two delivery windows (A, A), to expedite the weighing of the milk. Under the platform is a water-tank,
the overflow from which runs over flagstones laid beneath the wood floor, carrying away any slops which might otherwise have collected there.

We now describe a factory possessing a peculiarity in its construction which, on account of the principle of manufacture involved, makes it worthy of notice. The Newville Factory is located near Little Falls, Herkimer County, N.Y., and has, factory the "shute" (see Fig. 127, page 259) is used when removing the curd from the vats to the sink—an arrangement described at p. 259. The curing-rooms, with the exception of one used in cold weather, are over the making department, and the cheese is carried to them by the hoist (7). This building includes living-rooms for the work-hands.

We now come to the description of the system through the skill of its manager, Mr. A. G. Weatherwax, obtained a high reputation for its goods. The delivery platform is in a shed projecting from the building, under which the waggons stand when delivering the milk. Here a hoist lifts the cans to a certain height, when they are tipped and their contents emptied into the weigh-can (1). At the other end, and within a foot or so of the five steam-vats (2), the floor sinks some 4 ft., so that they may be said to stand on a platform, below which, in the lower part of the building, are the sink (3) and presses (6). In this of manufacture pursued in these associated dairies, and the apparatus used in the work. The cheese-tub, or vat, is first in importance. Among the earlier apparatus of this kind is that known as the "self-heater" vat. It is constructed with an outer case of wood and an inner one of tin. The sides and ends of the latter slope away from the wooden case to the extent of two or three inches, as shown in Fig. 282, which gives a cross-section of the apparatus. Under the body of the vat is a long metal tube, which connects with that part of the vat between the inner and outer cases by other
and smaller tubes. Through this cylinder passes a flue (1), at the mouth of which is fixed a small grate, in which is a fire to heat the water, and this in its turn raises the temperature of the contents of the vat. The water is poured into the vacant space between the inner and outer cases through a hopper, and being heated, flows upwards and inwards against the sides and bottom of the tin case, and returns to the flue in the manner shown by the arrows in the illustration. The smoke finds egress through a pipe at the other end of the vat. It is said of this apparatus that it distributes its heat uniformly and without the use of much fuel.

In Figs. 283, 284, and 285 are given illustrations of a most useful combined milk-vat and heater, such as may be used in either factories or farm-house dairies.

The heater is constructed separately from the vat, and consists of wrought-iron pipes, screwed together in such a manner as to form a fire chamber, and present a large amount of heating surface directly exposed to the action of the fire. This coil of pipes is enclosed in brickwork, which prevents loss of heat. A pan, or tank, rests on the top of the brickwork, and is connected to the coil in such a manner as to form a perfect circulation; so that when the tank is filled with water, and a fire started, the water is warmed very rapidly. A flue is formed underneath the bottom of the tank, so that it receives the heat from the fire after it has passed the coil.

The coil is also connected with the vat, and forms, with that, a perfect circulation. The upper pipe, the one that supplies the heat to the vat, branches off, and two smaller pipes are connected to it, and these extend through the space between the tin and wooden vats, and are perforated, so as to distribute the heat equally. The lower pipe, the one that supplies the coil with water from the vat, is attached directly to the bottom of the wooden vat. Proper stop-cocks are attached, so that the heat from the coil may be turned on or shut off from either the tank or vat at pleasure. A safety-pipe is attached to the cold water, or lower pipe of the coil, which allows the water and steam to escape into the tank, to prevent all danger of exploding, in case all the stop-cocks should be negligently closed at once.

The tank is filled with water, a fire started in the chamber formed by the coil of pipes, and the water in the tank is first warmed; the stop-cocks that connect it to the coil being open, while those
to the vat are closed, thus forming a circulation with the tank only. After this water is warm, and when the milk has been placed in the tin vat, the stop-cock to the vat is opened, and the warm water immediately passes from the tank, filling the space between the tin and wooden vats. When filled, the stop-cocks are closed, leaving the coil in connection with the vat only. The heating of the vat then immediately commences. The water passes from the vat through the lower pipe, and circulates slowly through the coil, becoming gradually heated, until partially converted into steam. In this condition it is returned to the vat through the perforated pipes, and by them is most evenly distributed. As the steam condenses on meeting the cooler water in the vat, the same circuit is continued until the proper temperature is reached, when the stop-cock to the vat should be closed. This cuts off the circulation, and prevents a further rise of temperature. When the heat is shut off from the vat, the stop-cock to the tank should at once be opened, and the tank, having been re-filled with cold water, receives the heat from the coil until the vat is ready to be warmed again. In this manner a supply of hot water may be kept on, and for any purpose. One or more vats may be attached to a single heater, and the whole construction is such that it can scarcely be injured, even by the greatest carelessness.

We now give an illustration of a neat and efficient combined steam-generator and engine (Fig. 286), in general use among the factories. It is fitted for burning wood or coal, and the flues are arranged to present a great amount of heating surface to the action of the flames, by which economy of fuel is obtained. In some dairies self-filling tanks are attached to the boiler. One of these is shown in Fig. 287, elevated on a wooden frame, and connected with the boiler by two pipes. When the water in the generator is so low as to free the end of the pipe (1), the steam rushes through it into the tank, some of the water from which passes through pipe (2) into the boiler, neither water nor steam being able to return, the valves working only one way. This insures absolute safety if the valves are in working order and the tank filled.

When enough of the morning's milk has been delivered to fill one vat, the work of making the cheese commences. The agitator floats are removed, the milk heated to about 80° Fahr., and the rennet and sour whey added. The vats used for making rennet among the American factories are dried and stretched on sticks, often badly cured, and always variable in their action. Some factories are supplied by the patrons, who cure them at home. Nothing surprised us more in our visits to American dairies than to find a rennet of such an uncertain character so commonly in use. In Canada, however, much better vells can be obtained; these are known as "C. P." and are selected and cured by an English dealer.

When coagulation is completed—generally in sixty minutes or less—the curd-knife is called into use. There are two sorts of knives—the vertical and the horizontal (see Figs. 135 and 136, pp. 275 and 276). The former consists of a number of sharp steel blades fixed half an inch apart in a head-piece of wood or metal, and provided with a handle. In the latter the blades are fixed horizontally to two side-strips of steel. Wherever this is used the vertical knife accompanies it, though in many cases the perpendicular instrument is used alone. The latter is drawn through the curd from one end of the vat to the other, then, after an interval of several minutes, across it. Now another pause occurs in the work, and then either the horizontal knife is used to cut it as far as possible into cubes, or with the vertical instrument it is divided into still smaller pieces. After a time the contents of the vat are stirred by the hands and arms of the maker, or by a rake, such as that shown in Fig. 137, p. 276. We have seen this work done with common hay-rakes, by makers who preferred them to all other implements for the purpose.
When the pieces of curd are reduced to about one-third their original size, steam is turned on, and the whole mass heated to about 95° Fahr. When it has been scalded sufficiently it is allowed to sink to the bottom of the vat, and remains there under the whey for some two hours, more or less, to become acid.

When the curd-knife is used (which essentially belongs to the American and not to the Cheddar system) it must be at intervals, or loss of solids will be the result. But during these intervals the strips or lumps of curd grow tough and skinny. By the time the scalding process is completed each lump has become, as it were, dry and tough on the outside, though gradually more moist towards the middle, the whey not having been properly separated. We have split open many such lumps, and found this to be invariably the ease to a greater or lesser extent. We give (Fig. 288) an enlarged section of such an one, which will explain our meaning. Now, whatever may be the belief of the followers of that system on the question, the whey not separated before the scalding process is finished will never be separated by pressing, nor fully by grinding, although by the latter treatment some whey, and with it solid matter, may be worked out. This result of grinding, not known with well-made Cheddar curd, is so common in America as to have necessitated a curd-mill, with knives instead of bars (see Fig. 93, page 207). We have seen in American factories, where the curd was ground with the ordinary peg or bar-mills, a quantity of thick white liquid pressed from it in the grinding. But whether ground or not, there is enough whey left in to account for the bad-keeping quality of much American cheese. A lack of acid will, in a fair curing temperature, render the cheese tasteless and "soapy;" too much acid and moisture will produce a tendency to early decay.

When the curd is sufficiently acid the whey is drawn off with a syphon, with which is used a cylindrical strainer, both shown in Fig. 139, page 278. In factories on the plan of the Whitesboro' and Truxton establishments, the next work is the removal by the "flat-side pail" (Fig. 289) of the curd and remaining whey to the "sink." It will be readily seen that this utensil is peculiarly adapted to the purpose. When the vat is tapped, nearly all its contents may be removed by it.

In salting, the proportion of salt to curd varies in different factories, but about 2 lbs. to 1,000 lbs. of milk manufactured is the general rule. A large quantity of English salt is imported for the dairy trade, being considered by many the best; but some American firms are producing a really fine article, such as that of the "Onondaga Works," at Syracuse, New York, where it is manufactured on a process perfected by Dr. Goessman, a noted chemist, by which freedom from impurity is obtained. This article, known as the "Onondaga Factory-filled Salt," enjoys a well-earned reputation.

The best press yet in use in America is that made by Messrs. Fraser and Benson at Rome, New York, and known as the "Gang-press" (Fig. 270, page 461). It is so constructed that the cheeses are pressed horizontally against each other, the lower part of one hoop fitting into the upper part of the next. The screw runs in a movable wooden block, which can be set in the proper position for one or two cheeses as well as for the whole number for which the press is intended.

As soon as the newly-made cheeses reach the curing-room, they are neatly marked on the bandage with the date of the manufacture, a damp paste being used for the purpose, applied with a stiff brush over a stencil-plate. In the "drying" or cheese-rooms two classes of racks, or tables, are sometimes to be found. The one of which we give a section in Fig. 290 is the most convenient, and allows more cheese to be stored in the same space.

The temperature believed to be most favourable to the early ripening of American cheese is 70° Fahr., in which it usually becomes fit for exportation in three weeks. When a quantity has been sold, each cheese is weighed separately, scales of the pattern shown in Fig. 291 being used. This machine serves two pur-
poses: in the scoop (x) salt, &c., may be weighed; on the table (y) cheese.

The expense of packing the cheese in boxes for exportation is considerable, each box, 10 inches deep, costing one halfpenny for every inch of its diameter; a package of that depth, and 16 inches across, costing 16 cents, or Sl.; and if a greater depth than 10 inches is necessary, a cent is charged for every additional inch of vertical measurement. Thin discs of wood, called "scale-boards," are placed against the top and bottom for protection of the cheeses when they are boxed.

Many dealers visit the factories and inspect the goods previous to the weekly market, but the cheese from the dairies of reputed makers is generally sold without any such inspection, and sometimes even without samples. Some dairymen, well known on the market as skilful makers, receive a certain sum per pound in advance of all other prices, and sell their goods only to one house. The dealers are well aware that in first-class factories the quality of the goods is uniform, and great confidence is therefore placed in the managers of such establishments. When samples are carried to the markets (for factory-cheese is never sold and delivered on the spot, as in our English fairs) the "plugs" are often placed in glass tubes, and carried in a leather case (see Fig. 219, page 416), by which means they are preserved from dust and damage.

There is a time in every season when the inferior condition of much cheese that is made in American factories seriously affects the market. Those goods made during the months of June, July, and August go "off flavour" rapidly, and have to be sold at a lower price on that account. "Hot weather" cheese becomes a drug on the market, a source of vexation to all parties concerned, from the patron to the consumer. The causes of this are not difficult to discover. The mischief may be traced to the farm, where the cows drink water from stagnant pools; to the factory, where the whey tanks and hoggeries are situated too near to the making-room, and send forth their vile odours to taint the milk. We have seen the curd made from tainted milk rise, during the scalding process, en masse to the surface, and at such times the work is positively unhealthy, on account of the smell rising from the vat. We remember visiting a factory where a bad "floater" was being dealt with, and hastening from the vat to the door, found that escape from one evil only brought us in contact with another—the smell from the whey-tanks, which were within a few feet of the spot we occupied.

In the management of "floating curds," two principles are usually recognised—that acid will, in a measure, overcome taint, and that a minute division of the curd will do much, by liberating the gases. In factories where the "loose curds" system prevails, the mill is used for the latter purpose. By following these principles, makers have in many instances succeeded in so far conquering the mischief as to produce cheese in which only a slight peculiarity of flavour could be detected as the result of the original taint. But while such is the case, it is yet certain that great losses are sustained every year through the milk supplied in a tainted condition to, or spoilt in, the factories during the summer months. The cheese which goes "off flavour" early is not all, however, necessarily made from bad milk, for the produce from the sweetest and purest milk will also, under circumstances unfavourable to its proper making and curing, be more or less injured in "keeping" quality. On the markets many persons betray anxiety to clear out "hot-weather" stocks at almost any obtainable figure, especially if the factory curing-rooms are unfit, through faulty construction and a lack of the means of preserving and preserving a correct and uniform temperature, for holding such goods.

In most factories the whey is conveyed by pipes or shutes from the vat directly to the tanks, and drawn from these either by the farmer to his home, or for the fattening of hogs on the factory premises. In the former case, the patron is allowed to take a quantity proportionate to his milk-supply, as part payment for the latter, or he can remove as much as he requires at a fixed price per gallon; while in cases where the fattening of pigs is a part of the factory business, the patron is allowed one pig for every five cows' milk supplied, or the company owning the buildings use the whey on their own account.

Some years ago considerable attention was directed to the manufacture of whey-cream butter,
and a fair article was produced by two processes. One of these, known as the "hot" process, consisted in the addition to the whey, if sweet, of a certain amount of sour whey, and heating it to 175° Fahr. and upwards, by which means sufficient cream was raised to produce rather over \( \frac{1}{4} \) oz. of butter to a gallon of whey. The other method of cream-raising was surrounding the tank containing the whey with cold water. The churning in either case was performed in the ordinary manner, at a temperature of about 60° Fahr. But the manufacture of this article has been to a great extent abandoned, being considered unprofitable, and the practice is now confined to a few establishments. In many factories, however, a "grease" is prepared from whey, by heating and removing from it the cream and albumen, which, when cold, is used for rubbing the cheese.

The quantity of milk required to produce a pound of cheese varies greatly in different instances, both the quality of the milk and the skill of the maker influencing the results. From the statistics of forty-eight factories in the State of New York, in 1864, we learn that the largest quantity was 10 38 lbs., and the least 8 31 lbs., whilst the average of the whole number was 9 82 lbs. of milk to every pound of cured product. The average of forty-eight factories in 1865 was 9 61 lbs.; of thirty-nine in 1866, 9 68 lbs.; of twenty-eight in 1867, 9 83 lbs.; of thirty-seven in 1868, 9 88 lbs.; of forty-two in 1869, 9 61 lbs.; and of twenty-five in 1870, 9 95 lbs.; showing a general average of 9 80 lbs. of milk to 1 lb. of cured cheese. From the reports of ten well-known factories in the columns of the Utica Herald (December, 1876), we find that they have used on an average 10 lbs. of milk for the production of 1 lb. of cheese.

The quantity of milk required to make a pound of cheese is the basis of the calculations regarding the payment for milk, the patron receiving for it as much as the price per pound obtained for cheese, less the cost per pound of making. Let us suppose that during a certain week 10 lbs. of milk were used to each pound of cheese produced, and the latter was sold at 10 cents (5d.) per pound, while the cost of manufacture was 2 cents (1d.); the patron would receive 8 cents (1d.) for each 10 lbs. of milk delivered by him.

When the dividend is declared, a statement is presented to each patron, showing the price realised for cheese, the quantity of milk supplied by and the sum due to him, with any other statistical information which it may appear desirable to publish. We give a specimen of such a form:—

<table>
<thead>
<tr>
<th></th>
<th>Cheese Factory.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk supplied</td>
<td>lbs.</td>
</tr>
<tr>
<td>Cheese sold</td>
<td>lbs.</td>
</tr>
<tr>
<td>Milk required for one pound of cheese</td>
<td>lbs.</td>
</tr>
<tr>
<td>Cost of manufacture per lb.</td>
<td>$</td>
</tr>
<tr>
<td>Milk supplied by Mr.</td>
<td>lbs.</td>
</tr>
<tr>
<td>Value per .... lbs.</td>
<td>$</td>
</tr>
<tr>
<td>Value of milk supplied</td>
<td>$</td>
</tr>
</tbody>
</table>

In certain cases, especially where the factory is owned by a private individual, the system of regulating the price of milk by the figures of other factories is adopted. The patrons choose two dairies well known for their fine goods, and agree to accept as much for their milk as is the average of the prices paid by these dairies; so that if one pays 8 cents (4d.) and the other sets its patrons 7 cents (3½d.), the average, 7½ cents (3½d.), will be paid by the proprietor for the quantity of milk representing a pound of cheese.

**CREAMERIES.**

Since their introduction, in 1861, butter-factories have spread rapidly, and at the present time a large number are in operation. But by far the largest proportion of American butter is still made in farm dairies, the quantity from the former in 1874 being 3,214,125 lbs., whilst that made in the latter amounted to 107,873,361 lbs.; so that for every pound of butter made in factories, 33 lbs. were made in the homes of the people. The creameries are increasing in number; but as a fine quality of butter is produced in home dairies at less expense and with far more certainty than first-class cheese, they are not likely to monopolise the manufacture of the former as the cheese-factories have done that of the latter.

The "spring" system of cooling and setting milk followed on many farms may, at the outset, be briefly described, the main principles having been adopted in most of the early factories. Over a cool spring of water, and a portion of the stream flowing from it, stands a small wooden building known as the "milk-house." The bed of the stream within the house is made uniform, and its sides extended to suit the farmer's necessity.
Stones are fixed here and there in the water, to prevent the milk-pans being moved by the force of the stream. The milk is brought to this spring-house and poured into clean earthen crocks. These are placed in the water between the stones, covered by a tile or piece of wood, and left until the cream has risen. Among the first factories this arrangement in a modified form was generally followed, though other methods of milk-setting have since been introduced.

As an instance of a factory where the "spring" setting is followed, we select that belonging to Mr. Gardner B. Weeks, of Syracuse. The water from the spring is conducted by a pipe, situated 20 inches under the ground, to a large pool (2), in which the pails are placed, the water flowing into the pool in sufficient volume to retain its natural coolness, and to rise around the pails to within 2 inches or so of their tops. The pails are 8 inches in diameter and 20 inches deep. An example is given in Fig. 168, page 306. The milk is left in the pool until all the cream has risen, when the latter is removed by the "dipper" (Fig. 168), a long-handled, conical cup, which is pushed downwards into the milk of the pail until its edge is slightly below the surface, when the cream runs into it, and is poured from it into another vessel to await churning. Some butter-makers believe that the cream will not all rise in less than thirty-six hours; others skim at twenty-four hours after setting, and hold that all that may be removed afterwards will not be worth waiting for; but there are many circumstances to be taken into account in these calculations outside the mere question of time.

The skimmed milk is emptied into the vats (3) and made into cheese, and the pails cleansed for the next setting.

We have selected for purposes of illustration two other creameries, each possessing, in its construction and furnishing, peculiarities worthy of notice. The first of these, the Finck's Basin Creamery, is located near Little Falls, N.Y., and is the property of Messrs. Whitman and Burrell, an enterprising hardware firm of that town.

The delivery-window at this establishment opens on a covered drive-way, under the shelter of which the patrons unload their milk. The making-room contains three vats (2), a large gang-press (3), and in a partitioned recess a combined horizontal boiler and engine (4). The milk is set in the ordinary steam milk-vats (2), and to cool it rapidly a very ingenious apparatus is used. This "cooler" (Fig. 291) consists of a frame of tin pipes, of 1\(\frac{1}{2}\) to 2 inches in diameter, fitting into two similar pipes at each end, the length and width of the frame being a little less than those of the vat. At one corner is a pipe (1) with a funnel-shaped mouth, into which cold water flows from the supply, and, circulating through the frame, emerges at the end of the bent pipe (2) at the opposite corner of the apparatus. This frame is suspended from the sides of the vat by hooks (1), and in such a manner as to be at about half the depth of the milk. After the cream is taken off, the cooler is also removed, steam applied, and the skim-milk made into cheese. In the butter-room is a large "Blanchard" churn (Fig. 249, p. 453) driven by steam-power, a wide shelf (6, see plan), and a large spring water-tank (8),
over part of which a cooling-cupboard (7) is fixed. When the butter has been taken from the churn, and the buttermilk worked out by the “Cunningham” worker (Fig. 297), it is placed in this tank, and when firm removed to the cupboard. A very superior butter is made here, and the business is profitable to owners and patrons.

The other example is a creamery near Rome, Oneida County, N.Y., the property of Messrs. Gaddis, McAdam, and Co. Here the milk-setting and cheese-making departments are separated. The milk, after being weighed, is set in the vats (2), which are constructed as shown in section in Fig. 296. The outside wooden case is similar to the corresponding part of a milk-vat. In this two tin cases, of the shape shown in the annexed illustration, are placed side by side, which arrangement allows more room for the water supplied for cooling. The water (2) is kept at a slightly higher level than the surface of the milk (1). On the top of the cooler is placed a cover having a ledge (3) raised around it, cross-strings (4) for strength, and cylindrical ventilators (5) fixed at intervals throughout its length. Over this cover water flows continually, materially assisting in the rapid cooling of the milk. When the cream is skimmed off, the milk is conducted to the vats (3, see plan) and made into cheese. The “Fraser” press, the “Blanchard” churn, and the “Cunningham” butter-worker are all in use in this factory, and butter of a fine quality and good skim cheese were being made at the time of our visit in 1876.

It is generally held by American butter-makers that cream should be churned at a temperature ranging from 58° Fahr. in summer to 65° in winter, and if it does not stand at the proper heat, the pail containing it is placed in warm or cold water until the thermometer indicates the required temperature. Among the Orange County, New York, makers, the old vertical dash churn (Fig. 253, page 455) is a favourite, and various devices are employed to work several of these at one time in large establishments.

In most American butter-factories the human hand has been superseded by machinery for working the butter after it comes from the churn. The appliances for the purpose are many, ranging from complicated and expensive machines to the simplest and cheapest form of pressure lever.

The rotating butter-worker with corrugated roller (shown in Fig. 179, page 313) is also used in American creameries, but the best worker we have seen in America is the “Cunningham” (Fig. 297), a machine in which the corrugated roller is used, as in the last example; but in this instance it (2) is attached to a movable frame which traverses the length of a sloping table, running smoothly and being kept in place by small wheels and leavets. On the frame are brass springs (3), to govern the rising and falling of the roller, and at the lower end of the table is a hole through which the buttermilk escapes to a pail (4) suspended from a hook. The operation of “working” is shown in Fig. 298, where the roller has spread out the butter on the table. The handle being turned, the roller and
MARKETING THE PRODUCTS.

and preserving the contents from injury. Such a one is the "Westcott" return-pail (Fig. 300), made from white oak, and provided on the cover with a simple hinge and staple, fastened by a wire or lock. In pressing the butter into these packages, a wooden pounder (Fig. 301) is used, and great care is exercised to fill every part and exclude all air.

For "roll" or "pat" butter, the best package is the "Philadelphia" pail (Fig. 302). The ends are partitioned off and filled with broken ice, and the butter arranged on plates, as in our illustration, thus insuring its coming to market in a good condition.

The variation in the proportion of butter to milk is great, the amount of the latter required to produce a pound of the former ranging from 7 to 17 quarts. This may be accounted for partly by the management, but mainly by the difference in the quality of the milk in various instances. The purchase of milk for butter-making at a price regulated by the percentage of cream it gives is therefore reasonable.

In Wisconsin a creamery has lately been started in which it is proposed to manufacture into butter the cream from the milk of 4,000 cows, the patrons setting their milk at home, and the agent visiting them daily to convey the cream to the factory. By this system the farmer will be saved the trouble of delivering the milk; and as the cream-raising and skim cheese-making will be removed from the creamery, the making and marketing of the butter can be done with fewer
Lands, and thus great economy of labour will be one result of its adoption. By it also the objectionable custom of paying for poor milk at the same rate as for that which is rich in cream will be done away with, and it will be to the farmer’s interest to raise as good milk as possible. This new development of the principle of association gives promise of rapid growth, and of solid benefit to the dairy interest.

We have already stated that the skimmed milk of the creameries is made into cheese. The manipulation is the same as in the manufacture of whole-milk goods, but more rennet and heat are used in coagulation, and a greater amount of acid developed in the curd before pressing. Creamery cheese is to a large extent exported, being suited to the trade of warm countries.

Some years ago an attempt was made at improving skim cheese by adding to the milk an animal fat known as “oleomargarine,” which, it was believed, would in coagulation become incorporated with the curd, and so take the place of the butter removed. A patent was taken out on the process by Mr. H. O. Freeman, who built a large factory at Ridge Mills, near Rome, N.Y., where it is carried out on a large scale. As in another part of this work the subject is treated more at length, we will not enter into a description of the process, but simply remark that, after having seen it at the Ridge Mills establishment, we do not consider it a success, and believe that a more palatable and saleable class of goods may be made from the pure skim-milk than from any to which foreign fats have been added.

J. O.
CHAPTER XXXIII.

RECENT MODIFICATIONS IN AMERICAN CHEESE-MAKING.


ACIDITY has been of very great service to American cheese-making. In a hot climate like that of the States tainted milk is a common occurrence, and particularly so in the case of cheese-factories where the milk is carried a mile or two in closely-lidded cans, and proper care is not taken to cool and aerate it soon after it is milked. Acid has bridged over many a difficulty, seen and unseen, but American authorities on cheese-making think the time has come when it must be employed in a different manner; and they pay a high compliment to English Cheddar cheese-makers by going back more closely to the original Cheddar system. In the following article, Professor L. B. Arnold sets forth very clearly the new line which American dairymen are about to adopt:

"MAKING CHEESE WITHOUT ACID.

"In the days of dairy cheese-making, before factories came into use, it was the almost invariable practice as soon as the curd, after being cut and 's aged,' had become tolerably firm—so it would squeak between the teeth and feel hard when squeezed in the hand—to draw the whey, cool the curd at once, and salt and put it to press. This was emphatically a sweet-curd process, no acid being used or developed in any stage of the manufacture. But this is far from being the 'no-acid process' I have recently advised. This was a faulty mode of making, and is not to be recommended. It left too much whey in the cheese. They would often Huff, lean aside, be porous and spongy, and assume all sorts of flavours, according to the extent of whey retained in the curd, so that it was difficult for two workmen, or even the same one, to make cheese alike. Though there was usually a decided cheesy flavour developed in this process, the want both of high qualities and uniformity made it a bad article for commercial transactions. The cheese being different on each farm, the purchaser never knew what he was getting without a personal inspection of every man's dairy or every man's load of cheese as it came to market, and much of it being short-lived, as well as otherwise faulty, the traffic in cheese in those days was a precarious business. These circumstances, which, to a considerable extent, still lie against dairy cheese, materially lessened its market value.

"When the factory system was introduced, this sweet-curd process, with but few exceptions, was in full vogue, and was carried into the factories, where it worked even worse than in the dairies. When made up on the farm there was no tampering with the milk to its injury. It had all the freshness and qualities it possessed, whatever they might be, which it had when it came from the cows. But in the factories it was different. Being carried from one to two, three, or four miles from the farm to the factory, while warm and closely covered, the animal odour, or peculiar odour of new milk, became developed into taint, especially when, from bad water, heat, or other cause, there was anything like feverishness about the cows. Animal odour, tainted milk, and floating curds became the pest of the factory system, and caused many a ton of spoiled cheese to be taken from the factory slyly, and buried or thrown into the dock after it got to the market. The increased development of odour and taint from the lack of cooling and proper ventilation while in transit to the factory, and also
from keeping milk in large masses over-night without sufficient cooling, gave so much trouble to cheese-makers who worked after the sweet-curd process, that the whole factory system was at one time threatened with annihilation.

"By degrees factory-men found an improvement by (as they called it) cooking or scalding their curds more, which simply meant keeping them in the warm whey longer, to effect a greater separation of whey. This made the curd and cheese harder and drier. It took more milk to make a pound of cheese, but the cheese was better. At length the curd was continued in the whey till the latter was distinctly sour. The souring made the separation of whey as complete as desired. It retarded curing, and for a time at least held the taint in check, and became an antidote for floating curds. This was a great point gained for the factory-man. He was now able to manage milk in almost any condition successfully. If it was much 'off,' he soured more; if in better condition he soured less. Thus with a little experience he was able, by nice discriminations in the degree of acidity in his whey, to control the curds to his liking. This acid process, then new to the great majority of cheese-makers, wiped out all tendency to huffing and porosity. The cheeses made by it had the merit of being firm and compact in texture. They would stand up stiffly in hot weather till they could be got to market, and they had the further merit of greater uniformity than manufacturers had been able to give them before.

"The ability to secure these qualities has given satisfaction to manufacturers and dealers, and in the markets of the past has secured prices fairly remunerative to producers. Probably nineteen-twentieths of the cheese-makers in the United States and Canada are now following out the practice of developing a decided acid in the whey, and keeping the curds in it till they are matured for the press, and, feeling satisfied with their work, regard the acidity developed as the sheet-anchor of their art. The acid process, as described, was unquestionably a step in advance of our early factory make. Indeed, almost anything was better than a cheese full of tainted whey, whose tenure of life was so uncertain that it was not always sure of reaching the market it was made for. The certainty of reaching fair and approximately uniform results, whether the milk was all right or not, was an item of importance. While I concede and appreciate fully all the excellences of the acid process, I do not regard it as the end of perfection. It fails to meet many of the requirements of a perfect cheese. The acid cheese is generally too short-lived, or, if made for keeping, it is too dry and hard, and insipid. It develops too little of a distinct cheesy flavour, and too much of a sour one instead. It is not salve and rich enough. It dries up too readily when cut. Its cheesy matter is too insoluble, and it is so difficult of digestion as to favour dyspepsia and constipation, and much of it is positively unhealthy for invalids and dyspeptics, who constitute a very large per cent. of our population.

"The great bulk of our factory cheese, though made on the acid plan, is not, even with all the cream worked in, sufficiently appetising and healthful to promote a liberal use of it by our people. The amount of cheesy flavour, the rich and buttery texture of fine old cheese, the rapid melting on the tongue like a ripe pear, and the solubility of the caseous matter, all depend on the completeness of the cheesy fermentation induced by the agency of rennet. As I demonstrated last summer by thorough tests, the acid in sour whey permanently injures the action of rennet, so that the cheeseing, or curing, as it is called, all other conditions being the same, never goes on so well when the curd is affected by its presence as when it is not. It is for this reason that the more acid we use the less cheesy taste we get, the less buttery texture, the less of the cheese is soluble, and the less of it digestible.

"The Cheddar process, in a somewhat modified form of the English mode, has been adopted to some extent in this country, and has worked well. It mends many of the defects of the acid process. The factories adopting it proceed about as follows: The milk is set for curding at 80° to 81°, the curd is cut, worked, and 'scalded' to blood-heat or thereabouts, the same as in the acid process. The distinctive feature of this system consists in drawing the whey at some period before the curd is ripe enough for pressing. The time for doing this is different in different factories. Often when otherwise it is drawn as it approximates souring. The vat being tipped to secure ready drainage, the curd is heaped upon its upper end, where it is allowed to pack and keep warm till the requisite amount of whey is expelled, and the curd is ripe enough for the press, which is generally determined by the
hot-iron test. At this stage it is ground fine enough to take salt evenly, and is cooled and pressed.

"While cheese made by this process is as firm and close in texture as that made by the acid process, it is better in most respects. First, it will have a more nutty flavour. The acid in the whey "gets" the flavouring oils in the curds lying in it, and carries them off, leaving the cheese insipid and wanting in the delicate aroma which cheese fanciers highly esteem. The more acid, the less nutty flavour. Second, it will have more cheesy flavour, be richer and more buttery, melt sooner on the tongue, and be very much easier of digestion. All this because the action of rennet is not interfered with by acid whey. By ripening the curd a part of the time out of the whey, as good a cheese can be made of the same milk, after skimming the night's milk, as can be made with the cream all in, when the curd is wholly matured in the whey, and the acid well developed. Third, it will keep better.

"Lactic acid is a strong antiseptic. But it is an animal acid, and unstable, soon changing into other forms. While it endures, it is a powerful antidote for taints in cheese-making, but it kills none of them, it only suspends their activity. Its amount in cheese is limited by the sugar in the whey retained. Whenever it assumes a new form, as it soon will, it loses its preservative power, and the taints, if any are present, resume their sway at once, and carry the cheese to swift destruction. This is the fate of cheese by our acid process, when, to guard against the effects of faulty milk, a strong acid is developed. The cheese stands up well while it lasts, but goes down at one leap when the acid has spent its force. Cheese made by the Cheddar process, if we may so call it, meets with no such sudden failure. It ripens and decays gradually, and for a long time grows better with age.

"Dr. Voelcker asserted several years ago that whey reacted upon the curd which lay soaking in it. Warm whey, like warm milk, is a most fertile field for the development of ferments, which always mean change. Whey, we know, is all the time changing, from the moment it separates from the curd till it is disposed of, and the curd lying in it feels instantly all the effects of its ever-changing condition. In the last stage of the acid process, the whey makes its most damaging im-

pression when it has become sour and stale, but its influence is deleterious all the way along. Observant cheese-makers will recognise these facts. The change which I have recently urged in our process of cheese-making is simply to draw the whey earlier than is generally done in the Cheddar process—to draw it at the earliest moment practicable. By letting the whey run off as fast as expelled, the cause, or a part of it, is removed with the whey, and the fault is reduced instead of aggravated. This process is, therefore, not only adapted to milk in its normal condition, but also to that which is in any way demoralised. In extreme cases it admits of rinsing the curd in warm water, to remove more completely any remaining traces of taint or acid. It is important, in any process, that the temperature of the curd, whether in the whey or out, should be kept up squarely till it is done. To fail in this is to do damage to the resulting cheese. Manufacturers who attempt to experiment in this early drawing of the whey should provide themselves beforehand with the means of keeping their curds at blood-heat till they are done, whether in the whey or not. The whey will then separate, and the curd ripen just as perfectly and as rapidly out of the whey as when in it. If this precaution is observed it will be safe to draw the whey as soon after heating up as the largest lumps of curd have become thoroughly warmed through, and for the rest to follow the Cheddar method.

"It will facilitate the process and save curd, and require less labour and skill in manufacturing, to heat the milk to 98°, and apply the rennet at that temperature instead of heating up after it is coagulated. Milk may be heated much more evenly and rapidly than the curd can be. Several experiments in this direction have worked finely. When setting milk so warm, the smaller quantity of rennet which must be used to prevent coagulation before the milk comes to rest may not push the curding so fast as some may desire; otherwise there seems to be nothing in the way of heating the milk instead of the curd, and thus simplifying and facilitating the work. The process I have endeavoured to describe has been called a 'no-acid process,' and it is essentially such, as it objects to the use of acid, either in rennet, in milk, or in whey in which curd is held. The questions in respect to whey escaping from warm curd while packed in the vat, whether acid or otherwise, and
the indications of the hot-iron test in regard to acidity and cheesing, have not yet been sufficiently investigated to be considered in this connection. They must be left for future study."

The system here advocated by Professor Arnold is not strictly a no-acid process, because keeping the curd at blood-heat, after the whey is removed, will cause acid to develop. It is, however, a very different thing from allowing the acid to develop before the whey is removed. It should be called the no-acid-in-the-whey process, which would be a correct definition, though not perhaps a complete one. It really consists in drawing off the whey while it is perfectly fresh and free from acid, and, by keeping the curd covered and at a temperature of 95°, to develop the acid in the curd; and in order to this the curd has to lie a longer time before grinding and salting takes place. It is a fact well known to those who are acquainted with the Cheddar system of cheese-making, whether in factories or in farm-houses, that excessive acidity produces a cheese which, when cut for eating, is to all taste and appearance poor in fat; it will be dry, hard, and granular, not moist, soft, and mellow in texture. This is not wholly because such acidity destroys or carries off a portion of the butter—though it certainly does carry off or destroy the light oils which give a flavour to cheese and butter—but because it checks the ripening of the cheese by weakening the action of the rennet; and an unripe or imperfectly-ripened cheese never appears to be so rich as a properly-ripened cheese in fats.

At the same time this acidity checks the further development of taints that have already taken possession of the milk; and were it not for the acid, such milk would produce a cheese in which the incipient taint would go on developing during the time the cheese was ripening, becoming very offensive at the last; hence the employment of acid in making cheese from milk that is more or less tainted, though it may do some harm in the way of dissipating the flavouring oils and in retarding the ripening of the cheese, does good in the way of checking taints, in expressing the whey, and in causing the cheese to be more compact than it would be without it.

The following description of Professor Arnold's system of cheese-making, written by Mr. T. D. Curtis, Secretary of the American Dairymen's Association, is both interesting and important:

"Heat.—The milk is received in the ordinary vat in the ordinary way, and then gradually heated to the temperature of 90° before the rennet is added. The customary way is to set the milk at 81° to 86°. The new method prefers the higher heat because the liquid is more readily and more evenly heated than a solid is. The temperature of 98°, or blood-heat, would be preferred for the same reason, but experiment shows that the rennet does not produce as good results at 98° as at 90°, but they are better when the setting is done at 90° than when it is done at a lower temperature. After the curd is cut it is allowed to stand until sufficiently hardened to permit of stirring without waste; then the temperature is steadily raised at the rate of a degree in two minutes, to 98°. Here it is kept, as nearly as circumstances and facilities for keeping up the temperature will permit, until the end is reached. But a slight fall of temperature, or even its gradual descent to 80°, does no damage to the curd, if it does not sour; it simply retards the action of the rennet, and delays the time ofgoing to press. Unless the milk is sour or too far gone with age the curd is not allowed to remain in the whey long enough to sour. Where acid comes on before the whey is separated, special treatment is required.

"Setting the Milk.—This, as before said, is done at 90°. Prepared rennet, of uniform strength, is preferred. It is better to mix the concentrated liquid—one pint of which is sufficient for 3,500 or 4,000 lbs. of milk—in about one gallon of water at or a little above the temperature of the milk, for every pint of rennet used. This secures an evener action of the rennet throughout the mass of milk than could be secured if it is added to the milk in the concentrated form, no matter how much it is stirred. It is readily distributed evenly through the water without affecting in any way the virtue of the rennet; but when in the concentrated form it strikes the milk, some of its virtue is expended upon the milk first touched, and this coagulates a little in advance of the mass, making denser points all through it, as can be seen by putting the hand in the curd and permitting it to run off gradually as the hand is raised. These points get too much rennet-action at the expense of the rest of the mass. Hence the advantage of diluting the concentrated liquid rennet in water. The stirring to incorporate the rennet should be continued—agitating the whole mass, and not merely ruffling the surface, as some do—until the milk will barely have
time to come to rest before coagulation begins. The strength of the rennet being known by actual experience, a good judge of the condition of the milk can easily approximate the time at which coagulation will begin. He will, of course, avail himself of any doubt, and stop stirring soon enough not to spoil the curd. If he uses enough rennet to cause coagulation to begin in fifteen minutes, he is safe in agitating the mass of milk for twelve minutes.

"Cutting the Curd.—Under the old method there is no definite rule for cutting the curd. It is an advantage of the new method that it furnishes a definite rule, in no way depending on contingency or guesswork. The operator may be deceived in the strength of the rennet, if it is a batch he has not carefully tested, and get coagulation sooner or later than he desires. He proportions his rennet to the time he wants the cheese to cure and keep. If he wants it to keep a long time, he uses a proportionately less amount of rennet, which will require more time in which to perfect the cheesing process. If he wants a quick-curing, short-keeping cheese for immediate consumption, he adds a larger amount of rennet. The day we spent with Professor Arnold he wanted to make a rather quick-curing cheese, and put in rennet enough to cause the beginning of coagulation in a little over eleven minutes. Had he wanted a fairly slow-curing and long-keeping cheese, he would have had the point of coagulation at twenty minutes or longer. And here, after these explanations about proportioning the amount of rennet to the character of cheese desired, comes in the rule for cutting. No matter how soon or late the coagulation begins, the time intervening between that and the setting is multiplied by $2\frac{1}{2}$, and this gives the time after setting when the cutting should be done. For illustration: The day we were with Professor Arnold coagulation began in a little over 11 minutes; he cut the curd 28 minutes after setting. Thus $2\frac{1}{2}$ times 11 are 27.5, and making allowance for the time over 11 minutes when coagulation began made 28 minutes from the time of setting the milk. If coagulation had begun in 20 minutes, the cutting would have been done at the end of 50 minutes. This makes a rule that every one can comprehend, but it requires a timepiece and strict attention to business. It is valuable, however, as everything definite about so empirical an art as cheese-making helps to reduce it to a science, and enables us to secure uniform and reliable results. The cutting, when begun, should be continued with tolerable expedition until finished, and the cutting should be what is called 'fine'—quite fine. The object in cutting is to facilitate the escape of the whey from the curd, and hence the finer it can be cut without waste, the more the escape of the whey is facilitated. The day of what was called 'coarse curds' long since passed, except among a few fossils who never change, and all intelligent dairymen now concur in the practice of fine cutting.

"Stirring the Curd.—With the process of raising the heat begins the stirring, not only to prevent the packing of the curd on the bottom and around the sides of the vat, where the heat is greatest, but to secure an even distribution of the heat throughout the mass of curd. Some, but not so many as formerly, think it necessary to begin the stirring and breaking of the curd with the hands. Once there was no cutting of curds, and all breaking was done with the hands. Even since the days of associated dairying and dairymen's conventions, some leading dairymen have inveighed against the use of the curd-knife as dangerous and wasteful. The same class maintain the use of the hands in the first stages of stirring the curd, and oppose and denounce the use of the rake as likely to 'make white whey.' But they are honestly mistaken, and stand in their own light. The rake at all stages when it is safe to stir the curd will do it more easily, more expeditiously, and more cleanly than the hands. It is disgusting to see perspiring men and women working in the whey up to their shoulders, and painful to see them nearly breaking their backs reaching across the edge of the vat. They may be, and are quite likely to be, more destructive and wasteful than the rake. Professor Arnold uses the rake from the beginning until the whey is drawn off. All the stirring done in the whey is done with the rake, and a smooth hand hay-rake, with about one-half the handle cut off, is as good as any. The stirring, after the heat is up to 90°, does not need to go beyond just sufficient to keep the curd from packing and gathering in large lumps, which will not readily take the salt when salting-time comes.

"Drawing the Whey.—Formerly a portion of the whey was drawn off as soon the curd acquired
sufficient hardness to not run through the strainer. Enough was left to float the curd easily, and this was kept on until sufficient acid was developed to make the curd fit to dip. Then there were great hurry and commotion to get the balance of the whey off and the curd dipped and salted before it got too sour. But sometimes the acid developed so rapidly that it would get the start of all hands, and the curd would be more or less injured by too much acid. Gradually it became the practice among cheese-makers to draw off all the whey as soon as there was any indication of souring, and cheddar the curd—that is, haul it away from one end of the vat, elevate the other end, and then part the curd in the middle, lengthwise, piling it up along the sides of the vat, so that the whey ran off and settled in the lower end as fast as it exuded from the curd. This is now the prevailing method, the hot iron being depended upon to indicate the degree of cheesing or acidity, whichever it may be called, by the number and length of the threads of toasted curd that can be drawn out when the hot iron is applied and adheres to it. When ready, the curd has to be ground in a curd-mill before salting. The new method draws off the whey early—as soon as the curd is hard enough to prevent all waste—and keeps the curd from packing and lumping by stirring with the hands until it reaches the point where it will not pack, so that it cannot be readily crumbled apart by stirring and using the hands; and it is desired to avoid all necessity for grinding, while the hot iron is considered useless as an indicator of condition. But here comes in a contrivance for facilitating the separation of the whey and keeping up the temperature, while making the work of stirring easier and aiding in ‘oxygenising’ the curd.

"The Rack."—Something like the old-fashioned sink-rack is placed in the bottom of an empty second vat. One extra vat, in place of the usual sink, would answer for a factory, as the first vat is emptied in transferring the curd to the second, and the vat just emptied can be used as a second vat or sink for the next one. But let us describe one or two peculiarities of this rack. It is made in two, three, or four sections, as may be chosen for convenience of handling. The slats, 1 inch or 1½ inches wide, run crosswise of the vat, and are placed so as to nearly touch each other. Of course they are as long as the vat is wide. These are nailed to side pieces, running lengthwise of the vat, and placed 4 to 6 inches from the sides. These side pieces are ½ inch or ¾ inch thick when planed, are 10 inches wide, and stand up edgewise, thus causing a space of 10 inches between the lower side of the slats and the bottom of the vat. These side pieces are supported by one or two braces on each section of the rack near the bottom, but not so as to obstruct the passage of whey under them. The side pieces are 10 inches wide, not only for the purpose of leaving considerable space below the curd, as it lies on the rack, but so as to raise the rack high enough to make it convenient to stir the curd on it with the hands. If permitted to lie too near the bottom, the reaching would be tiresome, and even painful. On this rack is spread an ordinary cloth strainer, and then the curd, with as much whey in it as is left when the syphon stops drawing, is dipped and emptied in this cloth and rack. Of course the whey drains through and occupies the 10-inch space beneath. This whey is not only thus easily got rid of, with the whey remaining in the curd as fast as it exudes, but aids in keeping up the temperature and in keeping it even and not too dry. This warmth is not so essential to making a good curd as it is in hastening remelt action and expediting work. If in cold weather it is likely to get too low, steam is turned on, and the temperature of the whey is raised, which warms the curd by radiation. In ordinary summer weather no additional heat will be needed.

"Oxidation."—Here we have to consider one of the principal points of the new method. It has for some time been known that to let a curd stand in the open air, with occasional stirring after salting, appears to improve the texture and flavour of the cheese, and many of our best cheese-makers practise airing the curds as much as possible in this way. But none of them, so far as we know, have tried the experiment of airing curds before salting. Under the new method, the early drawing of the whey and spreading it on the rack we have described is for the purpose of airing or oxidising the volatile oils in the curd. These form gases by oxidation while curing, and, if they form gases faster than they can escape freely through the rind of the cheese, cause porosness and huffing, so much disliked by all. But exposing the curd to the air by stirring it on the rack, while it helps to get rid of the whey, also oxidises the volatile oils and gets rid of them, while such as are not volatile, but remain to
give flavour and richness to the cheese, are progressed in the process of curing to an advantageous degree. In cheddaring, this oxidation is greatly facilitated, and hence the advantage of this method over that of keeping the curd in the whey, where little or no oxygen reaches it, save as it is brought to the surface by stirring. Aside from this, there is a positive disadvantage in leaving the curd in the whey and excluded from the air. This exclusion of the air facilitates fermentation or the development of the yeast fungus. There is not only decomposition, but recombination by the action of organic forces. It is when this action begins that it is so difficult to get rid of the whey and salt the curd before it is injured by acid. The avoidance of this fermentative action is what gives the cheddaring method its superiority. All who have tried cheddaring know that it greatly, if not entirely, avoids the danger of too much acid, unless it be by misjudgment. But the new method does not want the acid development at all in the curd, and seeks to avoid it. It aims at simple chemical changes, by breaking up old combinations and forming new ones. Two agents only are recognised—rennet and oxygen—and these are relied upon to produce only chemical changes, such as breaking up some combinations and forming others without developing organic action. The rennet gradually destroys the cohesive power of the atoms of casein, and prepares them to unite more closely with the new compounds formed by the fats and oxygen. The casein has no positive flavour of its own, and without the proper chemical union with the fats, which the rennet prepares the casein for and the oxygen prepares the fats for, it is practically indigestible and innoxious. By the oxidation of the fats, carbonic acid gas, as well as other gases, is thrown off; and the union of the oxygen with these fats is what gives the distinctive cheesy flavour. When this flavour is attained, it is desirable that the oxidation should go no further. Beyond this, decay is gradually approached, and is indicated by the rank, 'off-flavour' taste, which grows stronger and stronger until putrefaction is reached. The rennet action is chiefly digestive, and should keep pace with oxidation. When the culminating point of both is reached, we have the best flavoured and most digestible and nutritious article of cheese. Whoever discovers a method of stopping the action of both rennet and oxygen at this point will confer a boon, not only on the dairyman, but on mankind, and stand a fair chance of reaping a handsome reward.

"Salting.—With the new method it is not so particular when the salting is done, provided the milk is all right to begin with, and there are no signs of fermentation. It is usual with those who adopt the new method to let the curd air until ready for the press, before adding the salt. At first the curd steadily hardens as the whey separates, until it feels quite hard and harsh. But gradually, as oxidation goes on, after the rennet has expelled the whey, the curd softens and grows smooth and silky to the touch. It also grows tenderer, and gets quite mellow, apparently becoming richer in flavour and appearance, or showing more 'quality,' as the buyers say of cheese when it is fine and buttery. When the proper degree of softness is reached, or the cheesing and oxidation are progressed far enough—to determine which is a matter of observation, experience, and judgment—the curd is salted, and, if cool enough, is put to press. In hot weather the curd should not be pressed at a temperature much above 80°, but in cooler weather, if the temperature of the press-room is not kept up, 81° to 85° would not be an injurious temperature. Unless the surrounding atmosphere is quite cool, so that there is considerable escape of heat by radiation, the temperature of the cheese will rise after it is put to press, owing to the combined action of rennet and oxygen, and the centre of the cheese will be warmer than the outside, because curd is a poor conductor of heat, and the heat generated will but slowly pass off by radiation. The temperature of a curd in the vat or on the rack may be raised somewhat by allowing it to remain quiet, so the heat will not radiate into the atmosphere. The salting should be at the rate of 2 1/2 lbs. to 1,000 lbs. of milk.

"Taints.—It is claimed for the new method that by oxidation the taints in milk can be wholly got rid of; and that even the flavour of onions, leeks, turnips, rank grasses, or other strongly-flavoured food can be dissipated into the atmosphere, as all these flavours and smells depend on
volatile oils which pass through the cow's system into the milk, and are oxygenised and expelled in the form of gases, by exposure on the rack. The thorough separation of the whey from the curd, as fast as it exudes, also facilitates the escape of the elements of taint. Hence, in working tainted milk, the process of oxidation is prolonged until the taints disappear; but should there be danger that fermentation will set in, the curd may be salted and afterwards exposed to the atmosphere, the salt not hindering the action of the rennet or of the oxygen, but checking the development of acetic acid. Lactic acid may be had by simple oxidation without fermentation, which should be prevented if possible, and checked as much as possible should it set in. Floating curds and slippery curds are improved by oxidation before or after salting. They are always tainted curds.

"Sour-milk Curd.—When the milk is so far gone that souring cannot be prevented, it should be set at a low temperature, and not heated beyond 91°. But the cutting and separation of the whey should be expedited in every way, and the salt, in extra quantities, got on as soon as possible. If some is thrown into the milk before it is set, and stirred in with the rennet, it will be an advantage, as the sole effect of the salt, beyond flavouring, is to check fermentation and retard decay. It may safely be used freely on a sour curd because thrown on early, and much of it is carried away by the whey, which will hold it in solution. If a curd is very sour, it may be washed by pouring warm water—say of 100° to 105°—over it while stirring it, and improved thereby.

"Curing.—There is nothing peculiar about the curing process under the new method, save that it continues its philosophy in the curing-room. The temperature should be even, and should be 65° to 75°, according as more or less rapid curing is desired. Here the oxidising process which was put ahead of the cheesing process in the make-room—in order to volatilise all offensive oils, and expel them in the gaseous state—needs to be held in abeyance, to give the rennet a chance to do its work. Too much ventilation is not good for a curing-room, if cheese is properly made so that offensive gases will not be generated. It is impossible to prevent further oxidation—at least in the ordinary curing-room—but it can and should be kept down to the minimum point until the cheese is fit for market. It must go on so slowly that the small amount of gases generated may find escape through the rind, and not cause the cheese to puff, or show its former presence in excess in the form of holes, big or little, when the cheese is bored or cut. Nor should oxidation be rapid enough to generate too much heat and cause fermentation to set in, as the yeast plant will play upon the casein and form out of it a compound neither valuable nor profitable; and this fermentation, with the rapid oxidation of the fats, will soon form a compound of decay and low organism unfit for human food.

"Colouring.—We have thus far said nothing of colouring, because on the day that we took our first lesson in the new method of cheese-making, Professor Arnold was making cheese for himself, and used no colouring. But we got his views on the subject, which, as may be inferred, were not favourable to putting colouring matter into cheese. He says the addition of the vegetable matter used for colouring slightly affects the flavour, and is an element of fermentation and decay. If used at all it ought to be cut with oil instead of alkali. All colouring for cheese-making is dissolved in potash. The alkali unites with the colouring, but when put into the cheese the alkali finds a stronger affinity in the casein and unites with it—instead of with the fats, as some have supposed—while the annatto forms new combinations with the fats and oxygen, both sets of new combinations making a bad flavour and hastening decay."

A New Method of Making Skim-milk Cheese.

It might have been thought that almost every possible and impossible method of cheese-making had been tried in America—the country, par excellence, of experiments. We have heard of oleomargarine cheese, in which melted animal fat has been substituted for the butter of which it has been deprived; oil from suet, or from leaf-lard, has been used for the purpose; and broad hints have been given from time to time that more questionable ingredients have been employed to give to skim-milk the adventitious richness which naturally belongs to cheese made from milk that has not been skimmed. A wholesome prejudice against such bastard cheese has grown up, and the "system" on which such cheese was made is likely soon to die out.

The inventors of the new method of making skim-milk cheese are Amos L. Larabel and Joseph
NEW METHOD OF MAKING SKIM CHEESE. 495

M. Jocelyn. The process is carried out at the factory of Whitman and Burrell, of Utica, N.Y., and is described as follows:

"The cheese-vat contained milk that had been set for twenty-four, thirty-six, and forty-eight hours, and the cream taken off as closely as it could be gathered. The proportions were 555 lbs. at twenty-four hours, 372 lbs. at thirty-six hours, and 517 lbs. at forty-eight hours, making 1,504 lbs. in all. This included the buttermilk, which amounted to about 300 lbs. The skimmed milk was heated to 82°, the buttermilk was poured in and mixed well with it, and the whole was then allowed to stand until the entire mass was properly acid, as it is considered that thoroughly sour milk makes better cheese under this process than sweet milk. It was then heated to 86°, and at this point the anti-huffing extract, which is the peculiar feature of the process, was added in the ratio of 1 ounce to 100 lbs. of milk. This extract is composed of an alkali, which changes the milk from sour to sweet, and it is an antiseptic which acts as a preserver. For ten minutes the milk was continually stirred, in order to have the extract thoroughly distributed through it. Then the requisite amount of Hansen's extract of rennet was added; in eleven minutes the milk began to thicken, and in twenty-five minutes it was cut. The heat was then increased to 98° (this cheese being intended for a southern market), although ordinarily it would only be sealed to 94° or 96°, according to the weather. As soon as the curd was well separated from the whey, the latter was drawn off, leaving the curd perfectly sweet. The object then was to get it to press as soon as sufficiently cool, and the temperature was reduced to 70° by pouring on cold water. The curd was then salted at the rate of 3 lbs. to 100 lbs., which was rapidly but evenly mixed in, and then it went to press. It is considered of more importance to put the curd to press while still sweet than to have it thoroughly drained, as the whey will be squeezed out in the press.

"The most striking peculiarity of this process is its positive contrast with the old method. Instead of working a sweet milk up to an acid standard, it reduces sour milk to a perfectly sweet curd. The alkali used to effect this result is potash, a substance that is taken out of the milk along with the cream, and is as essential to its full value as any other constituent. Of course, there is always more or less fat which is not taken out of the milk by skimming, and it is claimed that the alkali 'saponifies' this fat so that it will not become rancid upon exposure to the atmosphere. During nearly the whole process, before setting and after cutting, the milk and then the curd was kept in a state of agitation by the hands and arms of the men working it. No curd-mill was used, Mr. Jocelyn claiming that he could make a better, finer, and more even curd by hand than he could by the use of a mill. The extract alone gives a rich color to the milk; but where a deep color is desired, annattoine is added in the proportion of about 1½ drachms to 100 lbs. of milk.

"It remains to give the result of operations upon the mass of milk of which we have been speaking. From this 1,504 lbs. of milk, 50 lbs. of butter and 146 lbs. of cheese were made. The average would be 1 lb. of butter to 2½ lbs. of milk, and 1 lb. of cheese to 10 lbs. of milk. This was in the latter part of October. Mr. Burrell was selling his butter at 35 cents per lb., and at the rate at which the cheese has sold during the past summer (1880), it is safe to say that this will bring 11 cents when it is ready for market. The total value of the products of this milk would therefore be 36.71 dollars, or an average of 2.44 dollars per 100 lbs. of milk—almost double the amount received by the patrons of our cheese-factories. We regret exceedingly that the process should show such a result, as it will have a tendency to draw full-milk cheesemakers into the skimming business. But we believe that, one of these days, a change must come over the cheese-trade. Either full-milk cheese must rise to a price which will make its returns commensurate with those of the butter and skimmed-milk cheese-factories, or cheese of the latter quality must be reduced to a much lower level in price. As the prospect of the latter alternative is rendered more unlikely than ever by the successful introduction of the anti-mottling and anti-huffing cheese extract, we shall expect to see our full-milk cheese establishments either driven to the wall, or else compelled to go into the manufacture of butter and cheese with the use of this extract. Mr. Burrell has been making this quality of cheese during the whole summer, and with astonishing results. It has sold far beyond his expectations. It seems to have kept
as well as full-milk stock. It shows up rich and stocky under the trier. And as the maker gains more experience in its manufacture, it steadily improves in quality. He is now making a lot of small cheese, weighing only 25 lbs. each, for the express purpose of shipping to the West Indies, to test their keeping qualities as severely the lowest and highest given in the catalogues of reliable American dealers in dairy implements and machinery for the year 1880. The different prices named for the same utensil indicate difference in quality, in kind or in pattern. For example:—A "factory-churn" may be a plain barrel of the Philadelphia pattern, costing only 10 dollars, or

List of Articles, with Prices, required to thoroughly Equip a Factory or Creamery receiving the Milk from about 500 Cows.

<table>
<thead>
<tr>
<th>ARTICLES</th>
<th>Whole-milk Cheese Factory</th>
<th>Cheese and Butter Factory</th>
<th>Pool and Pall Butter Factory</th>
<th>Pan or Vat Butter Factory</th>
<th>Butter Factory receiving only Cream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number and Name</td>
<td>From</td>
<td>To</td>
<td>From</td>
<td>To</td>
<td>From</td>
</tr>
<tr>
<td>1 Steam Boiler, Engine, Pump, &amp;c., 14 H.P. complete</td>
<td>300</td>
<td>400</td>
<td>300</td>
<td>400</td>
<td>300</td>
</tr>
<tr>
<td>2 600-gallon Steam-vats</td>
<td>120</td>
<td>150</td>
<td>120</td>
<td>150</td>
<td>120</td>
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<tr>
<td>4 300-gallon Cooling-vats</td>
<td>...</td>
<td>...</td>
<td>300</td>
<td>400</td>
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<tr>
<td>300 Deep Cooler Tanks</td>
<td>...</td>
<td>...</td>
<td>250</td>
<td>375</td>
<td>250</td>
</tr>
<tr>
<td>Cream-vats, 1, 2, or 3</td>
<td>...</td>
<td>...</td>
<td>20</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>1 Card-drawer</td>
<td>8</td>
<td>15</td>
<td>8</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>1 Card mill</td>
<td>15</td>
<td>25</td>
<td>15</td>
<td>25</td>
<td>15</td>
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<tr>
<td>1 Gang Cheese-press (or 2)</td>
<td>40</td>
<td>90</td>
<td>40</td>
<td>90</td>
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<tr>
<td>20 Cheese-hoops</td>
<td>60</td>
<td>160</td>
<td>60</td>
<td>160</td>
<td>60</td>
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<tr>
<td>1 Factory-churn</td>
<td>...</td>
<td>...</td>
<td>10</td>
<td>50</td>
<td>10</td>
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<tr>
<td>1 Butter-worker</td>
<td>...</td>
<td>...</td>
<td>8</td>
<td>25</td>
<td>8</td>
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<tr>
<td>1 Platform-scale for Milk</td>
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<td>50</td>
<td>20</td>
<td>50</td>
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<tr>
<td>1 Butter or Cheese Scale</td>
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<td>15</td>
<td>10</td>
<td>15</td>
<td>10</td>
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<tr>
<td>1 Salting-scale</td>
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<td>5</td>
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<tr>
<td>1 Receiving or Weigh Can</td>
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<td>Hauling-cans</td>
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<td>100</td>
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<td>Hoisting crane Fixtures</td>
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<td>Milk-spool and Conductor</td>
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<td>Curel knives</td>
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<tr>
<td>Syphon and Strainer</td>
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<tr>
<td>1 Set Creamery Glass-ware</td>
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<td>6</td>
<td>2</td>
<td>6</td>
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<tr>
<td>1 &quot;; Stenills and Markers</td>
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<td>6</td>
<td>2</td>
<td>6</td>
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<tr>
<td>Small Cheese Utensils</td>
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<td>6</td>
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<tr>
<td>Small Butter Utensils</td>
<td>...</td>
<td>...</td>
<td>3</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Tryers, Butter and Cheese</td>
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<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
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<tr>
<td>Kneat and Colouring Jars</td>
<td>5</td>
<td>15</td>
<td>5</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>Cleaning Utensils</td>
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<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Rubber hose</td>
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<td>6</td>
<td>4</td>
<td>6</td>
<td>4</td>
</tr>
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<td>Account Books</td>
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<td>5</td>
<td>2</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Plumbing, Scaffing, &amp;c.</td>
<td>25</td>
<td>50</td>
<td>25</td>
<td>50</td>
<td>25</td>
</tr>
</tbody>
</table>

Total ... ... ... ... ... 652 | 1,144 | 1,060 | 1,883 | 680 | 1,026 | 756 | 1,205 | 435 | 750

as possible. The success attained hitherto warrants the belief that there will be no failure in this experiment."

ESTIMATES AND COSTS.

To explain in detail the articles necessary for fitting out dairying manufactories of different kinds and the cost of the same, the subjoined list has been prepared. The size assumed is a capacity for the milk of 500 cows. For a smaller factory the fittings would cost nearly as much, and for one twice as large the equipment would cost only 20 or 30 per cent. more. The prices stated are the same of best finish, 22 dollars, or a 100-gallon "Blanchard," 45 dollars, or a gang box-churn, 60 dollars. Any one of these might serve the purpose, but true economy would dictate a churn costing 40 to 50 dollars for a creamery of the size assumed. Again, there is a great difference in the expense between fitting up a cheese-factory, with the old style single screw-presses and plain hoops of wood or metal, and giving it a full complement of gang-presses and patent self-bandaging hoops. Several articles named in the list might be dispensed with, while some managers would wish to add others.

H. E. A.
CHAPTER XXXIV.

Canadian Dairying.

Advantages Possessed by Canadian Dairymen—General Comparison of the Provinces—Present Supremacy of Ontario as a Dairy Province—The Maritime Provinces.

The dairying husbandry of the United States has been treated at length and elaborately in the preceding chapters; and the description may, to a great extent, stand for that of Canada as well, because there are so few salient differences between the practices of the two countries. A few general remarks, mentioning climate and other differences, so far as they may be said to exist, will be sufficient, and for details of the methods employed the reader must needs be referred back to American dairying. It would indeed be strange if the dairying of two closely-adjacent countries, whose boundary-line for the most part is not even a river, but has to be marked out on terra firma, and whose people and language are the same, should differ in any essential features beyond those which are easily accounted for in the difference of climate, and in the trilling variations of local practice; and it may be affirmed that differences quite as great are found within the limits of either country separately as are found between the two combined.

The southern latitude of Canada at its lowest point is that of Madrid, Rome, or Constantinople, and its northern terminates at the North Pole, so that it may be supposed to have all the climates of Europe from the Mediterranean to the Frozen Sea; still no part of Canada has a summer climate so unhealthy as that of Rome, nor is its general climate so fickle as that of Europe; as a general thing it may be said that the climate of Southern Canada resembles that of Western and Central Europe, except that its summers are somewhat hotter, and its winters as a rule more severe, yet neither the heat nor the cold of Canada is so hard to be borne as the same degrees are in Europe, mainly because the air is drier. Such a crop as Indian corn, which will seldom ripen in England or in the northern departments of France, is cultivated to a vast extent in the valley of the St. Lawrence, and in the north-west territory it comes to maturity in a latitude equivalent to that of Liverpool.

Over the United States, especially over the Western ones, Canada has the immense agricultural advantage of a summer rainfall, which prevents the land from being parched and scorched with excessive heat and drought. Wheat will ripen at latitude 58°, and barley at 65°, which is some three to four hundred miles north of the Orkneys and Shetlands; but this occurs only in the north-west of Canada, for in the north-east, in the direction of Hudson's Bay, the arctic currents that sweep down the coast of Labrador lower the temperature, and push further south the limits of grains and grasses. But wherever wheat and barley will ripen, in a climate whose summer rainfall can be depended on, there is a good prospect for grasses and roots and green-crops generally; and though the winters are severe, making the wintering of live-stock an arduous duty, they begin and leave off again with a regularity which enables the farmer to make nicer calculations than he can think of doing in the British Islands; and, as the frosts are keen, and last as a rule for a considerable period, the ground is mellowed and pulverised to a degree which greatly lessens the work of preparing it for the seed, while the gradual melting of the snow in spring gives to the soil a supply of moisture which is of great service to the newly-germinated seeds.
Over a considerable portion of the United States, west of St. Louis—west, that is, of the 98th meridian—the summer rainfall is altogether insufficient for the needs of vegetation. During four or five months of the year, and they the most important agricultural months, grasses cannot flourish, and roots and green-crops are out of the question, so that the vast district west of Illinois, reaching to the Pacific, is not adapted to dairying, and never can be, unless vast forests are planted to increase the rainfall, and irrigation works on a vast scale are carried out wherever water for the purpose may be had. All this tells against the expansion of American dairying to the almost unlimited extent which would otherwise have been possible; and Canada promises at no distant period of the world’s history to become almost as great a stock-raising and dairying country as its neighbour the United States—pursuits for which its soil, climate, and general characteristics appear to be eminently suitable. The soil and climate of Canada, in fact, throughout a vast area, are favourable to the growth of many useful pasture and forage grasses, and the country in general is well watered, while both the land and labour are cheaper, and taxation lighter, than in the United States.

The Province of Quebec possesses, in common with the maritime provinces of the Dominion, for the pursuit of dairy-farming, advantages which are unsurpassed, and probably unequalled, in any other portion of North America. Throughout the summer months the temperature is cooler and the rainfall greater than in the western or southern portions of the Continent. Proximity to the sea, to the St. Lawrence, the Saguenay, and the St. Maurice rivers, and to the innumerable lakes and streams which cover a large portion of the province, makes the climate moister, and secures excellent meadows and the best of pastures; and the rich bottom-lands or alluvial flats, so general alongside the larger rivers, especially of the St. Lawrence, are extremely fertile in the production of an abundance of food for cattle, while the general health of stock is excellent. Springs of pure cold water are found in many places, and in the winter a supply of ice for summer use may be secured with ease and facility; these advantages are of great value in cheese and butter making during the hot portion of the year.

In the neighbourhood of Montreal there is a large tract of country adapted to dairying; but it is the district known as the Eastern Townships, lying to the south of the St. Lawrence, and bordering on the States of Maine, New Hampshire, and Vermont, which may be regarded as, and will ultimately become, the best dairying region in the extensive and struggling Province of Quebec. Here the configuration of the country is rolling, and the soil, as a rule, is loamy; there are also many streams and running brooks—features that may be regarded as essential to a dairying and stock-raising country. So far, however, the province has not made the progress it might have done in agricultural pursuits. Live-stock of all kinds, especially dairy-stock, stand in need of cultivation and improvement, and the general condition of agriculture is far enough below its possibilities. Improvements, however, are now in progress, and as the province enjoys the advantage of a contiguous sea-board, which gives ready access to European markets, and as many of the populous places in the Eastern States are within easy reach of the southern part of it, we may expect dairy-farming to spread while it improves in many parts of Quebec.

At the present time Ontario is far ahead of any other province, alike in its dairying as a speciality, in the quality of its cattle, and in its agriculture generally. For dairying districts, many portions of both Eastern and Western Ontario are clearly well adapted. At a moderate expenditure of labour and money, large crops of various kinds of forage can be grown for winter feeding, while for summer use it is easy to have a succession of green-crops for soiling. For the former, timothy grass and red clover are extensively and most successfully grown; for the latter, clover and “green corn”—that is, maize planted thickly and cut green—are chiefly employed. In some cases maize is planted thickly in rows which are some 12 to 18 inches apart, horse-hoeed until it is far enough ahead of the weeds, and cut green as it is wanted. Portions of land may be planted at intervals, giving a succession of crops. If there happens to be more of the green corn than is wanted for soiling, it is a simple matter to stock it up in sheaves, each stock containing a dozen or more sheaves. In this form the corn stands well out in the fields, and is fetched in as it is wanted during the winter. To be utilised in this manner as winter-forage, it is considered expedient, and no doubt it is expedient, to cut the stalks while they
are still green, tender, and sappy, and when the ear of corn is still "in the milk;" this will be about the time when the plant has attained nearly its full growth in height. Cut at this period, the plant retains the nutritive properties which have been elaborated in it during its growth; it has a smaller proportion of woody fibre, is sweeter and tenderer, and an altogether better article of food for stock, smaller ones of which are either less numerous now than they were before the forests were cut away, or are dry when they are most wanted. This question, indeed, is one which forces itself on the attention of dairymen in most parts of North America, and it has to be met either now or in the future by wells and ponds and meres.

In various Canadian provinces cheese-factories
DAIRY FARMING.

chiefly shipped. This factory cost about 4,000 dollars, which includes the cost of some expensive implements that have been discarded. It has been built at three different times, each year making it necessary to increase the size. The buildings are 76 feet long by 26 feet wide. One department has a concrete floor; in this building six wooden vats are set, about 15 feet long, 3 feet wide, and 1½ feet deep. Tin vats are placed in the wooden ones, leaving a space between the two to allow cold water to run at the bottom and sides of the vats. The milk is poured into the vats at a temperature of 80° to 90°; it is then reduced to 60°. In addition to the cold water running around the vats, a zinc float having ice in it is put into the vats; this is floated up and down each vat until the temperature is sufficiently reduced; the milk stands from twelve to twenty-four hours, and is then skimmed. Before churning, the cream is allowed to "ripen," that is, to get a little sour, and care is taken to have it all in the same condition. They formerly used large upright dash churns, but these have been discarded, and the "Blanchard" churn is now used. They churn about 150 to 200 lbs. at a churning, and churn twice a day. The churning is done by steam; it is commenced with thirty revolutions a minute, and gradually increased to fifty. It takes from one to one and a quarter hours to churn. The butter is then taken to a worker, washed, worked, salted, and allowed to stand one day; it is then worked over and packed in firkins that have been soaked three days, then steamed for three hours in salt and water, and properly prepared. A cloth is laid at the bottom of the firkin and another on the top; the top is then covered with a thin layer of salt. The keg is then put into the store-room, which is kept nearly ice-cold; there it is safe for shipment at any time.

There is another room in which the engine and boiler are kept. The engine is only a 3 horsepower, but it has proved itself of sufficient power for the factory. Cheese is made from the skimmed milk, when the milk is only allowed to stand twelve hours. After the milk has been skimmed, steam is put into iron pipes that are laid in the bottom of wooden vats. The water is soon heated, and the heat is imparted to the milk in the tin vats; when at a proper temperature the rennet is put into the milk, which soon coagulates. The process is then gone through as in cheese-factories, and the cheese is taken to a drying-room. The skim-milk cheese sells from 4 to 6 cents a pound, and the butter fetches 120s. per 112 lbs. in the Glasgow markets.

A plentiful supply of good, cold, clear water is essential to a butter-factory. On a rising ground near this factory is a beautiful spring of water; this is conveyed to the factory in wooden pipes, and thence into iron pipes. An ice-house is close by.

As in the United States so in Canada, cheese-making has in the past had more attention paid to it than has the sister art of butter-making. Cheese-factories are more numerous than creameries, and so it follows that cheese has become more a centralised, while butter has remained more an isolated, manufacture, the one receiving collective and the other individual study and experiment. It is probable, however, that this disparity between the two industries will not exist in the future. Mr. Ballantyne, M.P.P., of Stratford-on-Avon, Ontario, is among the prominent men who have worked out the problem of factory cheese-making in Canada, and his efforts, along with those of other agricultural reformers, have done much towards raising the cheese of the Dominion in the estimation of English buyers.

Formerly there was great difficulty and uncertainty in making autumn cheese in Ontario; it was liable to be huffy and porous; and, as the whey was not always well got out of it, the flavour was frequently unpleasant. This difficulty has been completely overcome by "ripening" the milk before adding the rennet to it. Mr. Ballantyne thought the matter out in his mind, and urged it to us in this wise: the summer's milk kept through the night is not so deadly cold as the autumn's, and so is in a more natural condition; its warmth has brought it into that state which produces the best cheese—that is, it has ripened somewhat, because warmth as well as time is necessary to the ripening of anything. He declares his belief, further, that the best cheese cannot be made from fresh, warm milk; because, though it is, of course, warm enough, and has never been cold, it has not the required age, and so is unripe. Hence he prefers that one-half of the milk he makes cheese from should be twelve hours old, and this, being ripe enough in itself, ripens the fresh morning's milk when the two are mixed together. In summer the ripening of the evening's milk is enough for the purpose, but in the colder weather of autumn it is not, so the morning's and evening's milk are
warmed up together to a temperature of 90° or so, and allowed to stand several hours before the rennet is mixed with them for coagulation, and this is done because the autumn's evening milk has been too cold to admit of enough, if any, ripening. As the mass of milk stands at the tempera-

The best system the world knows for making plain "hard" cheese—consists in the ripening which the curd gets after separating it from the whey, and before salting and pressing it. This ripening comes of keeping the curd warm, and exposing it to the air. But even in the Cheddar system it is

### Population, Agriculture, and Dairying at various dates, relating to the Dominion of Canada.

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
<th>Persons engaged in Agriculture</th>
<th>No. of Cows</th>
<th>Butter made</th>
<th>Cheese made</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1867</td>
<td>3,918</td>
<td>(668 Families.)</td>
<td>1,500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1719</td>
<td>22,530</td>
<td></td>
<td>9,000</td>
<td>(18,241 &quot;cattle&quot; in all.)</td>
<td>...</td>
<td>Census of &quot;New France.&quot;</td>
</tr>
<tr>
<td>1765</td>
<td>69,816 (12,920 Houses)</td>
<td>22,748 (50,013 &quot;cattle&quot; in all.)</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>Census of &quot;Canada,&quot; which does not include Nova Scotia, &amp;c. Pop. of N. B., &amp;c., 1774-5, about 55,000.</td>
</tr>
<tr>
<td>1874</td>
<td>113,012 (18,924 Houses)</td>
<td>44,294 (58,594 &quot;cattle&quot; in all.)</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>Census of Upper and Lower Canada and Nova Scotia.</td>
</tr>
<tr>
<td>1827</td>
<td>774,279</td>
<td></td>
<td>...</td>
<td>378,031</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1843</td>
<td>1,663,941</td>
<td></td>
<td>...</td>
<td>562,563</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1852</td>
<td>2,312,919</td>
<td>215,079</td>
<td>739,238</td>
<td>32,336,397</td>
<td>4,384,719</td>
<td></td>
</tr>
<tr>
<td>1861</td>
<td>3,391,147</td>
<td>337,304</td>
<td>995,566</td>
<td>51,700,446</td>
<td>4,502,413</td>
<td></td>
</tr>
<tr>
<td>1871</td>
<td>3,738,546</td>
<td>455,064</td>
<td>1,592,839</td>
<td>75,635,381</td>
<td>2,277,747</td>
<td></td>
</tr>
<tr>
<td>1871</td>
<td>1,629,851</td>
<td>228,708</td>
<td>635,759</td>
<td>37,623,843</td>
<td>17,979,817</td>
<td></td>
</tr>
<tr>
<td>1871</td>
<td>1,191,516</td>
<td>169,641</td>
<td>446,542</td>
<td>21,281,127</td>
<td>2,252,015</td>
<td></td>
</tr>
<tr>
<td>1871</td>
<td>283,594</td>
<td>28,394</td>
<td>83,230</td>
<td>5,115,947</td>
<td>224,833</td>
<td></td>
</tr>
<tr>
<td>1871</td>
<td>387,809</td>
<td>48,709</td>
<td>122,688</td>
<td>7,161,867</td>
<td>1,244,833</td>
<td></td>
</tr>
</tbody>
</table>

1871 Census. *Number and Size of Farms in the Four (4) Chief Provinces, Dominion of Canada.*

<table>
<thead>
<tr>
<th>Province</th>
<th>No. of Owners</th>
<th>No. of Tenants</th>
<th>No. of Farms of 10 acres and below</th>
<th>No. 10 to 50 acres</th>
<th>No. 50 to 100 acres</th>
<th>No. 100 to 200 acres</th>
<th>No. Over 200 acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontario</td>
<td>144,212</td>
<td>28,046</td>
<td>19,354</td>
<td>38,882</td>
<td>71,864</td>
<td>33,984</td>
<td>7,754</td>
</tr>
<tr>
<td>Quebec</td>
<td>169,059</td>
<td>9,027</td>
<td>10,101</td>
<td>22,379</td>
<td>44,410</td>
<td>30,891</td>
<td>9,896</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>29,079</td>
<td>2,143</td>
<td>2,609</td>
<td>6,415</td>
<td>11,888</td>
<td>6,900</td>
<td>3,330</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>43,830</td>
<td>2,486</td>
<td>7,448</td>
<td>11,201</td>
<td>13,138</td>
<td>10,401</td>
<td>4,428</td>
</tr>
</tbody>
</table>

**Notes.**—1871: Four provinces, 333 cheese-factories, 938 employés, 120,000 dls. wages, 1,601,756 dls. factory cheese sold.

The cheese-making—which, by the way, is probably well known that autumn cheese does not mature like that of summer, and this Mr. Ballantyne declares is owing to the evening’s milk of autumn not having a chance to ripen like that of summer. Professor Arnold, an able exponent of the Cheddar system, has done much good in Canada in teaching dairymen how to manage floating-curd—that is, by exposing them longer in the vat, and by developing more acidity to checkmate the taint which is common to floating-curd. The milk is generally
delivered once a day to the Canadian factories, and the farmers, under pain of having their milk rejected, are required to take proper care of the evening's milk, and to deliver it in good condition at the factory. This done, the transit is supposed to do good rather than harm to the milk.

In the foregoing table we give a record of the population, agriculture, and dairying of Canada, from which will be easily gathered the rate of progress of the country up to the year 1871, when the last census was taken. It will be noticed that the great bulk of farmers own their land and farm it, and that there are more farms of 50 to 100 acres than of any and all sizes below those limits on the one hand and above them on the other.

The ordinary mode of disposing of cheese in Canada is for the buyers to visit the factories weekly to see that the quality is right, and either buy the cheese on the spot, or at the adjacent towns on market days. The districts being extensive and the factories some distance apart, it is next to impossible to take the cheese in bulk to market, and to obviate this the buyers inspect the cheese where it is made. In other cases cheese is bought from sample, and in yet others it is contracted for at a given price for the season. When the cheese is sold, the farmers haul it in their waggon to the railways, whence it is taken to the shipping ports. Special trains run on stated days for the conveyance of cheese and butter, and in the summer months refrigerator cars are used to preserve the goods from injury by heat during the transit. The trains commonly run close up to ships that are about to sail; the cheese and butter are taken on board the last thing, are on their way to England or Scotland without delay, and are unshipped before any other lading is, on arrival on this side.

In 1865 Canada imported cheese from the United States to the value of 200,000 dollars, her own production being not enough for her own wants; but since that period the establishment of factories has so increased the production, that she not only supplies the wants of an ever-increasing population, but exports large quantities to the mother-country. The production and exportation of dairy products from Canada are destined to increase, and in course of time to exceed, in all probability, those of the United States.

In the table given above, for which we are indebted to Professor George Buckland, of the Department of Agriculture and Arts of Ontario, we give a statement showing the quantity and value of butter and cheese exported from the Dominion of Canada during the thirteen years ending 1880.

**Exported from the Dominion of Canada.**

<table>
<thead>
<tr>
<th>Years</th>
<th>Produce of Canada</th>
<th>Foreign Produce</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value</td>
<td>Value</td>
</tr>
<tr>
<td></td>
<td>Quantity</td>
<td></td>
</tr>
<tr>
<td>1868</td>
<td>10,049,783</td>
<td>1,056,942</td>
</tr>
<tr>
<td>1869</td>
<td>10,806,361</td>
<td>1,342,270</td>
</tr>
<tr>
<td>1870</td>
<td>12,293,887</td>
<td>2,353,570</td>
</tr>
<tr>
<td>1871</td>
<td>15,492,286</td>
<td>3,605,228</td>
</tr>
<tr>
<td>1872</td>
<td>19,062,447</td>
<td>3,612,879</td>
</tr>
<tr>
<td>1873</td>
<td>15,205,633</td>
<td>2,868,879</td>
</tr>
<tr>
<td>1874</td>
<td>12,235,046</td>
<td>2,620,805</td>
</tr>
<tr>
<td>1875</td>
<td>9,328,014</td>
<td>2,357,324</td>
</tr>
<tr>
<td>1876</td>
<td>12,239,066</td>
<td>2,541,804</td>
</tr>
<tr>
<td>1877</td>
<td>14,691,799</td>
<td>3,073,409</td>
</tr>
<tr>
<td>1878</td>
<td>13,060,623</td>
<td>2,382,257</td>
</tr>
<tr>
<td>1879</td>
<td>14,363,977</td>
<td>2,181,807</td>
</tr>
<tr>
<td>1880</td>
<td>15,256,362</td>
<td>3,058,099</td>
</tr>
<tr>
<td></td>
<td></td>
<td>352,341</td>
</tr>
</tbody>
</table>

**Cheese.**

<table>
<thead>
<tr>
<th>Years</th>
<th>Produce of Canada</th>
<th>Foreign Produce</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value</td>
<td>Value</td>
</tr>
<tr>
<td></td>
<td>Quantity</td>
<td></td>
</tr>
<tr>
<td>1868</td>
<td>6,141,570</td>
<td>629,543</td>
</tr>
<tr>
<td>1869</td>
<td>4,908,370</td>
<td>549,572</td>
</tr>
<tr>
<td>1870</td>
<td>5,827,782</td>
<td>674,486</td>
</tr>
<tr>
<td>1871</td>
<td>8,271,130</td>
<td>1,109,960</td>
</tr>
<tr>
<td>1872</td>
<td>16,234,025</td>
<td>1,540,294</td>
</tr>
<tr>
<td>1873</td>
<td>19,183,211</td>
<td>2,260,412</td>
</tr>
<tr>
<td>1874</td>
<td>21,050,982</td>
<td>3,523,291</td>
</tr>
<tr>
<td>1875</td>
<td>32,342,030</td>
<td>3,806,236</td>
</tr>
<tr>
<td>1876</td>
<td>35,624,690</td>
<td>3,551,268</td>
</tr>
<tr>
<td>1877</td>
<td>35,560,524</td>
<td>3,749,585</td>
</tr>
<tr>
<td>1878</td>
<td>38,054,284</td>
<td>3,992,521</td>
</tr>
<tr>
<td>1879</td>
<td>46,141,635</td>
<td>3,780,360</td>
</tr>
<tr>
<td>1880</td>
<td>46,368,675</td>
<td>3,672,434</td>
</tr>
<tr>
<td></td>
<td></td>
<td>61,698</td>
</tr>
</tbody>
</table>

**Notes on the Dairying Industry of the Maritime Provinces, specially of Nova Scotia.**

*By George Lawson, Ph.D., LL.D., F.I.C.*

In order to give a correct indication of the present state of the dairy industries in the maritime provinces, it is necessary to refer briefly to the agricultural conditions of those countries, which
differ essentially from Ontario in depending less upon wheat-growing and the raising of beef-cattle, and more upon the productions of the forest, the mine, and the sea. The "Maritime Provinces" (as they are called) consist of New Brunswick, Nova Scotia, and Prince Edward Island; to the eastward of these lies the large island of Newfoundland, whose bays and banks have been so long and favourably known, in common with their fisheries. Of the three confederated provinces, the smallest, Prince Edward Island, is most exclusively devoted to agriculture, whilst Newfoundland, geographically although not yet politically connected with them, is dependent upon its neighbours to a large extent for agricultural supplies. In Prince Edward Island the soil is light, easily worked and free from stones, and there are extensive deposits of mussel-mud at or below low tide-mark, which serves as a valuable fertiliser to lands near the shore. Large quantities of barley, oats, potatoes, besides butter, poultry, eggs, and other produce, are annually exported, chiefly in the fall of the year (before the ice forms around the shores), to the adjoining provinces, to England, and to the United States. There is a Government stock-farm at Charlottetown for the improvement of dairy and other stock, and the interests of agriculture are steadily, if not rapidly, advancing. Dairying and cattle-rearing appear to be subsidiary to the raising of grain and potatoes, so far as the supply of foreign markets is concerned. In New Brunswick, which is of great area, but only partially cultivated, grain-growing and dairying are both practised to a large extent, although a considerable portion of the rural population are engaged during a part of the year in the wild forest lands, chopping logs and bringing them down the rivers to the numerous and extensive saw-mills. Increased attention is being given to agriculture ; the Provincial Government make frequent importations of thoroughbred stock from Ontario, England, and the United States, and agricultural exhibitions are held under Government sanction for the reward of successful cultivators and stock raisers. For many years Jersey and Argyshire stock have been raised to some extent in New Brunswick, and have tended to improve the dairy qualities of the cattle generally. The occupations of the people of Nova Scotia are more diverse than those of the other provinces, for, whilst large numbers are engaged in lumbering, shipbuilding, and the fisheries, no inconsiderable portion find remunerative employment in the coal and gold mines, and the quarries of gypsum, grindstone, and sandstone. In Nova Scotia as in New Brunswick, so large a number of the people being engaged in other than agricultural pursuits, there is a home market for country produce which prevents the dairy and other farm products from obtaining as much attention in foreign markets at present as they are likely to command in the future. Notwithstanding the diversity of industries in Nova Scotia, dairy-farming is carried out to a greater or less extent, and with greater or less success, throughout the whole country, and not alone by the class who are properly styled farmers, for many of the fishermen and lumbermen, who can only ply their vocations during a portion of the year, have small farms by which they are enabled to supply at least their own domestic wants in the way of milk, butter, cheese, pork, poultry, and other produce. The possession of land and one or more cows by the lumbermen and fishermen generally throughout the province, although it does not make any show in the exports, forms a very important factor in the real wealth of the country, and the comfort of the people, who have thus, even in the most adverse of seasons, the means of healthy subsistence. In Nova Scotia the rural population never want for the necessaries of life.

Where the attention is divided between different occupations, we are not to expect the best methods of cultivation, the most improved implements, the finest live-stock, or rapid progress in the adoption of new processes. Accordingly in many parts of the country, especially in the shore counties, there is much room for improvement, much poor cultivation, and imperfect management of dairy-stock. Where holdings are small and scattered, the improvement of live-stock is especially difficult, as it is not profitable (even if it were practicable) for a fisherman-farmer to purchase an expensive male animal, and the distance of neighbours prevents combination for this purpose. It is otherwise in many inland localities where farming is the exclusive or principal pursuit, and particularly around the bays and estuaries, where rich dyke-lands have been reclaimed from the sea, or where extensive deposits of marine marsh-mud prevail; under such circumstances agriculture is conducted on a larger scale and in a more systematic manner, the newest
improvements in implements are introduced, and attention is specially given to the character and management of the live-stock. The dykes under proper management yield crops of timothy hay (Phleum pratense) of from two to three or more tons per acre, which supply feed for the winter, and the “after-grass” furnishes, during the autumn months, an abundant and rich pasturage, which greatly promotes the flow of milk. The marine marsh-mud and mussel-mud are used for spreading on the uplands, and are found to be very efficacious not only in promoting the growth of grass for hay, but also in yielding large crops of excellent potatoes and other roots. The cultivation of grain, and especially of wheat, has for many years been rather neglected, on account of the markets being filled with flour and grain at low prices from Ontario and the western States; but within the last year or two farmers have become more alive to the importance of grain-growing in a regular system of husbandry. From these explanations it will be seen that the Nova Scotian farmer cannot avail himself of straw and grain cleanings, which are so useful as winter feed to stock in essentially grain-growing countries, but that the abundant crops of hay and the excellent pasturage throughout the whole summer and autumn months make up for the deficiency, and specially indicate an adaptability of the country for dairy-farming. Turnips and mangels thrive well in all parts of the country, and there is a tendency to increase in their cultivation, the chief obstacles apparently being the expense of summer labour and the want of manual skill in hoeing.

We have no reliable statistics of the dairy-produce of Nova Scotia since 1871, when the general census was taken. It is certain that there has been a steady increase in all such products, as well as in all the field products of the country, since that year. The quantity of butter produced in 1871 was upwards of seven millions of pounds (7,101,867 lbs.). The production of New Brunswick during the same year was nearly a third less, the exact quantity being 5,115,917 lbs. Analysing the returns of the several counties, we find that the smallest quantity was produced by Queen’s, one of the Atlantic shore counties, viz., 132,453 lbs.; the largest by Pictou County, which bounds on the gulf shore, opposite Prince Edward Island, 804,661 lbs. A large portion of the inhabitants of Pictou County are of Scotch descent. The quantity of home-made cheese produced in the Province of Nova Scotia in the year 1871 was 884,853 lbs., the quantity made in New Brunswick in the same year being not much more than a sixth of that amount, viz., 151,758 lbs. The principal cheese county in Nova Scotia is Annapolis, which furnished 270,306 lbs.; Halifax, a very large county, which embraces the City of Halifax, the great local mart for all produce, manufactured only 252 lbs. of cheese, all of which, except 12 lbs., was made in the eastern division of the county. Since 1871 a great change has taken place in the cheese manufacture. No doubt the quantity of “home-made” cheese is less now than formerly. But the total amount of cheese produce in the country must be greatly in excess of the records of 1871, for, within the last five or six years, cheese-factories have been established throughout the country, particularly in the counties of Colchester, Annapolis, and Pictou. The factories are light wooden structures, with appliances sufficient for working up the milk of two or three hundred cows. The milk is brought by the farmers, or by special carriers, an account of its weight kept, and it is paid for at a rate proportionate to the profits of the factory or market value of the cheese produced. Although all these factories are worked on a more or less co-operative system, experience has introduced variations in the business management in different localities. The whey is used for the fattening of pigs, and may be carted home in casks to the farm, or the farmer may send his pigs (limited in number to the quantity of milk he supplies) to the factory, where there are pens furnished with troughs, into which the whey is conducted as it drains away from the curd-vats.

The common cattle of Nova Scotia vary much in size and appearance in different districts, and even in the same district, although they are commonly spoken of as the “native breed.” They are rather distinguished for their hardiness and suitability for rough pastures than for size or beef qualities, yet many of them are excellent milkers. No disease is ever known among them. For fifty years or more Guernsey stock has been in use in the neighbourhood of Halifax, and the male calves of the Guernsey cows, sent year by year from the city to various parts of the country, have improved the milking qualities of the cows in many districts. Cows are frequently found giving exceptionally large yields of milk, or milk of remarkable rich-
ness, well adapted for butter-making, and in such cases it is usually found on inquiry that they have inherited some Guernsey, Jersey, or Ayrshire blood. Within the last twelve years the improvement of the neat-stock has been systematic and rapid. Commencing with the year 1866, the Board of Agriculture, acting under the Government, have made regular importations of thorough-bred stock to supply the wants of the various Agricultural Societies. Ayrshires have been imported from Scotland and from the Provinces of Quebec and Ontario, Devons and Shorthorn Durhams from England and Ontario, and Jerseys from the United States. Twelve years ago there was not a single pedigreed animal in Nova Scotia. Now there are of thoroughbred registered animals in the province:—160 Shorthorns, 200 Ayrshires, 100 Devons, 50 Jerseys, 4 Guernseys, besides many animals whose pedigrees have not been preserved, especially of the last-named class. As the herds of thoroughbred animals are being rapidly swollen, not only by natural increase, but by yearly or more frequent importations from abroad, and there are at present hardly any exports of this class of stock, it will be seen that the domestic animals in Nova Scotia must be very rapidly undergoing change. There are eighty agricultural societies spread over the eighteen counties, and every society is enjoined by the Central Board to maintain a certain number of bulls (proportionate to the financial ability of the society) for the improvement of the stock in the district. In this way it is hoped, before very many years, to effect a complete change in the character of the live-stock of the whole province. In rich agricultural districts where the raising of cattle for beef is a principal object, the Shorthorns are chiefly in favour, and grade oxen of this breed are now becoming common. Where cattle are used for working as well as for beef, the Devons are to be preferred. In the dairy districts the preference for Ayrshires is very decided, and is now beginning to extend to Jerseys and Guernseys, pure or grade Ayrshires being found most useful for cheese-making, whilst the admixture of Guernsey and Jersey blood increases the proportion of cream and capacity of the milk for butter-making.

The depression of trade during the last year or two has given an impetus to agriculture in Nova Scotia. The country is naturally adapted for dairy-farming. Should the spirit now evoked continue, it may be expected that before many years the butter and cheese produced on the rich pastures of this cool healthy country will make their mark in the markets of Europe and America, as the unrivalled fruit of the extensive apple orchards has already done.
CHAPTER XXXV.

CONTINENTAL DAIRYING.

France—Sweden—Russia—Denmark—Germany—Austria—Switzerland—Italy—The Netherlands.

As the nearest to us, we commence a notice of the Dairying of the Continent with

FRANCE.

On the one hand the dairy industry of France is stimulated by a very large home consumption of cheese and butter, and on the other by an extensive export trade in the latter article, and a not inconsiderable one in the former. The Normandy and Brittany butters have long been well received in English markets, where they have obtained a position from which they will not easily be displaced, and they are also exported in considerable quantities to tropical climates, chiefly to Brazil and the South American Republics. Dairy-farming is also extensively followed in all the north-western departments of France, in some districts very successfully, on systems from which British farmers may copy much that will be to their advantage. The leading features in them are arable cultivation of the land in certain districts, minute care and cleanliness in the manufacture of the butter, and surpassing neatness in the methods of packing it for the market.

Mr. H. M. Jenkins says*: "The extent of business done by some of the French butter merchants is astonishing. For instance, the firm of Lepelletier, of Carentan, whose trade is solely with England, send the butter over in their own vessels, and in 1877 their exportation exceeded 4,000 tons, and the estimated average value in France for the ten years then ended was nearly half a million sterling per annum. They estimated that in 1878 their trade would show an increase of 30 per cent. over its average amount in the previous ten years.

"French butter is sent to market in a great variety of packages, according to the requirements of each locality. For the London market kegs holding about 70 lbs. each, crocks holding 50 lbs., and boxes containing one dozen 2-lb. rolls are most frequently seen. Extreme cleanliness and refreshing neatness (amounting almost to what the French call coquetterie) are characteristic of all the methods, and they are further distinguished by the free and almost lavish use of clean linen linings. The crocks and linen linings cost about 1s. 9d. each; the crocks, which are protected by an outside basket, and also lined with linen, cost about 2s. each, including everything; and the boxes holding a dozen rolls cost about 9d. each, including linen and paper. In the hottest weather the boxes are sometimes double, the space between the two boxes being filled with cotton wadding. In fact, the French butter-merchants thoroughly realise the importance of delivering their wares in an attractive condition, entailing neither trouble nor waste upon the retailer. On this point I may be allowed to quote the remark of an English friend:—'My cheese-monger said to me the other day, 'Look here at this French box. I open it' (which he did); 'here is the butter fit to weigh out to you without an atom of loss. Now let us break open this cask of Irish: you see I have to scrape it all round and lose a lot, besides the trouble.'" Small tins for exportation to the tropics add something considerable to the price of the butter—namely, in round numbers, 2½d. for 1-lb. tins, 3½d. for 2-lb. tins, and 5d. for tins holding 4 lb. Tins the cost per lb. decreases very rapidly in proportion to the augmentation in the size of the tin."

The cheese-making of France, as of most other Continental countries, is wholly different in cha-
racter from that of England, and it is distinguished by a much greater variety of features. While in England scarcely any sort but hard cheese is made, in France there is little else than soft varieties, most of which ripen in a short time and yield a quick return to the farmer. These soft cheeses are small in size and pungent in flavour, generally speaking, and are used less as a food and more as a flavour than is the case with English cheese. Many of the French kinds of cheese, varying in shape and size, look very much like cream-cheese that is mouldy with age, and some of them are not unlike it in texture and flavour. Being wholly different in all the essential points, and not less so in appearance than in flavour, from English cheese, they do not at present, save to a limited extent, appeal to the tastes of the English people; for though considerable quantities of the more famous kinds are sent to this country, they are required for the most part for the use of foreign residents, and it is probable that they will not, for a long period, become so generally used in this country as to encourage the English farmers to undertake the making of them. At the same time it must be admitted that our national taste is undergoing more or less of modification, so far as dairy products are concerned; and it is none the less true that these various foreign cheeses could be very closely imitated in this country by simply adopting the foreign methods of making.

There are, however, two conspicuous exceptions in France to the general run of soft cheeses, and these are the justly famous Gruyère and Roquefort. The former of these is certainly as "hard" a kind of cheese as we usually find made in English dairying districts, and the Roquefort is not in any sense a soft cheese. Gruyère is usually associated with Switzerland, but large quantities of it are made in France; it has a peculiar flavour which is very acceptable to those who are used to it, but it is less tender in texture than a ripe English cheese. It is usually made in very large sizes, flat, but of considerable diameter, and in appearance it is one of the handsomest, as in flavour it is one of the most pleasing kinds of cheese made anywhere. Hard, like the English cheese, yet very different in other respects, these two kinds are better known in England than any other of the French cheeses. The Gruyère is made from cow's milk, and in many countries, but the Roquefort is confined to the south of France, and made from the milk of sheep and goats. We come now to the dairy methods of the country.

**Milking.**

The cows are milked mostly twice, in some cases three times per day. Wooden milking-pails are still in use generally, though in not a few dairies tinned pails are preferred. For transporting the milk short distances, for instance, from the stable to the dairy, iron or wooden tubs holding 9 to 18 gallons are carried on a pole by two men. To prevent spilling, a wooden dish is allowed to swim on the surface of the milk. In the department of Bessin the milk is carried in jugs (Fig. 304), which are placed in wickerwork baskets after the Dutch fashion. The milk is passed through a sieve (Fig. 305) of wood or tin. The first consists simply of a wooden funnel, the aperture being stuffed with a bunch of clean straw; but the latter, which is in use in the improved dairies, has a fine netting of horsehair, which keeps back effectually all impurities. Another kind of sieve is used in the Bessin. It consists of a wooden bowl without bottom, and is laid out with a piece of linen. In the Calvados tin sieves (Fig. 306) are employed, laid out with linen.

**Transport of Milk.**

If the milk has to be taken a long way, tin cans (Fig. 307) are used. Very great care is taken in France as to the treatment of milk required to stand a long transport, and we think that the immense consumption of Paris is not the least reason for it. Paris consumes no less than 50,000 gallons a day of milk, which is brought by rail, not counting the considerable quantities produced in the suburbs and around them, which are transported by cart,
making in all an estimated 70,000 gallons per
day. As to the prices, the farmers are gene-

rally paid 10 to 13 c. (1d. to 1½d.) per litre (1½ pints),
by the wholesale dealers,
who supply the retailers in
Paris for 20 to 22 c. (2d.),
while the consumer must
pay 25 to 30 c. (2½d. to 3d.) per litre; some of the
leading dealers, who send
out their milk in a most
cleanly manner in sealed
cans, can command 70 c.
(7½d.) per litre, or 45 c.
(4½d.) per half-litre,
delivered at the house. Milk
from the suburbs or the
town itself, "baby's milk," as
it is called, is much
more expensive; 35 c. to 1
franc (3½d. to 1½d.) per
litre, or 4d. to Is. per quart. The treatment
of milk destined for the Parisian market is the
following:-The morning’s milk arrives at the
depôts, from whence it is sent to Paris, at 8 or
10 a.m. It is then poured
into tin pails (Fig. 308),
which are placed in the water-
bath (Fig. 309),
which has been
previously
heated to the
boiling-point.
After the milk has
reached
206° Fahr. it
is cooled as rapidly as possible by pouring it
back in the railway-cans, and putting these
small tube (f) allows the air to escape when milk
is poured in. In the lower part of the funnel at
a—b a perforated tin disk, and at c—d a fine metal netting are placed, which can be taken out for cleaning.

**Milk-setting.**

In France the utensils for milk-setting are still very undeveloped in shape, and often positively bad. We only mention the earthenware milk-pots of the Bretagne, &c. (Fig. 314), the Bessin (Fig. 315), and Isigny (Fig. 316). Flat dishes are also used a great deal. For taking the cream off, shells, tin and wooden spoons, sometimes perforated, are employed. The newer methods of milk-setting have as yet found few friends in France.

**Butter-making.**

The most famous French butter is made in the Bessin district of Normandy, and is known as Isigny butter. The best dairies in this district (Fig. 317) are built and arranged with special regard to cleanliness and uniform temperature, and no pains are spared to produce an article of the finest quality. The process is described by Mr. H. M. Jenkins in the following manner:

"In this district the cows are milked morning and evening, and in some cases three times a day, into jug-shaped vessels, made of copper lined with tin, and holding about 2 gallons each. The milk is taken to the dairy, and that from the several cows being more or less mixed together, it is strained through a sieve lined with clean linen into earthenware buckets. These buckets are placed in a row in the milk-house, generally on a course or two of brickwork raised above the general level of the floor, and the milk is then set for twelve hours. The cream skimmed after the first twelve hours is not mixed with what is taken off afterwards until immediately before churning, and in some instances butter of exceptional delicacy for Paris is made entirely from the twelve hours' cream. Some farmers let the milk stand twenty-four hours in summer and forty-eight in winter, and others even longer still, but it is almost needless to add that they do not get the best price for their butter. Nor does the increase in quantity which they obtain compensate them for lack of quality.

"The cream is churned twice or three times a week in a barrel churn. Generally the true Norman barrel churn is used (Fig. 318). It has fixed dash-boards, and they do not extend to the circumference of the churn. Thus the only corners where butter or buttermilk could lodge are very small ones at each end of the dash-boards. The
dash-boards are perfectly plain laths, and the churn altogether is a model of simplicity and effectiveness, completely illustrating the truth of the conclusion arrived at by the judges of dairy appliances at Bristol—"that numerous and large dashers are a mistake." According to the size of the churn, it is furnished with one or two large openings, which are opened and shut by one of the usual contrivances employed in other barrel churns. There is also a vent-peg placed in or near the head, and intended to be used as a ventilator if necessary, and a spigot placed in the bulge midway between the two large openings of a large churn or opposite the large opening of a small one. This spigot plays an important part in the process of butter-making.

"The churn is about half filled with cream, at a temperature more frequently guessed at than tested—of about 57° Fahr., and the best butter-makers do not churn at a greater pace than from thirty to forty revolutions per minute, according to the season. As a rule, the butter comes in from twenty to thirty minutes, and the churner listens most attentively so as to detect in an instant the slightest alteration in the sound of the churning cream. An alteration being detected, or even being thought to be detected, the churn is at once stopped, in such a position that the spigot is at about the level of the cream in the churn. The spigot is then carefully withdrawn, and the adherent matter minutely examined. If this is still cream, the churning is renewed and the sound carefully attended to; but if, on the contrary, there are particles of butter on the spigot, no larger even than a pin's head, the churning proper is finished. A quarter of a turn of the handle now brings the spigot to its lowest (nearest the ground), and immediately beneath it is placed a sieve over a vessel to receive, or over a conduit to carry away, the buttermilk. The spigot being then slightly drawn out, the buttermilk escapes and filters through the sieve, which retains even the smallest particle of butter which may be carried out with the buttermilk. When most of the buttermilk has thus been withdrawn from the churn, the small quantity of escaped butter is replaced in it, and fresh spring water is also put into the churn until it is half full. Three or four turns are then given, and the mixture of water and buttermilk is again withdrawn as before. This process is repeated, often seven or eight times, until the water which comes out of the churn is as bright and as clear as when it was put into it.

"These various washings and turnings completely cleanse the butter from the buttermilk from which it had been separated during the process of churning, and at the same time they consolidate gradually the particles which have been individually thoroughly scoured. At the end of the process the butter may be seen floating as one mass in a small lake of clear water. When removed from the churn by means of large wooden spoons or spatula, the butter requires no more working than is sufficient to solidate it and express the particles of clear water from its interstices. The
butter thus made goes direct to Paris, and I am informed on high authority that the farmer

receives for it as much as 2s. and upwards per English pound, according to the season. 

"The mere fact of such high prices being given for first-class butter implies that there is comparatively little of it. In fact, it may be safely asserted that none of it comes to England, and that the butter which is still good enough to command higher prices than our own on the London market is made with far less care and skill than that just described. A careful inquiry into the manner in which butter is made in the several districts of Normandy has convinced me that, other things being equal, the quality of the butter depends upon the earlier or later period at which the washing in the churn is commenced. This is so far recognised by some of the dairy-farmers that they have their churns fitted with a glass window to enable the eye to see, and thus assist the ear to hear when the butter first begins to be formed."

The butter of Isigny is formed into conical lumps (Fig. 319), wrapped in a piece of clean linen, and put each into a wicker or wooden basket lined with straw and sewed up with some coarse linen (Fig. 320). The superior brands of this butter go mostly to Paris, the good and middling qualities are bought up by dealers, assorted, salted, and exported to England. The butter of Gournay has also a very good name, and fetches, after Isigny, the largest prices in the market. The fabrication resembles very closely the one just described. When the butter has formed into pellets of the size of a pea, the stopper is taken from the small opening of the barrel churn, and the buttermilk allowed to run out through a hair-sieve to collect the small particles of butter, which will come out, though one is careful to cover part of the hole with his fingers. Then the stopper is put back, the butter on the hair-sieve having been returned, and cold water is poured into the churn. After turning a few times the water is drained off, fresh water added, and this is repeated until it runs off quite clear.

The butter de la Prevalais (Ille et Vilaine) is also well known enough, but is an inferior production, only made marketable by an immense amount of labour bestowed on it, which might be much lessened if the dairying was reformed there in principle. The cows are milked at 3—5 a.m., and again at noon, but not in the evening. Special dairies are very scarce, and mostly the milk is kept in the kitchen. The milk is set in unglazed earthenware pots, containing 2 to 4 gallons. Of course they require a daily boiling in water and a great deal of scrubbing to keep them clean. With the exception of some dairies which make sweet butter for neighbouring towns, the milk is allowed to turn sour before churning. Whether sweet or sour butter is made, a part of the milk is added to the cream for churning. The churns used are the common cylindrical or slightly conical tubs, and their movement is sometimes made easier by

simple mechanical means (Fig. 321). When the butter has formed into pellets, they are taken out with a spoon and put into a flat wooden dish (Fig. 322), where they are worked by hand for a long time, but without using any water. Indeed, this
butter is very often overworked, and therefore not durable but greasy.

Finistère has a dairy industry rich in original details. Considering that these are the result of superstition or ignorance, it may be believed that dairying in these districts is still at a very low point. We will only mention that unsalted butter is deemed unhealthy, and is therefore salted immediately after making. Also skim-milk in an unboiled state is thought injurious to the health, and together. In other cases the milk is not skimmed until after it has turned sour, which comes to nearly the same thing, as the souring of the milk causes the separation of a portion of the curd from the whey. The objects in view are to increase the quantity of so-called butter, and to obtain a constant supply of curd, which is a staple article of food for the Breton labourers who are fed on the farm, and indeed for people in more affluent circumstances. It need not be said that the money return from such an attempt to do two things together—namely, cream-rising and curd-separating—that ought to be done in succession, is not favourable to the pockets of those who follow it; but the Breton is, more than any other Frenchman,

<table>
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<tr>
<th>Classification of French Cheese.</th>
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<tr>
<td>I. Fromages de consistence molle.</td>
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<tr>
<td>(Soft cheese.)</td>
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<tr>
<td>1. Fromages frais. (New cheese.)</td>
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<tr>
<td>2. Fromages affinés. (Improved cheese.)</td>
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<tr>
<td>II. Fromages de consistence solide ou pâte ferme.</td>
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<tr>
<td>(Hard cheese.)</td>
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<tr>
<td>1. Fromages pressés et salés. (Pressed and salted cheese.)</td>
</tr>
<tr>
<td>2. Fromages cuits, pressés et salés. (Cooked, heated, and pressed cheese.)</td>
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may not be brought to the market without being boiled, wherefore it is boiled in pots until the surface is covered by a thick skin. In this state it is brought to the market, and the price is put the higher the thicker the skin. Another kind of milk is prepared by boiling whole milk with a little old, soured milk; it is called le gros lait. The churning is only done once or twice a week. The production of butter in the Finistère is very considerable.

Some French methods of butter-making are none of the best, and Mr. Jenkins speaks of them in the following manner:—"In the different parts of Brittany, butter is made by systems which vary between that of Isigny, already described, to the churning of a mixture of cream and curd. In the most pronounced of the latter methods the milk is actually curdled by artificial means, so that to a certain extent curd and cream may rise obstinate in his adherence to old practices, which even time and tradition should allow to be more honoured in the breach than the observance."

**Cheese-making.**

Pourian gives the above table of cheese made in France.

**Maigres, mous à la pie (Skim-milk, New Cheese).**

—The milk is left to stand until soured, when the cream is taken off and the curd filled into a form of wood, iron, or earthenware (Figs. 323, 324, 325),
and placed on a table on which the whey is collected and drained off (Fig. 326). From a gallon of milk about one pound of this cheese is made, which is eaten fresh with a little salt added.

**Fromage blanc** (White Cheese).—This cheese is made by the great milk-dealers of Paris from the milk left unsold on their hands. The skimmed milk is left alone for twenty-four hours to three days, according to the season, but before it gets thick. The milk is warmed to 77° Fahr., and then the rennet is added. When thick the curd is carefully put in successive layers into wooden forms, consisting of a hoop, the bottom of which is covered with wickerwork. These hoops are 12 inches in diameter, and about 2 inches high, and are placed on little straw mats. After the whey is drained off, the cheeses in their hoops are put into tin receptacles made for this purpose (Fig. 327) for transportation. In the shops these cheeses are kept on perforated tin plates, so as to allow the whey to run off, which is still let out by the cheese.

**Fromage à la crème** (Cream Cheese).—In Paris cream cheese is universally liked, and almost every visitor during the season has seen the people carrying in baskets the heart-shaped forms of wickerwork containing the favourite *fromage à la crème*. Fresh curd is allowed to drain very completely, and afterwards thoroughly mixed with cream, for which operation a small tin trowel is used. When the mass has become a homogenous paste, a wickerwork form (Fig. 328) is lined out with a piece of fine linen and filled with curd, which is pressed down with a trowel or spoon. In two hours the cheeses have acquired enough firmness to keep their shape, and they are sold as soon as possible, to be eaten with some fresh, sweet cream. In the summer months large quantities of this cheese are daily sent to Paris from the départments. There they are generally made of whole milk.

**Fromages de Neufchâtel frais** (Fresh Neufchâtel Cheese).—This cheese is of cylindrical shape, about 3 inches high and 2 inches in diameter. To whole milk about half its volume in cream is added from other milk, and it is then coagulated with rennet. The curd is left standing until the whey is mostly separated, and then filled in the forms, breaking it as little as possible. It is slightly pressed by putting a small weight on the top, and the linen wrapped round it turned every hour. When it has acquired the necessary consistency, it is taken out of the form, wrapped in thin blotting-paper, and placed on straw, where it keeps for ten to twelve days.

**Coulommier frais** (Fresh Coulommier Cheese).—These cheeses have a diameter of 5 inches, and are rather more than 1 inch in height. They are made like the foregoing, some makers preferring, however, to mix the cream with the curd when the latter has been already put in the forms.

**Fromages suisses**, **Bondons de Rouen**, **Malakoff**, and **Anciens imperiaux**.—These are all made in the same way, and their difference lies only in the shapes, as may be seen, for instance, in the Bondons (a), the Malakoffs (b), the Imperiaux (c), Fig. 329. The most important ones of this class are the *suisses*. Whole milk is warmed to about 77° Fahr., and rennet added. The curd is worked, mixed with cream, slightly pressed, and the whey allowed to run off. The action of the rennet must be a slight one, so that the curd does not get too
hard. The curd is collected into cloths and hung up for the whey to drain off. Afterwards it is put between two boards or hurdles and weighted to effect this purpose still more completely. The curd is now rolled in a cylindrical form and wrapped in paper; larger quantities are, however, much better made with the apparatus shown in Fig. 330.

While the little wooden piston paper rolls are arranged in the little tin cylinders, the curd is filled in, and the cheeses are taken out when hardened sufficiently. When the whey is quite drained off, the cheeses are packed in boxes containing a dozen of them, and sent to the place of consumption as rapidly as possible. These cheeses are even made by machinery.

Fromage de Camembert.—This cheese (Fig. 331) is about 4 inches in diameter and 1 inch in height. The making has a great many nice points, and is considered difficult. The rennet is added to the whole milk at about 78° Fahr., as soon as possible after each milking has been poured into stone pots (Fig. 332), containing about 15 gallons. Great care is taken to secure a uniform texture of the curd by employing the rennet with all possible precaution. The vases are then covered up and left standing for four to six hours, when the whey must have separated from the curd. The tin forms are then placed on mats of bamboo splints; the first (Fig. 333) are 12 cm. high and of the same diameter. With a spoon the curd is filled into the forms in such a way that they are full with four spoonfuls each. In summer the curd lets off more whey in the form than in winter, and sometimes they have to be filled up with curd from the next cheese-making. After some time the forms are turned, and at the same time the top of the cheese is salted. The next morning the cheeses are taken out of the forms, rubbed all around and on the lower side with salt, and placed on boards, where they remain for one or two days.

In some districts, instead of the stone jugs, smaller earthenware pots are used, which are wheeled on a kind of rolling chair (Fig. 334) to the form tables.

When the salting has been done as above mentioned, the cheeses are removed to the séchoir or haloir (drying-room), and put on shelves which have been covered with straw. This room must have exclusive arrangements for ventilation. The cheeses stay here twenty to twenty-five days, and are at first turned every day, later on every second day. Mould appears on the third day, with brown tiny dots, which grow in about eight or ten days into a rank white vegetation. The cheese becomes a dark yellow in colour. When the cheeses have arrived at a certain state of softness, which can only be ascertained by experience, they are taken into the cave de perfection, or cellar. This cellar must be kept somewhat damp and of a very even temperature; no draughts are allowed. Here the cheeses remain twenty or thirty days, and are turned every day or second day. The treatment at this stage is a very complicated and difficult one, and on it depends the success of the dairy.

Fromage de Livarot.—In the Calvados, where this cheese is made, the milk is set in earthenware conical dishes (Fig. 335), and the cream taken off after twenty-four hours.
The milk is then slowly heated until a very fine skin forms at the surface, which is taken away and the rennet added. The forms are the same as used for the Camemberts, but larger (15 cm. diameter) and perforated. They are made very like the Camemberts, only the curd is thoroughly cut up before being filled in the forms, and the cheeses are wetted with water when being turned in the séchoir, or with salt water, should they have not yet enough salt. After having been eight or ten days in the cave, their top and lower sides are bound up with horse-tongue leaves (Typha califolia) in order to keep the cheeses in shape. They remain altogether three or four months in the "cave," and are coloured before the sale. This cheese is generally made in July, August, and September, and in some cases it is made from new milk with cream added, like the Neufchâtel or the Stilton.

Fromage de Pont l'Évêque.—This cheese was made as long ago as the thirteenth century. Several different kinds are made:—First quality are called de commande, or délit doux; they are made either with milk fresh from the cow, or even mixed with the cream of the last milking. Second quality.—With the fresh morning's milk the two last milkings from the day before (noon and evening) are mixed after the cream has been taken off. Third quality.—The skimmed milk is used from the three milkings of the day before.

The first quality is made in the following way:—The milk is put on the fire until a little more than tepid, and then the rennet is added. The action of the rennet ought to be completed in about a quarter of an hour, and then the curd is cut up with a wooden sword, and pressed with a dish to make the whey separate. For ten minutes the curd is covered, and then heaped on mats of bamboo splints and left there to drain, after which it is filled into the square forms made of wood. In the first twenty minutes the forms are turned seven or eight times, and then taken to another table, where they are turned as often again during the rest of the day. After forty-eight hours the cheeses are taken out of the forms, salted with dry, fine salt, and salting on one side in the morning, on the other in the evening, is continued until the cheeses are sufficiently salted. They are afterwards placed on drying hurdles covered with rye-straw, and left to dry in an airy place for two or three days, during which time they are turned once a day. Now they are brought to the cellar and packed tightly against each other in boxes. The treatment the cheeses receive in the cellar is the following:—They are turned every second day for two weeks to four months, those containing much cream taking the least time for curing. Generally about one-twentieth part of boiling water is poured into the milk just before adding the rennet, as the people believe this to make the cheese soft. Of course this is not correct, and can only tend to spoil the quality.

Fromage de Neufchâtel.—We have already described the making of Neufchâtels for consumption in their fresh state; but the making of cured Neufchâtels is also a considerable industry. Fresh milk is brought to a room which ought to be kept at a uniform temperature of 59° Fahr., and poured into pots containing about 4 gallons each, when rennet is added, and the pots covered up with some woollen stuff to keep them warm. Twenty-four hours after the addition of the rennet the curd and whey are poured into a wicker basket or perforated wooden dish lined with a piece of linen, and left there twelve hours to drain. Now the curd is wrapped in the linen on which it lies, put into a perforated wooden box, and pressed by putting weights on the top. After again twelve hours have elapsed it is worked into a stiff paste with the hands. This curd is filled into little tin cylinders of 2 1/2 inches in diameter and 3 inches in height, smoothed on both sides and taken out again. Then it is salted on both ends by strewing some fine salt on them, and afterwards treating the sides in the same way by rolling them lightly between the hands, which are covered with salt. The cheeses are left to drain for twenty-four hours, and are placed afterwards in another room on dry straw on shelves, so that they do not touch each other. During the next two or three weeks they are turned often enough so as not to lose in shape and stick to the straw. At the end of this time they are covered by a blue mould, and then they are taken into another room, where they are put on straw as before, but on their ends, and turned from time to time. Another three weeks elapse, when red spots begin to be visible on the cheeses. In this condition they are marketable, but not entirely cured until two weeks more. In this state they can be kept about two months.

Fromage de Brie.—This well-known cheese represents a great French industry. It is made in
several departments, but in the greatest technical perfection in the departments de la Meuse et Marne. We give the description of the dairy Maison-du-Val near Révigny (Meuse), as described by Professor Pourian:—

The milk is collected in vans, on which tin cans of 2 to 4 gallons capacity are placed. The milk is strained and then poured into large copper receptacles, where it is heated by steam, the receptacles having double bottoms (Fig. 336). When the wished-for temperature has been arrived at, the receptacles are opened and the milk runs in a kind of gutter into the cheese-making room, where it is received in buckets and poured into receptacles, where the rennet is added. In about two hours and a half some cream has risen, which is taken off, as it would be detrimental to the uniformity of texture in the cheese. This represents only about 3 lbs. of butter per 100 gallons of milk. About fifteen minutes or half an hour afterwards, when the whey appears sufficiently clear above the curd, the latter is put into forms which are made of three sizes—viz., 16 in., 12 in., and 6 in. in diameter. These forms (Fig. 337) are tin hoops (c), resting on a small mat of rushes (u) placed on a table (x). The hoops are filled by carefully cutting slices from the curd with a perforated tin spoon (Fig. 338). After some time the hoops are changed for others which are less high, and can be made smaller or larger as convenient (Fig. 339). The next morning early the cheeses are taken into another room, and after leaving them for a few hours to settle, the hoops are opened and the top as well as the rim of each cheese is salted and the hoop put on again, changing the mats for dry ones at the same time. After six hours the cheeses are covered with small straw mats and turned, and after an hour the hoops are opened and the lower side salted. The cheeses are now put on fresh straw mats and placed for two days on shelves, salting and turning them each day. The making of the cheese until this point can be seen very well from the annexed engraving (Fig. 340). After the second day the cheeses are taken to the drying-room, where they are turned every other day, giving them a fresh mat every time. The cheeses get covered now with a coating.
of white mould, which turns into blue gradually, and after a week they may be taken into the cellar, which is arranged for extensive ventilation. Every second day the cheeses which lie on shelves are turned, and from time to time fresh mats are given. The blue mould turns first yellow, then red, and in about two weeks the curing is completed. The cellar ought to be kept at a temperature of 53°—57° Fahr. Fromage de Contumiers.—This cheese is, in fact, a "Brie," but of smaller shape. It is only 6 inches in diameter, and is made and treated in exactly the same way, ripening, however, in a few days less than "Brie." Fromage de Mont d'Or.—The milk is brought conveyed to the drying-room, where they are laid without hoops on shelves covered with straw. This drying-room must be well ventilated. On the shelves the cheeses are turned every two or three hours, and moistened each time with a solution of salt. The curing lasts six to eight days in summer, and about twice as long in winter.

Fromage de Géroné à pâte molle (Soft Géroné Cheese).—This cheese (Fig. 342) is identical with the German "Schachtel Kase" (box cheese) described later on.

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Fig. 340.—Interior of Dairy at Maison-du-Val.

Fig. 341.

Fig. 342.

to the dairy twice a day, and is immediately put in earthenware vases containing already some rennet, and after the coagulation is complete the curd is put with a spoon into the tin hoops (Fig. 341), which are placed on larger wooden hoops which are covered with a matting of rye-straw. The hoops have two sizes, the diameter is in both 5 inches, but the height 3 to 4 inches in one case and 1 inch in the other. The forms are placed in rows on inclined shelves, and the whey allowed to run off. After two or three hours the cheeses are turned, and this is repeated during the next twelve hours, when the smaller hoops are substituted, and after another twelve hours they are

Fromage Roquefort.—This celebrated cheese is made from sheep's milk. The plateau of Larzac, which is the home of this industry, has a diameter of about 16 to 20 English miles, and its height above the sea is about 900 mètres. The top is almost denuded of vegetation, while the mountain-sides are covered with a thin but good grass. On this pasture the sheep used to be solely fed, but the increased demand for Roquefort cheese has already, since the beginning of this century, occasioned the cultivation of crops of lucerne, saffoin, clover, and artificial grasses. Since that time the milking qualities of the sheep have been improved. In 1785 about 150,000 sheep were kept in this district, 50,000 of which were in milk; today the first number has risen to 650,000 head,
and the fabrication of Roquefort cheese, once limited to the plateau of Larzac, has spread from that centre very considerably.

The sheep are milked evening and morning, seven persons being necessary for milking 200 head. The foam of the evening's milk is first skimmed off, and the milk left standing for three-quarters of an hour, when it is strained through a piece of linen and poured into a kettle made of copper and turned on the inside. Here it is heated up to a certain point (not boiled, however), which varies very much according to the different weather, &c., and which is one of the nice points of the process. The hot milk is distributed in glazed earthenware pots, and the cream taken off next morning. The morning's milk is poured into the kettle, the evening's milk added, and both warmed a little, when the rennet is mixed with the contents. As soon as coagulation is complete, the curd is cut up in all directions with a wooden knife, and the whey which separates is taken off immediately during this operation. The curd is then lightly squeezed with a dish to extract still more of the whey, until no more appears, and then it is worked with the hands. The forms, made of glazed earthenware, are flat, perforated cylinders with bottoms, and about 8 inches in diameter. The height of the forms is 4 inches. Three layers of curd are put in each form, and between the first and second and the second and third finely-ground pain moisi (moulded bread) is strewn. The last layer is shaped dome-like, so as to reach about 3 inches above the rim of the form. By putting several forms on the top of each other the cheeses are pressed, and the dome serves to fill the forms exactly. The next two or three days the filled forms pass into large wooden boxes, being turned twice a day. These boxes are kept warm and damp by placing repeatedly in them vases filled with hot water. Afterwards the cheeses are brought for two or three days into the drying-room, which lies towards the north and is well ventilated, where they are laid on shelves spread with dry cloths and turned twice a day.

The pain moisi spoken of above is prepared with great care, as the quality of the cheese partly depends on it. A paste is made of equal parts of wheat, summer barley, and winter barley; a good deal of very strong leaven and some vinegar are added. This mass is kneaded very thoroughly and baked rather long. The loaves are kept in a warm place until mould has quite taken hold of them; the crust is then taken off, and the rest ground in a hand-mill and sifted.

The cheeses are mostly taken at night to the caves to obviate their being exposed to heat. These caves are formed by nature in the above-mentioned mountain, and their temperature is maintained at 39° to 46° Fahr., and their humidity at about 60 per cent., by the water appearing in them and the draughts created by the many fissures and holes in the rocks. The word "cave" comprises in this case not only the cave itself, but also a room where the cheeses are received from the dairy and the salting-room, both the latter being built above the cave.

The cheeses received from the dairy are put on the straw-covered floor of the room designed for this purpose and left there twelve hours. Then they are taken to the salting-room, and on each a handful of salt is spread on one side, three cheese being laid on each other. After twenty-four hours the pile is turned, and the other sides salted. After forty-eight hours they are rubbed strongly with a coarse towel all over, and piled up again. In this state they remain for two days, when they are taken back into the receiving-room for the raillage. With a knife the glutinous coating of the cheese is scraped off, and also another whitish coating immediately beneath the first. After this has been done the loaves are taken back into the cave, where they are kept in piles of three for eight days. Then they are put on their rims (Fig. 343), but in such a way that they do not touch each other. They get a yellowish or reddish skin in the cave. Exterior white mould must be scraped off when it appears; this is the case every week or two. After thirty or forty days they are cured, and may be sold. They keep for several months afterwards.

**Modes of Dairy Farming.**

As we have before stated, French dairying is in some districts carried out to a great extent in connection with arable farming and the growth of green crops, amongst which lucerne holds a foremost position. Mr. H. M. Jenkins tells us that "in the two westernmost departments of Normandy—the celebrated dairy departments of La Manche and Calvados—much less than one-fourth of the whole cultivated land is in permanent grass of all qualities; in the Lower Seine and the
Orne, between one-fifth and one-sixth, and in the Eure scarcely more than one-tenth. In Brittany the permanent grass is even less extensive.

"In Cornwall," by way of contrast, "one-third of the whole cultivated area is in permanent grass, in Devonshire the proportion is considerably more, and in Dorsetshire amounts to one-half. In Somersetshire two-thirds of the agricultural land is in permanent grass, but in Wiltshire not much more than one-fourth.

"In the treatment of dairy-cows the farmers of each district pursue the same method; but there is the greatest possible contrast between the practices of the grass-land and the arable dairy districts. In the best district for Camembert cheese (Pays d'Auge) and in the butter district of Isigny (le Bessin) the cows are always kept on the pastures, except for a short time before and after calving. On the other hand, in the arable regions of Eastern Brittany and in the neighbourhood of Paris, cows are kept in the sheds all the year round, except for a short time in the morning and afternoon in summer. Again, the food is nearly always the natural produce of the soil, the substances generally known as 'artificial' foods being seldom used in France for dairy-cattle. Bran, however, is largely used in the arable districts, where, also, the whole of the natural grass and a large proportion of the lucerne are always reserved for hay.

"An intermediate practice is to be found in some districts, where lucerne is pastured during the summer by dairy-cows, which are tethered or folded. In the latter case the cows are placed at night in a small fold near the homestead, and not unfrequently the hind sleeps in a movable hut placed close to the fold."

It is a commonly accepted fact that in England the extensive employment of green crops and artificial grasses, whether in soiling or
time, and not feeding it to the cows immediately it is eaten.

SWEDEN.

Sweden, with its mountainous country and cold climate, which affords part of a limited area to the successful raising of cereals, has for a long time devoted much attention to dairying, but fifteen or twenty years ago its products were not so famed in the market as they are now. Sweden has made an immense step in the advancement of dairying during that period. About the year 1848, however, Major Gussander invented a new method of milk-setting in very shallow tin pans, which became popular throughout the country, while until then wooden milk-dishes had been almost exclusively in use. This method is still in use in many places, not only in Sweden, but also in some parts of Germany; but as it is now almost entirely supplanted by the Swartz method, we need not describe it. The Swartz system itself has been fully described and illustrated in the chapter on butter-making (see p. 203).

In Sweden and Norway there are many factories which make butter, and either sell their skimmed milk, or make skim-milk cheese. Whole-milk cheese is rarely made. Amongst the Swedish dairy products there is one that is totally unknown in England, and a short description of it may be interesting:

Long-milk (Thread-milk; Swed. Filn-Mjöll).—This preparation is made in the whole of Sweden, and is a favourite dish with the people. It seems externally not to differ from ordinary milk; it has quite the colour of it, but it is so slimy that it may be pulled out in long threads or ribands, and it is just possible to wind the contents of a small tube on a stick. It has also the valuable quality of keeping for weeks and even months sweet and eatable. This very remarkable substance, the nature of which is yet unexplained, is produced by feeding to cows some dried or fresh Pingueula vulgaris (butter-wort), a small plant found in early spring almost everywhere on hill-sides, swamps, and wet meadows; or it will do as well to put a few handfuls of the plant in a pail with fresh milk, which after a few days will have thickened and become "long-milk." When this is once obtained it can be propagated like yeast by pouring about 4 inches deep of long-milk into a milk-pail and filling up with fresh milk; in two or three days the whole will have become long-milk. Strange to say, the Pingueula vulgaris seems not to have this property everywhere, for the writer has tried the experiment repeatedly with the plant from the Alps and from the plains below, and always unsuccessfully.

Mysost.—This is a kind of whey-cheese of sweet taste, which consists of a little fat and casein, the albumen, sugar, and salts of the milk. It is made in the following way:—Directly after the cheese has been taken out of the kettle, the whey is heated to the boiling-point as rapidly as possible, but not stirred, and the whey-cream taken off as soon as it rises to the surface. After this the fluid is stirred with a wooden, long-handled spatula until two-thirds are evaporated. To accelerate this, the whey is sometimes continually dipped out and poured back again from a height of about 2 feet with large wooden spoons. Then the whey-cream is added again, and if a superior quality of mysost is wanted, some cream or butter-milk is likewise added. The stirring is continued until the bubbles which rise form a foam on the surface, but from the moment when bubbles appear the fire must be lessened. In four or six hours the whey is turned into a kind of paste, which is poured into a wooden dish and there poured with a wooden instrument until it is quite fine, after which it is filled into small square wooden forms, where it remains one or two days, and it is then sold for immediate consumption, as it does not keep long.

RUSSIA.

Russia has no less than thirty millions of cattle on her vast domains in Europe, but how great the augmentation of this large number might still become is shown by the fact that she has only 300 head per square (geographical) mile, while England has no less than 1,300. The Russian cattle are composed of many breeds, the most important of which are the following:

1. The Holmowgory breed derives its origin from Dutch cattle, which were brought into the province by the command of Peter the Great. It still resembles the Dutch cattle very closely in appearance and qualities, but it is thoroughly acclimatised and has grown much less fastidious as to quality and kind of food. Cows of this breed give on an average no less than 600 gallons of milk per year. The breed has been crossed with many of the indigenous breeds, and in this way
several sub-breeds have been produced whose hereditary qualities are now fixed.

2. The Ternobłów breed are of medium size, but give a good quantity of milk, which is richer than that of the Holmogory cows. They yield about 500 gallons per year.

3. The common Russian breed, distributed over all districts of the country, is very different in its qualities, according to the locality in which it is found. On the whole it may be said that this breed has neither milking nor fattening qualities worth speaking of, but proof has been given that with careful selection and feeding a wonderful development may be attained.

4. The Ukraine breed is esteemed principally for working purposes, as the yield of milk is not great.

5. The Komolaya breed, which is hornless, gives about 260 gallons of good rich milk per annum.

Russia has imported many animals of renowned breeds; the Shorthorn, Dutch, Friesland, Angeln, Breitenburg, Algäu, Simmental, and others are represented, and herds of them are kept at the expense of the government, on the farms affiliated to the different agricultural colleges and schools.

The export of cheese has been greatly reduced of late years, and the Russians explain the falling off by saying that the consumption has largely increased amongst the lower classes, with whom cheese was formerly considered a luxury. The lack of persons who know how to make marketable products is the principal reason why the dairy industry has made only slow progress in Russia. Government has made and is making praiseworthy efforts to overcome this difficulty, and dairy-schools for men and women have been established in different provinces.

For butter-making the milk is set generally in wooden or earthenware vessels, but of late Swartz's method of deep-setting and cooling has been adopted on many farms. Many different kinds of churns are in use, but the old high conical churn, in which is a rod with a perforated board attached to its end, is still very common. The methods of making a few of the more specially Russian dairy products are as follows:—

Paris Butter.—The kind of butter which is sold under this name at St. Petersburg, at high quotations, is generally called Petersbóurg butter on the Continent. Perfectly sweet cream, which has been allowed to rise in about twelve hours, is skimmed from its milk and poured into a tin vessel, which is steeped in boiling water until the cream has assumed a temperature of 158° to 163° Fahr., but extremes of 140° and 190° are sometimes used. The cream is slowly stirred all the time to acquire uniform heat, and then directly cooled to 53° to 57° Fahr., whereupon it is churned. Of course the cream must be quite sweet to stand the heating, otherwise it would coagulate. The churning of such cream is easy, and it ought not to be agitated too strongly. The taste of the butter is very sweet and delicate, and has a peculiar flavour which is much appreciated by the gourmets of the capital.

Tworog.—Milk is allowed to stand until sour, then it is skimmed and poured into a pot, which is placed on a warm stove. After twenty-four hours the curd is poured on a sieve, where it is allowed to remain until all the whey is drained off. The curd is afterwards put into wooden forms, which are closed by a well-fitting cover which is pressed down by weights. To keep the tworog fresh some water is poured on the cover. Tworog is eaten in large quantities by the rural population, and also employed to bake a kind of bread, the Woluschki. Also sheep's milk is employed to make tworog, especially in Bessarabia, where flat loaves of salted tworog are made in two sizes; the smaller are called Brusa, the larger (2½—5 lbs.) Katechawal.

Koumiss.—This, the favourite alcoholic drink of the nomadic tribes in South-eastern Russia, is made from mares' milk. The excellent effect it has on weak constitutions, and on persons brought down very low by disease and exposure, was known long ago to the nomads; but it is only during the last thirty years that the medical faculty has made any use of it. Up to this day its effects are not closely studied, but it may be stated that it is a rich food, easily assimilated, and of very beneficial effect on the energy of the physiological processes in the human body.

The preparation of koumiss is simple. Some old koumiss is poured into a vessel, and fresh milk is added. The whole is stirred violently for fifteen minutes, and then again for a few minutes every few hours. The next morning some more milk is added, and the same treatment is pursued during the day. In the evening the koumiss may be passed through a sieve (to hold back the
casein) and filled into bottles. Some of it is, however, reserved to be used as ferment for a new leaven. In three days after bottling the koumiss may be used, but it may be readily kept another fortnight and even longer, growing stronger all the while. The bottles must be strong and the stoppers secured, otherwise the bottles will burst and the stoppers be driven out by the force of the carbonic acid which is developed. The temperature of the room in which koumiss is made ought not to be below 60° Fahr.

DENMARK.

Dairying is in a state very near to perfection in Denmark, the chief incentive being the great facility for exportation which the country possesses. An excellent breed of dairy-cattle, the Angler, has also contributed in no small measure to the success of Danish dairying; this breed came from Schleswig-Holstein, and is now to be found everywhere in Denmark. The export of butter to England has been going on for a long time, and of such excellent quality is it, that it is commonly sold to the consumers under celebrated French names, as if it were made in France; but the principal cause of the rapid development which has made the Danish dairy interest what it is now, is the export of butter to hot countries. Year after year since 1870, when this industry began to grow in importance, it has extended, and still there is no limit to the quantity which the tropics absorb. The Danes have notably developed their butter industry wonderfully, but they have also improved their cheese-making very much, and have created another export article—skim-milk cheese. These different dairy products are made in the following manner:—

Butter for Exportation.—The method on which this is made is not alone applicable to export butter, but it is certainly the best method of obtaining a perfectly sweet, durable article of first quality for any purpose whatever. Milk from sick cows, diseased milk, colostrum for eight to twelve days after parturition is condemned; it may not be used for butter-making. The first condition is the setting of the milk at a low temperature, after Swartz's method. The cream is taken off after twelve hours, never later. The morning's milk is skimmed in the evening and put in a tin can, which is placed in the water-bath to keep cold until the morning, when it is mixed with the cream from the evening's milk and churned. The cream must be churned every day, and if there should not be enough of it to fill the churn sufficiently the missing quantity may be supplied by sweet milk. In winter the tin can with the cream is placed in warm—not hot—water, and stirred until it has acquired a temperature of 52° Fahr. Now the cream is poured into the churn, which in the winter is previously rinsed with hot water, the colour is added, and the churning begins. The cream ought to be 52° Fahr. before churning, and 59° after it, and the time occupied about forty minutes. The butter must not be brought in contact with water, and the rinsing of the sides of the churn, which is done to obtain the small particles of butter attached to them, may only be done with skim-milk. The churns most generally in use in Denmark are called the Holstein or Danish churns, of which an illustration is given in Fig. 181, page 315. They are very convenient and efficient. The churning is stopped when the butter has been formed in little pieces of the size of a pea, which are collected by the aid of a hair-sieve. Immediately afterwards the butter is taken to the butter-trough and kneaded there by pressing pieces of about 2 lbs. with crossed hands against the sides of the wooden trough (Fig. 344), turning them over and pressing again four or five times. Now the butter is weighed, and the pieces piled on the top of each other, with about 3 per cent. of salt strewed between the layers.

To impregnate the butter evenly with the salt, pieces of about 3 lbs. are taken from the pile, by cutting them off so as to cut through all the layers, and with crossed hands are kneaded ten or twelve times (Fig. 345). Now the butter is left alone for some time to assume the necessary firmness. If it lies too long in winter it gets hard and crumbling, but if the right moment is hit, the butter will be just right after the fluted roller of the butter-kneading board (Fig. 346) has passed over it ten or twelve times.

In summer the butter requires application of cold before it is kneaded on the board, and it is therefore formed in elongated pieces of about
2 lbs. each and put crossways (Fig. 347) in a tin can (Fig. 348), in the bottom of which a piece of board has been placed, and flat pieces of wood loosely arranged all round, so that the butter cannot come in contact with the tin (Fig. 349). This can is placed for a few hours in cold water. Immediately after the butter leaves the kneading-board it must be packed in the wooden casks in which it is sent to the market.

Packing Butter for Exportation to Hot Climates.—As before mentioned, this is one of the principal features of the Danish trade in dairy produce. The butter arrives in barrels at the packing-house every day from the farms. In summer the barrels have an envelope of strong packing-cloth stuffed with straw to protect them from the heat. They are opened and chased by an expert, then the butter is cut in pieces and well mixed again and re-salted on large rotary kneading machines (see Fig. 150, p. 313). By the aid of machinery the round tin boxes, which must be perfectly air-tight, are filled with butter, whose surface is scraped and polished with a wooden spatula. The lids of the boxes are then soldered on, and afterwards painted and supplied with a label. The house of Busk & Co. alone exports no less than 2,500,000 lbs. of butter per year, packed in 1 lb., 2 lb., 4 lb., 8 lb. and larger tins.

Export Cheese.—The skimmed milk is heated to 96° Fahr., and 15 per cent. of quite fresh buttermilk added. The buttermilk must not be heated along with the skimmed milk, otherwise the cheese becomes bitter. Colour and rennet are now added, the wooden tub into which the milk has been poured from the kettle in which it has been heated is covered up, and the curd cut very slowly after twenty-five minutes, when the coagulation should be perfect. With the "lyra," an instrument consisting of a wooden frame spanned with brass wire, this cutting up is done first in one direction and afterwards in the other. For ten minutes this is continued, and then half of the whey is drained off. Now the movement of the lyra is accelerated to get the curd broken up into pieces of equal size. When this is done the curd is allowed to settle a few minutes, and then the whey is drained off as much as possible. Now enough of the curd is taken to fill one of the round wooden forms (Fig. 350) which are in use, and thoroughly kneaded for a few minutes in it. After this the curd is pressed with the palms of the hands, so that the whey which has collected can be poured off (Fig. 351), and the form will then only be half full. The upper layer is now loosened again with the fingers (Fig. 352), and more curd is added and kneaded until the form is nearly full. A cover is then put on the form and weighted with about 20 lbs., and the cheese frequently turned. After twelve hours it is laid in strong brine, where it remains three days and nights, being turned twice a day, and a handful of salt strewed on the upper side of the leaf. It is then
DAIRY FARMING.

GERMANY.

Schleswig-Holstein.

The largest part of this province is under a peculiar system of cropping: fallow, three to four winter or summer grain-crops, pasture. The fields are enclosed by a mound on which a hedge is grown. This arrangement is of course very favourable to cattle-grazing, and it must be remembered that in Germany fields are generally not enclosed.

All over the province the cows are grazed during the summer, mostly on ground laid down with grass and clover. In the "Marseh" the pastures are used to fatten cattle which are sent to England. In some places the cattle are tethered. The grazing lasts from the 15th of May to the 1st of November.

In the winter the feeding is done with oats and barley, straw, hay, and all kinds of artificial food. The heifers are timed to have their first calf when they are two and a half years old. The cows are milked twice, rarely three times per day, and on the average 410 to 480 gallons of milk may be counted upon per head and year, some cows giving as much as 1,000 gallons.

The milk is made into cheese and butter. The latter is well and favourably known in the market, and great efforts have been made to reach again the first rank, which Sweden and Denmark have now occupied for some time. Especially the larger estates and farms have taken the lead in this effort. The dairy is generally superintended by a married couple. The husband (Haushalter) overlooks the feeding, milking, and treatment of the cows, and the wife (Meierin) makes butter and cheese alone, or in larger dairies with her helpmates, the dairymaids or apprentices, of whom some are generally found at the better dairies, as all the daughters of peasants and farmers learn dairy-work. Two dairy-schools are erected for the
purpose of theoretico-practical instruction, and a consulting chemist on dairy matters, who is at the same time director of the Dairy Experimental Station at Kiel, furthers the scientific development of this branch of agriculture. In those parts of the country where small farms are prevalent, associations have been formed, and generally one of the company builds and works the dairy, while the surrounding farmers undertake by contract to furnish the milk for ten years at a price which is in a certain proportion to the price of butter at Hamburg.

Butter.—Butter is made almost without exception from sour cream. But the degree of acidity is attended to with great care, and the cream therefore watched attentively. After skimming, the cream is heated to 100° to 120° Fahr., poured into a wooden tub which stands in the milk-room, remains about twenty-four hours there, and is frequently stirred with a stick. When the cream is “ripe” it ought, if a stick is inserted and taken out again, to run off quite slowly, spinning a thread, and leaving a shining coating equally distributed on the stick. If the room is too warm the process of souring is too fast, and if too cold it is too slow, and either cold or hot milk must be added to attain the desired temperature. Sometimes cream is not heated before putting in the tub, but in this case is mostly allowed to stand for thirty-six hours before churning. This is why such cream must be always watched. Butter made from sour cream has a peculiar taste which is much liked in North Germany.

Skim-milk Cheese.—The cheese of Schleswig-Holstein, made from skim-milk, is generally of an indifferent quality, and certainly much below the Danish article. It is made in different ways, but the following may be said to be one of the best methods:—The skimmed milk is poured into a kettle and heated by fire or steam. In large dairies a wooden tub of about 3 feet in depth, and sometimes large enough to contain 300 gallons, is used. When the milk has reached 95° Fahr., the rennet is added and the tub covered up. In about an hour the milk is coagulated, and is broken up in pieces of the size of an egg. Then the curd is allowed to settle for a few minutes, after which it is again stirred a little, and when settled again the whey is drained off. Now the curd is worked for ten minutes with the hands and then put in the forms. The cheeses are either salted in the curd, or by placing the loaves for two or three days in a salt-bath, after they have been twenty-four hours in the press.

Hanover.

This province has a great variety of soils and climates. It has mountains, plains, and sea-shore; and its agriculture is therefore very diversified. In some districts the cattle are grazed during the summer, in others they are kept all the year through in the stables, but fed with green fodder during the summer. In the neighbourhood of towns, where a good deal of artificial food is used, larger stables are not infrequent, where the cows give over 650 gallons per head a year. In the small stables, where inferior cows are kept, and inferior feeding the rule, 300 to 500 gallons may be taken as an average. In Ostfriesland the milk is made generally into butter and skim-milk cheese; some farms make Edam cheese, but in several districts the milk is churned, when the yield is too small to allow of cream-churning every day or every other day. The small farms are rather advanced in dairying, and have profited much from their Dutch neighbours. In the other parts of the province dairying is still in its infancy. The milk is set in earthenware, glass, or metal dishes, and left standing until it is quite sour and thick. The cream is then churned, and the curd formed by hand into small hand-cheeses of about four ounces each in weight, which are very much liked by the population. In some instances persons make a business of it to buy the curd of the peasants, and turn it into “Handkäse” (hand-made cheese). Larger sizes, but of the same make, are known in this case under the name of “Harzkäse,” because they are mostly made in the Harz mountains. On some farms the method of Swartz has been introduced, and there the skim-milk is turned into Limburg cheese, the fabrication of which will be described further on. In the Lâneburg district the production of milk only suffices for the nourishment of the people, who have not yet learnt how to save. We find many places in Germany where the same evil exists. In other districts calves are fattened and sent to Bremen and Hamburg, and most of them are bought from surrounding farms. In the district of Hildesheim a dozen dairy-factories have been established.

Harz Cheese.—When the cream has been taken off the sour milk, the latter is poured into a
copper kettle and warmed with a rapid fire to 88° Fahr., which makes the whey separate from the curd. Now the whole mass is poured into a wooden tub, where it is left standing for three to six hours. If it should remain in the copper kettle during that time, the latter would oxidise. After some hours the curd is put into coarse sacks, and these are put on an inclined table, where the whey can run off. Then some stones are put on the sacks to get out most of the whey, or if this is not sufficient the sacks are pressed. The curd is now poured on a table and well mixed with salt at the rate of 1 lb. of salt to 40 lbs. of curd. After this it is passed through a curd-mill, and kneaded on a table until it has turned into a tough paste; then the forms are filled, and after standing some time the cheeses are taken out and put on boards in an airy room, where they are daily turned until they leave no wet spot where they have stood. This generally lasts some days, and afterwards they are packed pretty tightly in a case, but never more than two in one pile. The cellar where they are now kept must be cool and dry, and during the curing they must be taken out once a week and rubbed a little all round with the palm of the hand to destroy the fungi which invariably appear, and would make the cheese bitter if left alone. This kind of cheese ought to have a humid, soft, yellowish rind.

**Prussia.**

In this province cereal crops are extensively raised, and large tracts of sandy soil form one of the principal features of the country. Many large estates exist. Most of the cattle are already improved by crosses with imported foreign stock. The improved breeds are represented in the province in the following order:—Dutch, Oldenburger and Ostfriesen, Breitenburger and Wilstermarsch, Angler and Shorthorns, Algäuer and Montafuner, Simmenthaler. In the summer the cattle are almost everywhere grazed; in some districts are very good pastures, so that oxen are fattened on them. In the winter roots are fed, with straw, hay, and artificial food. A good deal of potato refuse from the distilleries is fed. In one part of the province large dairies are established, and the Tilsit cheese, made after the Limburg fashion, is well known in the trade there. Factories on the principle of association have become quite numerous of late, and the Swartz system is in use in all the dairies of newer date where its application was possible. In all the dairies the principal object is the making of fine table-butter, which is sent to Berlin in great quantities, and also direct to consumers in small casks containing about 20 lbs. each.

**Ostpreussische Gemüse.**—This kind of cheese is of very simple make, and only adapted for household use. The soured thick milk is warmed by adding hot water, or over the fire, to 86° Fahr., and the curd taken out with a perforated ladle in large pieces and put on a hair-sieve to drain. When this is done it is eaten with fresh milk or with cream.

**Poseen.**

This province contains very large farms, and, on the other hand, also very small ones. The large farmers breed all kinds of improved races of cattle; there may be found Dutch, Oldenburger, Berner, Swiss, Algäuer, Montafuner, Voigtländer, Scheinfeld, Simmenthaler, Bayreuther Schecken, Wils- termarscher, Angler, Ayshire, Shorthorn, &c. The Shorthorns have not had much success, because they do not give enough milk, and for fat cattle there is no very good market. The Dutch cattle and other closely-related breeds have shown too much inclination for pleuro-pneumonia, and therefore the attention of the farmers has been drawn, with very good results, to Bavarian and Swiss cattle. The cattle of the peasants are of very bad quality, are fed very poorly, and their milking and flesh-forming propensities are proportionately small. On the large farms the food is not of first quality, as straw plays the principal part in it, supplemented by the products of distilleries, beet-sugar factories, &c. Mangels, potatoes, and rape-cakes are frequently fed.

While the peasants keep the milk until it is sour, and make bad butter and inferior little hand-made cheeses, the larger farms let their milk generally to a cheese-maker, who makes butter and Limburg cheese. Some large farms work the dairy by their own people in very good style. The Swartz system is employed, or iron enamelled milk-jars, which are frequently cooled with running water. All these large dairies send their butter to Berlin and other large markets, but the quality of the butter of small makers is very inferior, and averages less than half the price that the butter of Schleswig-Holstein commands.
Silesia.

The soils and agricultural capabilities of this province are very varied, but with the exception of smaller portions of mountainous and swampy country, it may be said that it enjoys generally favourable circumstances. Grazing is limited, and the feeding on small farms rather indifferent. The large farms have augmented their herds since sheep-raisinig has become unprofitable. More green crops have been raised, and the produce of the technological establishments combined with almost every farm are used as fodder.

Dairying was, until a few years ago, in a deplorable state. At the small farms the milk was kept until quite sour and the cream churned, while the milk was either eaten or made into the small ordinary hand-cheeses. In larger dairies the milk was a little better, the butter was washed before salting, and there was less salt mixed with it. But otherwise there was no improvement, until cheese-makers came from Switzerland and South Germany and rented the milk on the farms. Instead of the old earthenware milk-dishes, tin, wood, or glass dishes began to be used, and better churns were introduced. Swartz's method is now also introduced. The cheese made is generally Limburger of skim-milk, but also Emmenthaler is produced at one or two dairies. Artificial butter from Vienna, and ordinary cooking butter from Galicia, are extensively imported.

Schlesischer Weichquarg.—This cheese is quite a specialty of Silesia. The soured milk is warmed to 100°C to 105°C Fahr., and the curd collected on a sieve and then filled into a sack, which is suspended to allow the whey to drain off, and afterwards laid on a kind of ladder and pressed by straining a board over it. The board is tightened from time to time, after the curd has been shaken up. After twenty-four hours most of the whey is extracted, and the curd is now mixed with salt, and sometimes a little caraway-seed, and well kneaded with the hands in a trough. When this is done the curd may be eaten fresh with potatoes or bread, and it is mixed for this purpose with milk or cream; others add some garlic or onions. Otherwise the curd is left standing for a few days to undergo a kind of fermentation, and it shows in such cases a yellowish, transparent, rough skin. Six parts of skimmed milk yield one part of “Weichquarg.”

Schlesischer Sauermilchquarg (Silesian Sour-milk Cheese).—The salted curd mixed with caraway-seed, made as described before, is formed by the hands into little flat loaves of 4 to 6 oz. weight, and laid on straw to dry, in summer in a shady place in the open air, and in winter near the stove. During the drying the cheeses become covered by a transparent wrinkled skin, and in this state they are often eaten, or they are dried until quite hard. This drying must, however, be conducted slowly, as the cheeses are otherwise apt to crack, and in the cracks mould would appear. When the cheeses are thoroughly dried they keep a long time, but before they are eatable they must undergo another treatment. For this purpose they are put in layers in a barrel or pot, between layers of damp straw or brewers' grains, or wrapped in wet linen rags. The cheeses regain here the humidity lost by their drying, and begin to decompose, which shows itself by the rind becoming dark yellow and soft. Every four to six days the cheeses are re-packed in this way after having been cleaned with hot water, and in three to eight weeks they are ripe for eating. If they are kept warmer the ripening proceeds more rapidly.

Brandenburg.

In this province also the development of dairying is of modern date, and large districts are still in the old way. There the cattle are worthless, the meadows are in a bad state, green crops are not raised, and the soil is continually impoverished by grain crops. A rational system of feeding is practised only exceptionally. The dairies are consequently in a very primitive state, and the peasants make inferior butter, but a few associations which have been formed produce good marketable butter and cheese.

Märkischer Presskäse.—This cheese is made by filling fresh salted curd—prepared from soured milk by heating to about 100°C Fahr., but not higher—into a small bag, which is tied up and pressed very strongly for forty-eight hours. Then it is cut in oblong pieces and treated like the Silesian Weichquarg, by curing in barrels or pots, interlayered with damp straw.

Kochkäse or Topfkäse (Potted or Cooked Cheese).—Curd made from sour milk is put in a warm place for a few days until it begins to get soft, and then is mixed with salt, caraway-seed, and butter (half an ounce to the pound), and put over the fire. It must be stirred all the time, and when the whole mass is melted to a uniform paste it is filled in
pots, where it stiffens to a transparent jelly-like substance which may be eaten at once.

**Province on the Rhine.**

This province has a good deal of clay land, some of it being very strong; 10 per cent. of the total area is permanent pasture, and 7 per cent. meadows, which are well kept and in many instances watered. In the lower part of the province Dutch cattle are prevalent; some farmers have introduced Shorthorns to produce more meat, and in the other districts of the province native breeds are to be found. Birkenfeld cattle show still in their massive forms the infusion of Bernese blood effected at the beginning of this century. Westerwälter are middle-sized cattle, and give much milk of a very good quality. The cattle in the Eifel mountains have of late been much improved by crossing with imported Swiss or Bavarian bulls. In some parts of the province the cattle are grazed during the summer, in others they are fed in the stable. The growing of green crops is very extensive; amongst them are clover, lucerne, saffron, rye, *Trifolium incarnatum*, vetches, maize, turnips, mangel, carrots, and swedes. In the winter all kinds of cake, brewers' grains, pulp from beet-sugar factories, &c. &c., are added to the straw and hay. On the smaller farms, which belong to peasants, the cattle are not so well fed, but on the whole the improvements have been marked of late years.

In the well-selected herds of Dutch cattle, the average yield of milk may be taken at 550 gallons per year, but cows are to be found that give no less than 26 quarts of milk daily, in the flush. The cattle-dealers generally promise a certain amount of milk after calving for each cow which he sells in-calf; if it turns out to be less, he pays back a certain sum for each quart below the promised quantity. It speaks volumes for the milking capacity of the breed that dealers promise up to 17 quarts per day after calving.

The province of the Rhine, containing many large towns and a considerable factory population, is adapted to selling fresh milk direct to consumers, which is done on a large scale. The Swartz method has been introduced on many large farms where butter is made, but on the small holdings the milk is still kept in earthenware and wooden vessels containing 3 to 5 quarts, until it is quite sour. The butter is, therefore, mostly bad. All the more so as the milk is generally placed in the living-room, where, with tobacco-smoke, cooking, &c., and without ventilation, the air is quite the reverse of pure. In general the principal product is butter, while the soured milk is used for feeding, but many farms produce also cheese, made after the Gouda (Dutch) or Emmenthal fashion. The sale of dairy products in the whole province is easy and profitable, and rising prices have been the rule for fifty years. The province cannot supply its own wants, and butter as well as cheese is largely imported from the neighbouring countries, France and Bavaria.

*Rheinischer Käse* (Cheese from the Rhine).—The fresh milk is poured into a wooden tub and the rennet added. In three-quarters of an hour the milk ought to be coagulated. It is then broken up softly with the hands, and water at the temperature of 130° Fahr. in a quantity equal to one-tenth of the milk previously employed is now added. In a quarter of an hour the whey is drained off, and the curd well pressed against the bottom of the tub with a little board one foot long and a quarter of a foot broad held in both hands. Now the curd is cut up with a knife, in pieces one inch square, and kneaded with the hands before the forms are tightly packed with it. These forms are made of tin, and are square, but twice as broad as they are high. The curd is taken out of the forms again, and re-packed in one form of double size containing about 10 lbs. After this the form is put under the press, and frequently turned for the next twelve hours, when the cheese is taken out and put for three days in a salt bath. The cheese is cured in a cool drying-room, and daily turned and put on a fresh dry place on the boards. In four to six weeks it is sufficiently ripe to be salable.

*Mainzer Hand-Käse.*—This cheese, which derives its name from being made in the neighbourhood of Mayence, is very much like the other hand-made cheeses, only that it is richer. The curd is prepared in the way which has been described before (Harzkäse), but when it has been pressed, salted, and crumbled, it is moistened with sweet milk or cream, before it is formed into the small disks of biscuit size. The further treatment is identical with that of the Harz cheese.

**Westphalia.**

The greatest part of this province is in the hands of small owners. There are many factories,
and the province is thickly populated. In some parts the cattle are grazed throughout the year, in others only during the summer months, and in yet others they are fed entirely in the stable.

A great deal of the milk is sold fresh to the towns; the remainder is generally used for making butter, fattening calves and pigs, and some for making cheese. The butter has a very good market in the industrial towns. The system of Swartz is adopted in many dairies, but on small farms the old earthenware dishes are still in use.

Westfälischer Käse (Westphalian Cheese).—
This cheese is made from skimmed milk. The cream is not taken off until the milk has acquired a slightly sour taste. After this has been done the milk is put on the fire to coagulate. The curd is now put in a sack of coarse linen and pressed, so as to extract the whey. When no more whey runs off, the curd is crumbled with the hands and put in a wooden tub, where it is allowed to ferment for eight or ten days, but before it is covered with a thick crust it is taken out, salted butter and a third part of fresh curd mixed with it, and formed into loaves or cylinders. In the forms it remains until sufficiently hard.

Nieheimer Cheese.—These cheeses, made around Nieheim in Westphalia, are well known on the Berlin market, where they are also called Frankfort cheese. The milk is kept until sour and the cream taken off. The milk is now heated to about 130° Fahr., and poured into a sack of coarse linen, where it remains to drain for twenty-four hours. Then the curd is poured on a table and rubbed with a small board until quite fine. It is now spread 2 inches thick in small trays, and put in the cellar to ferment, where it is frequently turned. After three to eight days this process is finished, and may be judged by the aspect of the curd, which must be a homogeneous yellowish mass without white specks of unfermented curd. Now salt, caraway-seeds, and milk are added, and the cheeses are made with the hand. The finished cheeses are put on boards, covered thinly with straw, and left to dry in a cool and airy room. The packing of the cheese is done between layers of hops, which have been already used for beer-brewing, but afterwards dried again.

Bavaria.

The climate of the country is on the whole good, with the exception of the mountainous parts, and especially the Alps, which form the southern boundary-line of the kingdom. In the northern provinces the grape-vine is extensively cultivated, and also tobacco, which speaks well for the climate; but towards the south it is more elevated and cold. It may be understood that the dairy interest is therefore principally concentrated in the last-mentioned parts.

Bavaria has several breeds of cattle. The best milkers are the Altgäuer, which are to be found in the mountainous district of Altgäu. The cows are light or dark grey, and not very large—about 850 lbs. They yield about 500 gallons of very good milk per annum. This breed has long been exported to all the countries of the Continent, and its fame is great. In crosses and pure-bred herds it is to be found on a great many farms.

In the north of Bavaria dairying is not in a very flourishing state, because the breeding of draught-oxen is the first consideration. The milk is generally put in earthenware dishes and allowed to become sour. The cream is made into butter, and the sour milk is either used as food or made into the small hand-made cheese, as described in the dairying of the Prussian provinces. On the large farms, of course, the dairying is better, and the milk is sometimes rented to a cheese-maker. The latter custom is very common in the south of the country. In large and sometimes even in small villages, cheese-makers work on their own account, and buy the milk from the peasants; also the larger farms commonly sell their milk in this way. Butter-making is in a very bad state in Bavaria; even in the best dairy districts second and third qualities are the rule. The small farms especially melt great quantities of butter to preserve it. This is generally used for cooking purposes. The butter is never salted. In places where no cheese-makers are, on small single farms, &c., the waste of milk is frequently deplorable. Very often the cream is taken from the milk and the skimmed milk given back to the cows, and the families of the peasants drink astonishing quantities of milk, and in some cases two cows are required for each member of the household. Almost all the dairies of larger farms are pretty well appointed, and furnished with tin or wooden milk-dishes; also the Swartz system is employed by many, though it was only introduced a few years ago.

The Government employs a chemist, who makes
a specialty of researches on dairying, in order to
give advice on dairy matters to all the farmers
who apply for it. He furnishes plans and esti-
mates for new dairies, or arranges old ones. If
necessary, he visits the farms in question. He
also lectures on dairy questions at farmers’ clubs,
&c. As he is paid by the Government, his whole
work is absolutely gratuitous to the farmers who
consult him.

Backstein Käse.—This cheese is a modifica-
tion of Limburg cheese, which comes from Liége,
in Belgium. It is generally made of half milk or
skim-milk. The milk is put in a kettle and heated
to about 90° Fahr. in the summer, in the winter
to 95° or 96° Fahr., and so much rennet added
that the milk is coagulated in forty to forty-five
minutes. After this has been arrived at the curd
is cut into squares of about 3 inches with a wooden
sword; it is then allowed to rest for ten or fifteen
minutes, and then is broken up with a stick
into pieces about the size of an egg, and put in
the forms, which consist of perforated wooden
boxes. Here it remains a few hours, until most of
the whey has run off, and then is taken from
the forms and cut into square pieces; these are laid on
a table with a rim about 6 inches high, and from
this point the treatment and curing are identical
with those of the Limburg cheese, as described
elsewhere.

Romadour Käse.—The fabrication of this
cheese closely resembles that of Backstein, but as
Romadour is made from whole milk, the rennet is
added at a higher temperature. The curd is also
cut into squares, but these are halved again so as
to form pieces whose long sides are of equal
dimensions. This cheese must be turned every
day when curing, and requires a good deal of
care. When three-quarters ripe it is wrapped in
tinfoil, which makes the ripening more equal.

Schachtel Käse.—This cheese is very delicious,
but as it does not keep long when once ripe, it
is hardly ever made in large quantities. The fresh
milk is warmed to 95° Fahr., rennet added, and
after half an hour the curd ought to be formed.
This is cut up slowly and carefully, and stirred
gently until the pieces are about the size of a
hazel-nut. Now the tin or wooden forms (6 to
8 inches in diameter) are filled, and after a
quarter of an hour the contents turned. This
turning is repeated several times during the day,
and next morning the cheese is put in the drying-
room, and daily salted for the next three to five
days, when it is put in the cellar to be cured.
Every second day the cheese must be rubbed over
with the hand a little and turned. In eight to
twelve weeks it is ripe and eatable. By wrapping
it in tinfoil for a few weeks before ripening it is
much improved.

Wurttemberg.

This country is blessed with very good soils.
Large farms are rare, and the peasants own their
small farms. Green crops of all kinds are exten-
sively raised. The greatest part of the milk produced
is sold in a fresh state to the consumers. Also large
quantities are used for feeding young pigs.
In the small dairies the treatment of milk, generally
speaking, is still in a very backward state. In
large dairies, where the milk is often rented by
cheese-makers, mostly Backstein cheese is made;
in some instances also Emmenthaler. The country
does not produce enough butter or cheese for its
own use, and imports largely, while the export
amounts to next to nothing.

Hohenheimer Käse.—At Hohenheim, near
Stuttgart, a special kind of cheese is made in the
following way. The evening’s milk is skimmed
on the following morning, and the morning’s milk
added to it in the kettle. It is then warmed up
to 107° Fahr., coloured, and the rennet added in
such a measure that coagulation is complete in
about an hour and a quarter. The curd is then
cut into square pieces with a wooden sword, and
further broken up with the hand. After a few
minutes’ standing the whey is drawn off and some
caraway-seeds added, and the curd made still
finer, until the pieces are of the size of a bean.
Now the curd is filled in cylindrical tin forms of
4 to 6 inches diameter, which are perforated.
The cheeses are turned, at first very frequently, by
upsetting the form, which has been covered up
with a little board. After eight or ten hours the
cheeses are put in lower wooden forms and salted
every day for four hours. After this has been
done, they are put in the cellar, and take about
three months to be perfectly cured.

Saxony.

The Kingdom of Saxony contains a large pro-
portion of mountainous country and a large popula-
tion. The culture of the arable land is therefore
forced to a considerable degree. Grazing is only
allowed in the autumn; in summer, clover and grasses; in winter, mangel, potatoes, cabbage, &c. Artificial food is universally employed. As generally, good cattle are imported, the average of milk per cow from the larger farms may be computed at 400 to 700 gallons per year.

About half of the milk produced is used as such. Flat wooden milk-dishes are employed generally, but newer methods, as for instance Swartz's, are the rule on larger farms, which sell their milk to a cheese-maker, or work their dairies on their own account; there mostly Backstein cheese of skimmed milk is made, and the butter sold direct to the towns. Cheese-making is little developed in Saxony, and large quantities of better cheese are imported. Butter is in such demand, that only a little more than half that is required is produced in the country, while the rest is imported. The small farmers produce hand-made cheese, but a great deal of milk is used by them for rearing and fattening pigs.

Mecklenburg Schwerin.

This grand-duchy contains mostly large farms. The small farms are not owned by the peasants, but are rented by them, and generally descend from father to son. In 1873 Mecklenburg contained 272,795 head of cattle, including 200,126 cows. In the summer the cattle are mostly grazed. The country possesses no breed of its own; the so-called native cows are a mixture of all kinds of breeds, and they are very inferior as to form. Angler are bred very frequently; Breitenburger, Ostfriesien, and Dutch, are to be found also, but Ayrshires have lost the position they once had. The principal food for the winter is straw, with some hay or oil-cakes.

The milk is mostly used for making butter, the remainder for feeding purposes, and cheese-making is rare. The milk is kept in glass or stoneware dishes, rarely in wooden, but is treated in the same way as in Holstein. The butter is mostly sent to Hamburg, in wooden casks. At Raden there is a dairy-school and dairy experimental station,* which were founded by a few large landowners.

The grand-duchy of Hesse contains a great number of small holdings, but large farms are also to be found. The dairies are as yet mostly of an inferior kind. The milk is kept in low cellars with deficient ventilation; in the winter it is put in the general living-room, sometimes the bedroom, and is set in earthenware pots containing two to three quarts. Some of the larger dairies have, however, better appliances. Butter is made from soured cream, and is well washed with water. The thick, sour milk is eaten in towns and in the country, but mostly it is fed to pigs or young stock, or hand-cheese is made from it. Some time ago factories were established; these buy the curd from the peasants and make the cheese from it. The sale of all dairy products is very easy and remunerative, because of the many large towns in the neighbourhood, all united by railways.

Hand-made Cheese.—This kind of cheese is made in Hesse in the following way:—When the milk is coagulated, which may be accelerated by warming it, the curd is poured into a piece of linen and the whey pressed out. The curd is then mixed with salt, and often caraway-seeds, and kneaded carefully until it has become a fine mass. The forming of the cheese is done by taking a piece of curd on the palm of one hand and beating it with the other; the cheese are 2 to 3 inches in diameter, and about 1 inch thick. The cheese must present an even surface and have no fissures, as otherwise the curing does not proceed regularly, and mould would appear. In summer the drying is done in the open air; in winter, next to the stove; and occupies five to ten days. The dried cheese are then laid in pots or wooden the management of Dr. Wilhelm Fleischmann, whose valuable and long-continued researches into milk and its products are highly appreciated in many countries. In the month of March, 1877, it fell to our lot to pay a visit of two or three days' duration to Schleiffenburg, during which we were much interested in looking into Dr. Fleischmann's dairying arrangements. The salient product of the Radon Dairy is butter for the English market, and the Swartz system of cream-raising is followed up in its integrity. This system we have described at some length at p. 293. Besides butter, skim-milk cheese is made for local consumption, and almost the whole of the work in the dairy is performed by students, who have come to profit by the tuition of Dr. Fleischmann, whose services are paid for by Government, the remainder of the expenses of the station being defrayed by the students' fees, and the deficiency, if any, by the several noblemen and gentlemen who were instrumental in creating the station. The results of this system are very satisfactory. [Ed.]

* The Experimental Dairy Station here alluded to is on the fine estate of Graf von Schleiffen, who for some time past has devoted much energy, money, and intelligence to the improvement of agriculture, and particularly of dairying, in North Germany. The station has been for some years under
buckets, and put in the cellar, where they are washed with water and brushed after ten to twelve days, and are put back into the pots. This treatment has to be repeated two or three times, when the mould is growing strong. In eight to twelve weeks the cheese are ripe, and contain only in the centre a small nucleus of curd.

*Weisser Käse* (White Cheese). — The poor townspeople and the peasants eat this kind of curd in great quantities. It is simply curd from sour milk, well kneaded and mixed with salt. It is eaten like butter with bread or potatoes, and in some districts the people mix it with milk, cream, or garlic.

*Schmierkäse.*—The salted curd, made in the way just mentioned, is mixed with a small quantity of over-ripe hand-made cheese, frequently half a year or a year old, which has a very strong taste and smell. When it is mixed to a uniform paste it may be eaten, which is done by all classes of the population, and it may be therefore called a national dish.

**Austria.**

Austria has in its provinces so very many varieties of soil and climate, some of which are almost incompatible with dairying, that it is not to be wondered at if its general status of dairy products is inferior. This is still easier to explain, when we consider that by far the largest part of the population is in a state of civilisation which does not coincide with the care and cleanliness, as well as the fineness of taste in eating, which are certainly necessary to promote the production and consumption of dairy products of a better class.

Austria has many valued breeds of cattle, which not only suit her wants, but are exported in such numbers, that we may say Austrian successful stock-breeding is principally founded on the needs of the neighbouring countries. The principal Austrian breeds are the *Hungarian Steppe* breed (Steppe-plains), which is closely related to the Russian cattle of the plains. These plains are often dried up for months in the summer, and yield hardly anything, also the changes of temperature make themselves felt, and inundations often cover the land. This breed is the hardest of all European cattle, but it is also dreaded as the bearer of the rinderpest, which seems to have no such deadly effect on it, however, as only about 20 per cent. die of those attacked, while of the other breeds up to 70 per cent. succumb. These conditions have prevented any crossing with the Hungarian Steppe cattle being successful. They are of grey colour, and are easily known by their immensely long horns. The cows give very little milk—about 150 gallons per annum, of very rich quality—but often not enough to nourish their calves. The breed does not possess any good feeding qualities, but is excellent for draught.

It is difficult to give a short description of Austrian dairying, considering the many different nationalities, climates, &c.; suffice it to say, therefore, that some parts of the country have no dairying which may be classed as such, as they only produce butter and cheese, which is, in most instances, unmarketable. In the Steppes the cattle and food are of a kind which makes dairy-farming impossible. In the northern and western provinces dairying may be well compared to that in south Germany, possessing all its faults and making its mistakes in the treatment of milk and butter. The small farms rarely make good cheese, and never butter of first quality, as the cream is generally churned in a sour state. Dairy associations are rare as yet, but cheese-makers frequently buy the milk of villages and large farms. On the latter the dairies are mostly better appointed, some setting their milk after Swartz...
or other approved methods, and making good cheese. The principal kinds of cheese made in Austria are those described already: Backstein, of half new milk and half skim milk; Limburger, of whole milk; Emmenthaler and Swiss Gruyère, made from half milk. In small quantities Ouartel (hand-made cheese), Schachtel cheese, goats'-milk cheese, &c., are also produced.

The annexed engraving (Fig. 353) shows an Austrian mode of cooling milk, which is very simple and, in some respects, novel. It consists of a vat or tub through which cold water is constantly circulating. On the surface of the water floats a circular wooden plate, provided with a number of round holes, into which are inserted the vessels containing the milk. These are made of sheet zinc, two feet long, and each, according to the Wiener Landw. Zeitung, contains a little over a gallon of milk.

It takes about fifteen minutes to cool the milk down to a temperature slightly above that of the surrounding water. When not in use the cylinders are turned upside down, on a wooden rack, as shown in the engraving, to drain and dry.

SWITZERLAND.

The cheese-making of Switzerland is already very old; but only during this century it has developed to a considerable fame and importance in the markets of the world. After 1820 associations began to be founded, with the object of producing better and more marketable cheese during the winter months. On the mountains similar associations had been in action for many years during summer-time. From that period dates the development of Swiss dairying. These associations exist now to the number of several thousands; and either sell their milk to a contractor who makes cheese, or work the factory themselves with hired labour.

The milk is generally set in the round wooden dishes, containing 8 to 10 quarts, which have been used since time immemorial. In some Swiss dairies the Swartz system has, however, been adopted, and seems to be gaining ground.

The best-known kinds of cheese made in Switzerland are the following:—

<table>
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<th>Kind</th>
<th>Description</th>
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<td>Emmenthaler</td>
<td>Of all Swiss cheese this is the most important, as it is sent to many parts of the world. It is generally made of whole milk; but in summer, when the pasturing on the Alps has just commenced, a quarter or half the milk is set, and the cream taken off after twelve hours. These cheese are of very large size—80, 100, 120 lbs. on the average—and they have commonly a diameter of 3 to 4 feet, with a depth of about 6 inches, a size and shape whose appearance is striking. In some very large factories a cheese is made in the morning and in the evening from fresh milk, but mostly only one in the morning. For this purpose the evening's milk, which has been set, is skimmed in the morning. The morning's milk is poured into the kettle, the cream from the evening's milk added, and the whole heated up to 107° to 112° Fahr., during which time it is well stirred at the surface until no more flakes of cream can be seen. When the above-mentioned temperature has been arrived at, the skimmed evening's milk is added and the heating stopped, when the contents of the kettle have a temperature of 86° to 98°. The rennet used generally consists of pieces of calves' stomachs, steeped for twenty-four hours in whey; the liquid is poured into the milk and thoroughly mixed with it. In thirty or forty minutes the milk ought to be coagulated, and is then cut up with a wooden sword into squares. Then a shallow wooden dish with a handle is employed to break up the curd evenly in pieces, of the size of a small apple. Now a curd-breaker, Fig. 354, is used to stir the mass, until the curd is reduced to pieces the size of peas, when the work is stopped and the curd allowed to settle for ten minutes. After that a good fire is made under the kettle, and the contents stirred until a temperature of 130° to 140° is reached. Now the kettle is taken from the fire and the stirring continued until the curd is &quot;ripe.&quot; To know this is of course solely a matter of practice. Some cheese-makers know it by biting the curd, others by feeling it and squeezing it between their fingers, and it takes about forty to sixty minutes stirring to arrive at the proper point. At the close the contents are stirred for a minute, so rapidly that a deep funnel is formed in the centre.</td>
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Switzerland.
This makes the curd settle down in a compact mass, which can be easily taken out with a cloth. For very large cheese, machinery is sometimes employed to lift out the curd and transport it to the press; 17 to 18 lbs. of pressure for each pound of cheese are employed for twenty-four hours, and then the cheese is taken out and put in the cellar to be cured. Under the press the cheese is frequently turned, and the wet cloth changed for a dry one. Mostly two kinds of cellars are employed, one of which is subterranean and therefore cooler and damper.

Cheese is either directly salted after leaving the press, or it is commenced with after one to three days. The salting is done by rubbing with dry salt, and after a fortnight the cheese is brought into the upper cellar. The salting is done every day at the beginning; for a few months every second day, and afterwards less often. For large cheeses, often a year, and even longer is necessary for ripening, and about 4 to 5 per cent. of salt is required. A good Emmenthal cheese ought to show when ripe a homogeneous mass without cracks, and contain round holes of the size of peas, which must contain a little liquid. It ought to melt on the tongue without leaving any crumby matter, and have a pure, agreeable, rather sweet taste.

Skim-milk Cheese.—In some dairies of Switzerland skim-milk cheese is made during the winter, when so little milk is at disposal that no large Emmenthaler cheese can be made. The Swiss skim-milk cheese is rarely good; it is made too much after the same fashion as Emmenthalers, without taking into consideration that all the cream has been taken off; the curd is too rapidly coagulated and worked and heated, and in consequence the cheese is generally hard or tough.

Gruyère Cheese.—The making of the Gruyère differs only a little from the Emmenthal method. The rennet is added at a lower temperature (86° Fahr.), and the curd is heated up to 130°, 135°, and even to 140° Fahr. The forms used are similar to those employed for the Emmenthalers, but in this case they are concave, so that the sides of the cheese-leaves have a convex shape.

Buttelmatt.—Fresh milk is directly coagulated with rennet, the curd broken up and heated for forty-five minutes, and stirred for fifteen minutes afterwards. The curd is then taken out and hung up in a cloth. When most of the whey has dripped off the curd is put in a wooden form and daily salted. This cheese is only made for local consumption.

Schabzieger.—This cheese is also called Kräuterkäse, and is made in large quantities in the cantons Glaris and Grisons; in the first-mentioned department alone about 2,500,000 lbs. are annually made. The milk is thoroughly skimmed, after having been set as long as possible, and then heated in a kettle up to the boiling-point, when cold fresh buttermilk (up to 20 per cent.) is added. The heating is continued, but not so strongly as before, and sour whey added, and the kettle taken from the fire. After the whole mass is coagulated it is stirred up a little and left to cool, when the curd is put in large wooden perforated boxes, or in sacks, and pressed with large stones. The Zieger now undergoes a kind of fermentation, which is most favourably conducted at a temperature of 60° to 62° Fahr., and lasts from three to six weeks. If the temperature is too high the Zieger is apt to be decomposed, while at a low temperature it gets blue and tough. After the fermentation is concluded the Zieger is ground in a mill, and at the same time 5 per cent. of salt and 2 to 2½ per cent. of dried Melilotus albus Lam. is added. This kind of clover gives the cheese its peculiar taste and bluish green colour. The mass is now firmly beaten and stamped in the small wooden forms which have been laid out with a fine cloth. After eight days the cheese, which are conical in shape, (5 to 6 inches high, and 3 inches in diameter), are taken out of the forms and seraped with a knife. In cool, dry rooms they are kept for at least six months, but they are only ripe after a year. For eating, they are grated to a fine powder, and either strewed on bread and butter, or some butter is mixed with the powder to form a paste.

Vacherin is a kind of cream-cheese, which, as a rule, is made only in winter. Saanen is a skim-milk cheese, and hard, so that it can be grated; it is made in loaves of 16 to 24 lbs. Urseren is made in the canton Uri, in thick loaves of 50 to 60 lbs. It is made of milk, half of which has been skimmed.

THE ALPS.

Dairying in the Alps has an originality all its own, caused by the peculiar conditions under which agriculture is followed there. These conditions are created by the natural situation, the
form of ground, and the climate, and are consequently the same all over this large tract of mountainous country, whether it belong to France, Switzerland, Italy, Austria, or Bavaria. The resemblance is in all these countries so great that we may class them under one head.

Alpiculture in its present form is already of very ancient date, and as its exclusive object is and long has been production of cheese and butter, the following ancient mode is still adhered to at the present day:—The winter is passed in the stable in the valley, and the cattle are fed there with hay which has been made on the meadows which lie in the valley; these meadows are drained by open ditches when necessary, and well manured with stable dung. As soon as the grass has grown a little in spring, maybe in April or at the beginning of May, the cattle are grazed on the meadows, but not more than a fortnight or three weeks, otherwise the growth of grass would be too much checked, and the result would be a small hay crop, on which the herd must depend in the winter for its nourishment. Therefore the cattle are removed as soon as possible to the pastures situated on the lower parts of the slopes of the mountains. These sheltered pastures, where vegetation is much more advanced than on the higher ones on the mountains, are called “Maisäss”—mayseat, from “Sitz im Mai” seat (residence) in May—which is quite appropriate, as they are generally first used in the month of May. We have once found such a pasture called in an old parchment of the fourteenth century “Apryensitz” —Apriläss, seat in April—and this place is still known by its early vegetation, so that it can still be sometimes pastured in April. But this is an exceptional case; generally the Maisäss is pastured from the end of May or beginning of June until a fortnight or four weeks later, as also here the crop of hay which is expected from a Maisäss must not be imperilled by late grazing in spring.

By the end of June, or beginning of July, the cattle are again moved, this time to the “Hochalpe”—high alp. There they remain generally four to six weeks. Even then, in the height of the summer, not unfrequently a fall of snow compels the herds to seek warmer quarters farther down the hill for a few hours, or even days, until the snow has melted again, as they cannot graze on pasture covered with snow, and soon fall off in milk unless better feeding-ground is provided. Sometimes there is a second “Hochalpe” situated still higher, where the cattle only remain one or two weeks. When the grass runs short, or the weather begins to get cold, the cattle are removed to the “Maisäss,” and from thence to their home in the valley, but the time of their arrival hither differs very much. Sometimes the hay collected at the “Maisäss” is fed when the cattle return to it, and though they sometimes remain at this station until long after snow is on the ground, they generally return direct to the valley by the middle of September to graze on the meadows and bare fallows, and return again to the “Maisäss” to feed there on the hay, when all the grass in the valleys is done. Sometimes, on low-lying alps, the cattle remain there from the first, when they have grazed on the meadows in the spring, and return to their winter quarters towards the end of October. This is the case if no “Maisäss” belongs to the “alp.”* Also the farmers who live in the plains, but send their cattle to an “alp” for the summer, bring them directly to the “Hochalpe”—of course, later on in the season.

This description of the grazing has been necessary in order to explain the large flow of excellent milk obtained in the Alps. The cows are fed in the winter on generally very good hay from the valleys; the calves are timed to come, if possible, in February and March, and the cows are turned out to graze on the meadows in spring, and so the milk-secretion is very much increased by green food. Later, when the good effects of this are on the wane, the milk production gets a fresh stimulus from the nutritious grasses and herbs on the “Maisäss.” Further on there is another change to the fine short grass and the aromatic herbs of the “Hochalpe.” Here the milk is richest in flavour, and contains most milk-sugar; its delightful sweetness and flavour, unattainable by any other feeding in the world, are imparted to the cheese, which is then at its highest state of perfection if well made, but this is not always the case. By this method of feeding the milk-secretion is not only brought to the highest point in quantity and quality, but is also maintained a very long time in this state. In this system of changing pasture lies the secret of Alpine success in the production of milk.

*Alp, German “alp,” or “alpe,” is a pasture-ground in the Alps grazed by one herd.
Of course the value of the Alpine pastures is very variable; some are very dangerous for cattle, because of cliffs and precipices. Such "alps" are reserved to goats or sheep. Also a great deal depends on the state of cultivation which the "alp" is in. With not many exceptions alpiculture is still in a crude stage. Drains, though often necessary and easily made, as there are plenty of stones to be had, are hardly ever made; there are very few irrigating arrangements, though there is generally plenty of splendid water, and manuring is mostly not practised at all. Generally the pure manure — litter is not to be had—is thrown on a heap beside the stable, and left there to rot. It is only very slowly that some districts, especially in Switzerland, begin to utilise the stable manure on the Alps.

The pasturing is conducted in the following way:—In the morning the cattle are driven from the grazing-ground to the "Alphütte" or "Sennhütte"—chalet—where the cows are milked and given a little salt or bran boiled in whey, sometimes a little hay, etc. After that they are allowed to rest for a few hours in the stables, and then are taken out to the pasture, where they remain until the evening, when they are driven to the hut and milked, to be sent out again directly afterwards. On very hot days they remain in the stables during the hottest part of the day, and in very rainy or cold nights they are kept in the stables as well, especially if there are no woods on the "alp," where the cattle can find protection from the sun, and shelter from the rain. It is certainly a drawback to Alpine dairy-farming that the weather is so very changeable, for milk-production is very uncertain, though large on the average. A few cold days, or much rain, or great heat, when the cows do not feed so well, bring the secretion very low, while warm nights and pleasant days with a cooling breeze cause a considerable increase. These fluctuations often amount to 10, 15, and even 20 per cent., and always make themselves felt within the next twelve to twenty-four hours, a fact which throws some light on the physiology of milk-secretion.

It is not so very long, perhaps only a few hundred years, since the time when stables were unknown in the Alps, so that the cattle had to be out in the open air in all kinds of weather, and even new calves and heifers are rarely housed while on the mountain—though they have the highest and roughest pastures allotted to them. The stables are rarely built alone; generally they are under the same roof with the dairy and the lodging for the herdsmen.

The coloured plate of Alpine dairying represents two of these "Sennhütten," and they are built with little variety all over the Alps; indeed, these are drawn from nature in the neighbourhood of Tegernsee, in the Bavarian Highlands. Their situation is generally on a plateau or a soft incline, where the best pasture, dry ground, and a good spring of water may be found. Also a sheltered spot is preferred. The "Sennhütte" seen in the foreground of the picture is built of solid beams of pine-wood, which have been roughly hewed square, and fitted together with long nails made of beech-wood. A solid roof covers the hut. It consists of beams of one foot and a half diameter, covered by wooden tiles 3 feet long, about 1 foot broad, and 1 inch thick, roughly split from straight-grown pines. The tiles are kept fastened down by several poles stretching across them, and weighted by a number of heavy stones of from 50 to 100 lbs. in weight. This is absolutely necessary, as the roof would be blown off very often by the severe thunderstorms and gales blowing with incredible force on these heights. Fire-wood for cooking purposes is piled up against the wall on one side of the house, and a man in the costume of the country is leaning up against it. The door, and a bench fastened to the wall on the other side of it, are guarded from inopportune visits of the cattle by a rough bench and a gate, at which the dairymaid (Sennnerin) in her picturesque and neat costume is placed. The roof projects so far as to cover the whole verandah.

The systems of dairying vary very much in the Alps; sometimes Gruyère cheese is made, especially when there are large quantities of milk to dispose of, when the "alpe" belongs to an association, or when the milk is let. On small "alpes," or where there are several proprietors, generally sour cheese and butter are both made. The milk for butter-making is generally set in pans of glazed earthenware, containing 2 or 3 quarts, or in large wooden dishes. The cream is often taken off after twenty-four to thirty-six hours and directly churned, or left standing in the cellar until a sufficient quantity has collected for churning.

The butter on the Alps has wonderful keeping qualities. It may be kept there from two to three
months and yet not be rancid, but it will not keep in the plains or valleys. It is generally kept in the same room with the cheese, which impairs its otherwise excellent flavour; it is not salted, but very often melted and kept for winter use. Generally speaking, we must not look to the Alps for perfect methods of dairying.

On some alps milk-sugar is still made. For this purpose whey is boiled down until only a kind of brown syrup remains in the kettle, which is raised so high above the fire that the flames can only reach the bottom, otherwise the sugar would be burnt. This syrup is poured in flat dishes, and after twenty-four hours the sugar is crystallised like yellowish sand; this is washed in a little cold water, dried, and sold.

Whey-cheese is eaten with great relish by the inhabitants of the Alps; it is therefore most generally made. Whey is heated to about 140° Fahr., when the whey-cream rises, which is taken off; then some sour whey is added and more heat applied until the albumen rises, when near the boiling-point, in a compact mass to the surface. It is now taken off rapidly and hung up in a cloth to drain. After this it is either eaten fresh, or salted and cured, or salted and smoked. For the two latter methods it is packed during one or two weeks in sacks, or wooden boxes perforated with holes, and pressed by putting heavy stones on it. Buttermilk is often added to the whey to make this kind of cheese richer.

The labour of the Alpe or Sennhütte is done either by men or women. Sometimes there is a man in the dairy (Senner) who has a helper (Beisenn) and others besides, who milk the cattle (Melker) and attend to their pasturing (Hütter). If the "alpe" is small there is generally a woman (Sennin), who acts as dairymaid and attends to all the other work.

ITALY.

In the northern provinces of Italy all the conditions are fulfilled which make it possible to feed milk cows in a profitable way. Extensive irrigation works produce, in combination with a warm climate, heavy crops of succulent grass and vegetables. In the south it is not so. The burning sun is not relieved by water, and generally the cows are very poorly fed. It will not be astonishing if we find a great difference between the dairies of the north and the south, which is, in fact, the case. In Lombardy, for instance, the meadows are irrigated throughout the winter, and may be cut eight or ten times in the summer, or they are watered only in summer and manured with urine, so that they can be mowed five or six times. In other places the soil is cropped with cereals, then laid down with grass, cut three or four times a year, and grazed in the autumn.

When this has been done for two or three years another cereal crop follows. These artificial meadows are well stocked with clover, especially with white clover, which is much esteemed because it is said to give the milk a certain flavour, very desirable for Parmesan cheese, which is generally made in these districts. In the south grass is rare, and the cows are fed mostly on leaves, weeds, refuse from vegetables, &c., and the bad nourishment stops not only the proper development of the cows, but affects also the quality of the milk in a degree we should hardly believe possible, and renders the production of good cheese an impossibility. While dairying in the northern provinces is in a high state of perfection, it is, with few exceptions, very bad in the south, and there is no hope of a speedy development, because all the conditions are very unsatisfactory for dairy-farming.

The butter industry in Italy is yet in its infancy; the bad butter everywhere is a sufficient proof that it is not much eaten in its fresh state, and for cooking purposes only olive oil is employed.

The following is a list of Italian dairy products, including all the more important and famous ones:

- Cream—Latte miele.
- Butter—Fresh butter.
  " Burri vestiti.
  " Mascarpone.
- Cheese—Parmesan (Formaggio di grana).
  " Chiavari.
  " Cacchiovallo.
  " Stracchino di Gorgonzola.
  " Pecorino dolce.
  " Proveta.
  " Ricotta (fresca, saltata, et affumicata).
  " Provvoloni.
  " Pecorino.
  " Calvezano.
  " Mazzoldo.
  " Pecora e capra.
  " Guascini.
  " Gruyère.
  " Dutch.

And the methods employed in making several of the more important and better known of the foregoing are briefly as follows:
1. Latte-miele.—Cream is put in a vessel surrounded by ice, and then beaten until it rises, when an equal weight of white pounded sugar is added and beaten in.

2. Burri vestiti.—A paste made from curd is formed in cylinders or other shapes, and filled with butter. The sort of cheese from which this paste is made decides the name of such butter, for instance—in pastati cacciocavallo.

3. Mascarponi.—Cream is heated over a slow fire until thick, a little sour whey or vinegar is added, and the mass filled into a cylindrical form.

Parmesan Cheese.—The milk is set and the cream taken off after a certain degree of acidity in the milk is attained. The skim-milk is warmed in a kettle to 80° to 85° Fahr., and the rennet added. The kettle is then covered up and withdrawn from the fire. After forty-five to sixty minutes the milk ought to be coagulated, when it is turned and cut up rapidly while a hot fire of dry wood is made under the kettle. After a quarter of an hour more wood is added to the fire, and the curd stirred until a temperature of 125° to 132° Fahr. is reached, when the kettle is taken from the fire and left untouched for a quarter of an hour. Afterwards nine-tenths of the whey is drained off, and cold water carefully added until the hand can bear the temperature. The curd is then balled together with the hands, a cloth slipped under it, and it is lifted into the wooden form, where it remains until the evening. This cheese is not pressed. The next day the cloth is taken off, and the cheese put in a cool cellar, where it remains for four days. After that the leaf is turned and salted once daily for twenty days, and the same treatment is repeated once every second day for a similar period. After these forty days the cheese is taken out of the form, scraped with a piece of iron, washed with hot whey, and put in the store, a large high and dry shady room. Here the loaves are turned, first twice a day, and oiled once a day with linseed oil; later on this treatment is only repeated every second day.

Generally the dairies sell their cheese after the salting is finished, and the merchants undertake the curing, which requires great care, in their own storerooms. Parmesan cheese ought to be three years old before it is used. In the first year it is called maggengo, in the second vecchio, and in the third stravecchio.

Chiavari Cheese.—Milk is heated rather high, 100° to 120° Fahr., the curd stirred a little, filled into cloths, and put into wooden forms in which it is pressed slightly. After a few days the cheese is taken out of the form, and salted and turned every few days. This is one of the simplest and oldest methods of making cheese.

Cacciocavallo Cheese.—The name of this cheese seems to imply that it is made from mares' milk, but it is not so, and though it may seem strange at first, the name is most likely derived from the shape of the cheese, which adapts it to be slung over horses' backs when carried away. Cacciocavallo may now be found having all imaginable shapes. Some resemble vegetable marrows, or melons, others look like bottles, or flasks, or animals' heads.

As the thermometer is hardly in use in the south Italian dairies, the statements as to the temperature of the milk before adding the rennet are very different. We may say, however, that it lies between 85° and 110° Fahr. The rennet is employed in a very primitive way; mostly the stomachs of young goats and lambs are dried without having been cleaned, a part is cut in small pieces, wrapped in a linen rag, and suspended in the milk until it is coagulated. The curd is then broken up and stirred until the whey has sufficiently separated, when most of it is drained off, and a part put on the fire and poured in a boiling state over the curd, which has been put in a wooden tub. In this state the curd is allowed to ferment, in a cool place, until it rises like bread-paste. A great deal depends on choosing the right moment to stop this process, which generally is arrived at after eight to fourteen hours. The ripeness of the paste is tried by dipping a piece of it in boiling water, when it ought to draw out in long threads. If this can be done, the whole curd is put in a wooden vessel filled with boiling water, cut to pieces with a wooden knife, and the paste drawn out in long tough ribands, which are formed into a kind of ball afterwards by winding them round. When a sort of nucleus is formed this way, it is easy to give any desired shape to the cheese by winding on different parts of the ball. By kneading, turning, and pulling the shape is rounded and finished. Now the cheese is put for two to four hours in cold water, and after-
wards for twenty-four to forty hours in a solution of salt. After this it is hung in the smoke until it has received the desired light-yellow colour. These cheese are made of very different weights, from half a pound to twenty pounds; they are considered a great delicacy with the Italians, who not only eat them with bread but also with macaroni, risotto, and other favourite dishes. Caciocavallo is a very hard cheese of rather indifferent taste, reminding of young Parmesan; it dries up easily when once cut, and then has a rancid oily taste. It contains but few and small holes, and on breaking it the concentric layers show the way in which it was formed.

Stracchino di Gorgonzola.—This cheese is made in loaves of the proportions of Cheddar, and of 20 lbs. to 40 lbs. in weight. The milk is coagulated warm and fresh directly after milking, so that it is thick in ten to twenty minutes. Now the curd is slightly broken up and left alone until it has sunk to the bottom, when it is still more cut up with a wooden instrument, always drawn in one direction. After this it remains untouched for an hour, and is then cut in squares. When the whey has collected pretty clear over the curd it is drained off, and the curd is left to hang in a cloth until all the whey has run off; after this it is filled in the wooden forms, which can be made smaller. The filling is done in the following way:—Curd which has been made the day before is crumbled and put in alternate layers with the fresh curd, which is also crumbled, with the provision that the first and last layers are from the fresh curd. The forms are then covered up and left standing for six hours, when the top of the cheese is loosened three or four inches deep, covered with a cloth, and the loaf turned upside down. After twelve hours the cheese is again turned, and after twenty-four hours the cloths are taken away, fresh forms substituted, and the cheese taken to a room whose temperature is about 65° to 70° Fahr., where it is placed on a table thinly covered with straw. For the next three or four days the loaves are turned several times a day, then the forms are taken away and the cheese placed for twenty-four hours on a table strewn with salt, where it is turned several times. For the next twenty-four hours it is put back into the forms. This alternate treatment is repeated from ten to twenty times. Afterwards the cheese is kept six to eight weeks in a cellar, where it is turned, wiped, and salted repeatedly. These cheese are very highly prized, and are very delicious food; when they are ripe blue mould permeates them throughout, and they resemble, alike in flavour, appearance, and consistency, a fine specimen of a rich and ripe old Stilton.

Pecorino Cheese.—This cheese is made from sheep's milk, which is rather abundant, as there are a great many sheep in Italy, especially in the mountainous parts, where they have cheap feeding on the mountain pastures in the summer, while they are grazed in the plains during the winter. The fresh milk is poured into a copper kettle, and the rennet added at 77° to 82° Fahr. There are different kinds of rennet in use: the stomachs of lambs, young goats, calves, the dried flowers of thistles (Cynara Sylvestris), artichokes, &c. When the coagulum is formed it is broken up and rapidly stirred for a few minutes; then it is allowed to settle for ten to fifteen minutes, and then stirred until the curd is broken up in small particles, while the kettle is heated to about 100° to 120° Fahr. This is done very differently in some dairies. When the curd has been allowed to settle at the bottom of the kettle it is taken out with the hands and put in wooden forms, which are perforated at the bottom and at the sides so that the whey may run off. After twenty-four hours the cheese is taken out of the forms and put into a solution of salt, where it remains one to two days, when it is washed and dried, and then put into a very dry room, which is only ventilated in summer nights. In the beginning the cheese is washed every second day with water and salt—in summer with water and vinegar—and later on it is rubbed with olive oil twice a week. The Pecorino is rarely good, mostly bitter, rancid, and dry, and its size not very large.

Provole Cheese.—Provole is made from buffaloes' milk, which is small in quantity and very rich, and contains no less than 8 per cent. of butter-fat. The method of making Provole is very simple. The milk is coagulated with rennet and broken up with a wooden knife. The curd is now put in hot water, and formed there directly into a loaf; this is put first in cold water and then in a salt-bath for seven to eight hours. This cheese is mostly eaten fresh, and Italians from the south consider it a delicacy, while strangers generally do not like it.
Ricotta.—This product is made from whey (whey cheese), by heating it up to the boiling point, having first added a little sour whey. The albumen which rises to the surface is taken off, and either eaten fresh (fresca), or salted and cured (salata), or salted and smoked (affumicata). To make it more palatable, often some milk or buttermilk is added to the whey before heating it.

BELGIUM.

Fromage de Limburg is usually associated with Belgium, and it is perhaps the only noticeable thing in the country’s dairying which has not been elsewhere described; it is, however, made in other countries as well, to wit Bavaria, Wurtemburg, &c., either in its integrity or with unimportant modifications. In the Province of Liège the manufacture of it is a speciality, and, as in the case of other noted kinds of cheese which have been more or less successfully imitated in districts other than those in which they originated, and whose name they bear, it is probably not made with equal success elsewhere. It is a specially distinctive feature in the neighbourhood of the town of Herve, for which reason it is not uncommonly spoken of as Fromage de Herve on de Limburg. When perfect it is a light yellow in colour, and has much of the consistency of butter; it is, however, in many cases made from milk from which a portion of the cream has been removed, in which event, as in the case of any other kind of cheese, it cannot be regarded as a first-rate article. According to Pourian, Limburg cheese may be kept in the cellars or vaults eight or ten months, to ripen; the making of it ordinarily commences in August or September, and it is ready to be sent off at the end of May. The method of making it differs but little from that of Backstein cheese, described on page 530.

THE NETHERLANDS.

The Dutch cattle are to be found distributed almost in all parts of the civilised world, and before the shorthorns came in general use no breed of cattle was so generally known. The reason of this is principally the excellent milking qualities of the breed. The Dutch cattle are all of one common origin, but different feeding and crossing have caused the development of several distinct groups in the breed. The two groups called North and South Holland cattle are the most nearly perfect in shape, and yield and form the best ideal of milk-cows. The Westfriese is somewhat courser and heavier; they used to be the best cattle of Holland, but by injudicious crossing and by disease they have degenerated. The Gröningen have a great reputation for their milking qualities. They are conspicuous by their broad hips and large udders. The Zeelanders are heavy cows, which do not give quite as much milk as the other breeds, but are very good for fattening purposes. To develop the latter quality, extensive crossing has been going on for some time with shorthorn bulls, and this measure has had good effect.

All Dutch cattle are either black-and-white, grey-and-white, or red-and-white.

The keeping of cattle in the Netherlands is conducted with proverbial care and cleanliness. Indeed, there is no other country where dairying is in such a flourishing state; the populations of large districts living sometimes entirely from its proceeds. The milk is of course of great value, and very often the calves are killed directly after birth; keeping them for a few weeks and then selling them to the butcher, as is generally done on the Continent, would not pay for the milk consumed. Calves reared for the herd receive new milk for two or three weeks, then skim-milk for a time, and later on buttermilk, whey, cooked linseed meal, &c., are gradually substituted for milk, and at the same time some hay is given. After ten or twelve weeks grass feeding begins, but throughout the summer some nourishing mash or drink is given when on the pasture. During the next winter the calves are fed on hay of middling quality, as the best is given to the cows, and they are allowed as much exercise in the open air as the weather permits. In the next winter the heifers (one and a half years old) are chained alongside the cows, and receive better food; and they are timed to have their first calves when they are two and a half to three years old.

The cows are kept in the stables during the winter, and are grazed during the summer. On the pasture a shady and sheltered spot is selected and fenced in, where the cows are driven twice a day to be milked. Wooden milk-pails, neatly painted, are used, and the milk strained directly through a fine horsehair sieve into barrels or larger
pails (Fig. 355) painted white on the inside, and blue or green on the outside, and containing about 4 gallons, and to prevent splashing a round and flat disc of wood swims on the milk in the pail. In some districts, however, metal vases (Fig. 356) tinned on the inside are in use, of a shape which is quite unsuited for the purpose, and requires Dutch cleanliness to keep them in a pure state. They are carried in neat baskets, which secure them well, and placed on a small hand-cart to take them to the dairy. Sometimes the milk is cooled by placing these vases and also the pails, which are made of tin in this case, in cold water, but very often only by pouring the milk in vats or open barrels, where it can cool. This cooling is done, because it is thought absolutely necessary to obtain first-class butter. Where the milk is cooled with water, the pails or vases are placed in wells or troughs, in the kitchen or in the stables, neatly built of brick and cemented. If underground they are supplied with covers to prevent dust or dirt falling into the milk. The annexed engraving (Fig. 357) shows the method of cooling in a well, which is only used in summer, when the milk cannot be sufficiently cooled in the open troughs. The milk remains in these cooling baths until it is of the same temperature as the water, and is then taken to the dairy and poured into the pans or dishes for cream rising. Wooden dishes and also differently-shaped earthenware vessels (Figs. 358 and 359) are used for this purpose.

The dairy is generally very well built, and all the precautions to provide for fresh air, dryness, and cleanliness are observed. The milk-pans are arranged on shelves, and a smaller tub is used for collecting the cream, while a larger one receives the skim-milk. The cream is taken off after twenty-four hours, and put in the above-mentioned tub or barrel, where it remains until it has soured and thickened. In the summer this process, if necessary, is accelerated by adding some buttermilk, in the winter by warming the cream. The skim-milk is poured into the milk-barrel or tub for further use. The arrangement of the milk-room in a Dutch dairy is seen in the following engraving (Fig. 360).

The churns are generally of a very primitive
kind; a rod with a perforated disc attached is moved up and down in a tub or barrel. The motive power is, however, applied sometimes in an original manner, as may be seen in Fig. 361, and besides this dog-wheels and horse-power are employed. Regularity of motion is quite correctly thought a great deal of, and is held as indispensable for rapid churning and a full yield.

When the churning is finished, the butter is taken out of the churn with a large wooden perforated dish, and put into a wooden pan, where it is kneaded slightly; water is afterwards added, and the working begins in earnest. After some time the stopper is taken out of the bottom of the pan, and the buttermilk allowed to run off through a sieve into the cask placed under the pan (Fig. 362). The butter is now kneaded with fresh water, and the process is repeated eleven or twelve times. In summer, when the continued kneading would make the butter soft, it is stopped after two or three times, until by lying in cold water the butter has hardened again.

A very strict law requires that butter shall be sold in given weights, and it is generally brought in one-pound pieces to the local markets. The forms used for printing the butter are made of wood, and are endless in variety of shape and pattern. The packing of larger quantities for the export trade is subject to a very stringent law, made with the object of maintaining the fame of the butter in the consuming countries. Only oaken barrels of certain sizes are used, and these are branded by the authorities. New barrels are filled for a few hours with a strong solution of potash, and afterwards with one of alum. Some farmers put the barrels for several months in water previous to using them. Used barrels undergo a frequent scrubbing and filling with water before they are used again. The barrels are filled with layers of butter, which are strewn with salt, and on the last layer some brine is poured.

**Cheese-making.**

Dutch cheese-making is in a very advanced state, and its products are celebrated all over the world. Considering the importance of cleanliness and accuracy, it is not to be wondered at that these two qualities, which may be claimed by the Dutch nation, tend to make their dairy industry a success. This cleanliness attends all the processes from the milking to the sale of the products, and might be copied by all nations with profit. In
the south of Holland sweet-milk and skim-milk cheese are made in the following way.

Spiced Cheese (Komynde Kaas) is made in round loaves, about 9 inches high and 18 inches in diameter, weighing about 20 lbs., and coloured red on the outside. The milk, from which the cream has been taken off, is poured in large barrels or casks, and left standing until the curd sinks somewhat to the bottom, which is generally the case in half a day. Now the milky whey from the top is poured through a sieve into the kettle where it is heated, and then added again to the remainder of the milk in a tub, so as to bring the whole mass to about 95° or 99° Fahr., when rennet is added. During this the mass is well stirred, and this is continued until the coagulation is perfect, so that the wooden spoon or stick used for stirring stands upright in it. Now the curd is worked for some time with the hands, and then put in a linen cloth, which is placed on a stretcher, under which a low tub stands to receive the whey drained off by kneading, squeezing, and pressing with the hands. When no more whey can be extracted in this manner, a very simple press (Fig. 363) is used to complete the work. The hard cake of curd which is obtained is now put in another tub and kneaded with the feet until transformed into a stiff paste. The forms used are made of oak with perforated bottoms and covers fitting closely. The curd is put in in layers, the first being pure curd, but the others being first well mixed with pounded caraway-seed and a little cloves, while on the top of each layer a few cloves are strewn. Every layer is pressed tightly into the form, for which hands or feet are employed. The cheese is now pressed in a simple cheese-press (Fig. 364) for twenty-four hours, the cloths being changed at first every two or three hours. It is then taken out of the form, placed on a small board, and placed in another press for some time until it has assumed the consistency wished for.

The salting is done by placing the loaves in shallow troughs and strewing salt over them, adding to it until the cheese is salted enough, and has a good skin. The right moment when this is the case can only be learned by practice. Now the cheese is washed in cold water, scraped, polished, coloured with annatto, rubbed with colostrum. The salting and curing of the cheese are often done in the cow-stables during the summer, when the cows are being pastured.

Sweet-milk Cheese (Zoetemelsche Kaas).—
This cheese is more generally known under the name of Gonda. The milk is poured in a wooden tub or a copper kettle and mixed with rennet, coagulation being completed in about three-quarters of an hour. The curd is now softly broken up and left to settle for three or four minutes; after that it is stirred again, always gently. When the whey has mostly separated the curd is allowed to settle, and the whey is then baled out. Now some heated whey or water is added to warm the curd, and after a quarter of an hour it is drained off again. After this the curd is thoroughly worked
with the hands, and all the remaining whey pressed out, when it is cut in small pieces, rubbed still smaller between the hands, and filled in the

forms (Fig. 365), which are perforated. These are put under a press which can accommodate up to sixteen of them, and the pressure, light at first, is increased gradually in the following twenty-four hours. The cloths are also frequently changed, and the cheese turned, especially at first. After this the leaves are put in a wooden or stone trough filled with brine, and there they remain three to five days, according to the proportion of salt it is desired to give. The upper surface of the cheese is strewed with a handful of salt every day after the leaves have been turned in the salt-bath, where they swim. When they are taken out of the salt-bath they are washed with warm whey, dried with a cloth, and put on shelves in an airy and dry room. They are turned at first every day, and later twice or three times a week, and wiped with a cloth dipped in warm whey. In four or six weeks the Gouda cheese is generally sold to the dealers, but by keeping them at least three to four months they are much improved in taste. Generally, however, this cheese is eaten when not perfectly cured. The whey is poured in an open cask, and the cream, which rises after a few days, is skimmed. Afterwards the whey, as well as butter-milk, are used for pig feeding.

*May Cheese* (Maikaas).—In the beginning of summer, when the grass is very tender and juicy, sweet-milk cheese is made in the way just described, but the leaves are smaller. This cheese is eaten or sold as soon as cured, because later on it loses its fine flavour, and does not keep so well.

*Jews' Cheese* (Jodenkaas).—This kind of cheese is made by comparatively few dairymen; it is looser and less salted than the sweet-milk cheese described, and also flatter in shape.

The *Privy Councillors* Cheese (*Heemraads-kaas*).—This absurd name is given to a sweet-milk cheese of a very small kind, and coloured extraordinary. This cheese is allowed to get somewhat old before using it, and it is employed generally as presents.

In *North Holland* sweet-milk cheese is almost exclusively made, and all the agricultural energies of the population are concentrated on this branch of farming. No less than about 10,000,000 lbs. are exported annually. The meadows and pastures are kept in first-rate condition, and yield heavy crops.

The North Holland cheese is best known under the name of Edam, and its red or yellow balls grace the windows of every cheesemonger in many countries. Cheddars also are made in North Holland, as well as some other English kinds of cheese.

*Edam Cheese.*—The larger sizes of this cheese, weighing from 10 to 20 lbs. are not made now, but principally small ones from 4 to 8 lbs. Fresh milk is poured into a kettle or tub, and the rennet added; should, however, the milk have cooled down too much, it is warmed again by some hot
milk, before the rennet is used. The coagulation ought to be perfected in a quarter of an hour. The breaking up of the curd is begun with even before the milk is fully coagulated, and conducted very carefully, making frequent pauses to allow the curd to settle. Now the whey is bailed out as far as possible, and the baling-dish, with some weights on it, is used to press the curd. The whey is again drained off, and after waiting a few minutes the curd is well mixed and formed into balls by hand. These are rubbed into fine particles, and tightly packed into the forms (Fig. 366). This is repeated, and the curd again filled into the forms. When this has been done the curd has (Fig. 368), which has only one hole for the whey to run off. This form is only used to keep the shape of the cheese. They are now arranged in boxes, and salted heavily every day for nine to eleven days, the larger kinds up to twenty days. Afterwards they are laid in a bath of brine for twenty-four hours, washed, dried, and put in the curing-room, where they are treated just like the Gonda cheese.

The brine-bath has now superseded the above-mentioned way of salting in many dairy's. In the curing-room the cheese remains four to five weeks, being daily turned, before it is ready for sale. During the week before selling it is laid in fresh water for three to five hours, brushed already assumed the shape of a ball, and can be taken out, wrapped in a fine linen cloth, and put back into the form. These forms are put under a press (Fig. 367), where they remain five to twelve hours. When pressed long they get harder, and can stand a longer transport, but take also longer to ripen, while the reverse is the case when they are pressed a short time. In the latter case they are better fitted for local consumption. After pressing, the cheese is put into another form off, dried, and put back in the curing-room to be turned daily. To improve its colour sometimes young beer is employed, with which it is rubbed every day during the last week. Before sending the cheese away it is rubbed with some linseed-oil, to give it a polished, smooth appearance. The colouring of the skin is done by rubbing them with Tournesol rags, which are prepared in France by dipping pieces of hempen cloth in the juice of Croton tinctorium.

H. L. de K.
CHAPTER XXXVI.

PIGS, GOATS, AND POULTRY.


OST writers agree that the different varieties of domesticated swine in this and other countries have been derived from the order Pachydermata, genus Sus, the common wild swine of the ancient forests. Ages ago, these animals roamed at large in Britain, where they formed common, and often dangerous, objects of the chase for the nobles of the land. Reminiscences of the wild boar still remain in the names of places in some parts of the country, as, for instance, in the moorlands of Staffordshire, "Boar's Grove" and "Wild-boarclough" are to this day the names of farms or localities in which, so far even as present aspect goes, it is very probable the wild boar was common in the olden times. The wild boar, it is true, long ago became extinct in these islands, except in a few remote localities, yet to this day he is hunted in the forests and mountains of France and Germany, while in various other countries of Europe and Asia he is not at all uncommon. In these olden times a large portion of England was covered with forests, in which the oak was, it is said, more general than any other kind of tree, and acorns formed, in the autumn and early winter, a sumptuous feast, on which the wild boar fattened; the beech-tree flourished, too, in those ancient forests on the limestone, as the oak did on the clays, and beech-masts served the boar for food; grasses and the roots of plants he fed on in other parts of the year. His keen scent told him where the latter were, and his long and powerful snout soon brought them up to light. The snout of the domestic pig, though still powerful for mischief, is much less vigorous than that of his wild progenitor; domestication, removing the need for so prominent an organ, has already reduced it much in length, if not in width, and, along with the need for work in search of food, it has lost its pristine usefulness. The pig of today has no need to "root" for food; he is fed regularly in the yards and sheds, his rambles at large being confined to the stubbles in autumn and to a pleasant hunt for acorns near the hedgerows, so that in some of the more cultivated breeds the snout has an absurdly helpless look, nearly hidden as it is by a prominent forehead and well-developed chaps, and it is next to impossible to root with it.

By many of the ancient nations the pig was held in abhorrence, and to this day the feeling prevails among the Brahmins and Buddhists of India, and the Mahommedans everywhere. The Mosaic Law declared the pig to be an unclean animal, and the Jews were forbidden to eat of it. The ancient Egyptians had a still stronger antipathy against it, according to Herodotus, who tells us that if a man touched one, even by accident, he presently hastened to the river, and without undressing, plunged himself into the water to be purified. Unclean himself, the pig promotes cleanliness in others. The Egyptians were forbidden to sacrifice him to any other deity than Bacchus, and to the moon when at the full, at which time they were permitted to eat of his flesh. But the ancient Greeks and Romans thought highly of the pig, and the Chinese of the present day use it largely as an article of food. Modern notions commonly agree with the ancient one that the pig is an unclean animal—in his habits of life, that is, but not
unclean to eat. We hardly think he merits all the abuse and contempt that are thrown at him. It may be true that in habits he is scarcely decent at times, as in feeding he has no delicacy, yet he is a very useful member of the community, and he provides us with many a tasty dish. The truth is, the typical pig is the victim of conditions, and is regarded as a sort of hereditary scavenger in the community of domesticated animals; consequently, self-respect with him is at a low ebb, and though thinner-skinned than he used to be, he still has a rebellious disposition, and goes in for a good deal of unseemly conduct. His propensity to root, we suspect, will remain in force so long as he has a snout that is fit for the duty, and he will wallow in the mire still longer when he gets the chance; yet, despite all his delinquencies, we could ill afford to do without him.

In the British Islands there are many varieties of pigs, and these, again, are locally divided into sub-varieties, but with many of the latter the differences are so slight as to be scarcely worth notice. As a rule, the pigs of Scotland and the north of England are white in colour; those of the midland counties and in Wales black-and-white, red-and-black, or red-and-white, commonly enough white, or red, or black, though the two latter are not so numerous as the white; and in the southern counties they are most commonly black. Of the white ones in the north there are three tolerably distinct varieties: the large, the medium, and the small; in the south the black pigs may be similarly classed, though perhaps the varieties are somewhat less distinct as to size; while in the midlands they are of the mixed and indistinct character that might be expected in a neutral zone. We are not aware that the origin of these differences in colour has been, or can be, determined so as to exclude all doubt on the matter, but the positive colours found in the southern and midland counties are supposed to be owing to foreign blood, while the white colour of the northern ones is said to be that of the ancient breed of the island. There is no certainty, we think, in these conjectures, but they are probably correct. It is, however, in any case true that Neapolitan and Chinese pigs have been imported into this country, and they have greatly helped in improving the build and usefulness of our native breeds; selection in breeding and care in treatment have done the rest. In the days of the Ancient Britons the pig was a raw-boned, thick-skinned, rakish-looking animal, weird and gaunt, with long legs, light quarters, a narrow back, and a figure-head that was surprisingly ugly; whereas his descendant of to-day is plump and symmetrical, short-legged, fine-boned, with well-developed hams and shoulders, a broad back, and deep thick sides, and a face which has lost its ferocity.

The white breeds are known under the generic name of "Yorkshires," though they are, and perhaps always have been, equally common in various other counties; the large white breed, from which the others have been obtained by crossing and by selection, are specially known under that name, while the sub-varieties, though also known as Yorkshires, are sometimes known by the name of other counties in which they are bred, as Cumberland, Leicester, or Lancaster.

The Large White Breed.—Up to the middle of the present century it was a common thing to find at our leading agricultural shows huge specimens of this variety (Fig. 369), some of them weighing as much as a fair-sized heifer, but in recent years they have been dropped out of sight as a rule, chiefly because they were slow to mature and large consumers of food, leaving consequently little or no profit for fattening, though at the same time they produced bacon of good quality and were prolific breeders, the litters often numbering sixteen or eighteen; and now the quality of early maturity is cultivated in connection with smaller size. The famous Robert Bakewell is said to have been the first to improve the white pigs of Leicestershire, and these in turn have improved the Yorkshires by crossing. Bakewell pursued with pigs the system he had with such marked success applied to Longhorn cattle and Leicester sheep, viz., selection; discarding the coarser ones, he bred only from such as were symmetrical and compact in form, and fine in skin and bone,
cultivating at the same time the properties of early maturity and aptitude to fatten.

The Small White Breed.—This breed (Fig. 370) affords a striking contrast to the foregoing, not in size only, but in the period at which they mature, in quality, and—if the expression is applicable to pigs at all—in delicacy of character. It is supposed that this variety has been chiefly obtained from crosses with Chinese pigs, and it is commonly known as the small Yorkshire breed. Being small in size, indifferent breeders, and less hardy than most other kinds, these small Yorkshires are not as a rule profitable, and so are not adapted for practical dairy-farmers. There is, however, a good and constant demand throughout the country, and especially in London, for these small and dainty porkers, and the price they fetch is the highest in the market. But this small white breed has a special value for breeding purposes—for carrying on the improvement of the larger breeds, for reducing the hugeness and the coarseness of the largest sort, and for providing a model which, differing more or less so far as size is concerned, breeders everywhere are striving to copy. Crosses with other breeds—Berkshires, for instance—have produced animals that were excellent for fattening. One of the most striking peculiarities of the small white pig is its plucky, dainty snout, of which, when the animal is fully fattened, all that can be seen are the up-turned nostrils, which sometimes nearly meet the projecting forehead; the eyes are completely hidden, their position being indicated by creases in the fat, and the head is set on much below the level of the shoulder.

The Medium White Breed.—This breed has hardly yet attained the dignity of a distinct variety. Having been produced by modern crosses between the large and the small breeds, the type is not yet fixed, and individuals here and there are found to lean too much to the one or to the other branch of their diverse ancestry; by judicious selection of true specimens to breed from, the type will soon lose its nondescript character, and variations will in time cease altogether. This type promises to become one of the most valuable in the country for tenant-farmers' use; it has the early maturity and the facility to fatten of the small breed, while avoiding the coarseness and late maturity of the large one, and it is moderate in size, fattening nicely into twelve to eighteen stones, yet the longer it is kept as store, within limits, the larger weight it will fatten into. Its face resembles that of the small breed, but it is less concave on the snout and somewhat longer, while the frame is longer and larger, and less abnormally developed in the shoulders. It is one of the best of our bacon pigs.

The Berkshire Breed.—This, perhaps, is the most famous breed we have, and the most general of any distinct species in the British Islands. Formerly these pigs were of various colours, generally "a tawny, white, or reddish colour, spotted with black;" but now there are two distinct varieties, the one wholly white, and the other black, with a little white as a rule on the nose, on the feet, and on the end of the tail, and a pinkish hue on the skin. The Berkshires are understood to owe their type to the influence of Chinese blood, of which breed there are both white and black-and-white varieties; hence the two varieties of Berkshires; yet they have been less changed than some breeds have by the infusion of foreign blood, and their improvement is mainly owing to the care and attention that have been bestowed upon them through a long period.

Mr. John Coleman, formerly Professor of Agriculture and farm manager at the Royal Agricultural College, Cirencester, describes the black Berkshires in the following terms:—"Head moderately short; forehead wide, nose slightly dished, straight at the end—not retroussé, as in the small breeds; chaps full; ears slightly projecting, occasionally pendant, and covering the eyes. Prevailing colour black, with white blaze down the nose or white star on the forehead; sometimes uniformly dark; but this is the exception, and never the dead black of the Suffolk or Essex. The pink tinge should be always apparent. The eye is not sunk and closed as in the breeds remarkable for feeding properties, but large, intelligent, and denoting activity. General effect pleasing. The head is well set; the neck, of moderate length, is full and muscular; the
shoulders well set, so that we have a perfectly regular outline. There is not the extraordinary wealth of China seen in Suffolk, but the fore-quarters are well proportioned. Occasionally we find a slight deficiency in the girth, caused by the flatness of the fore-ribs. The back is fairly level, and the ribs, as a rule, tolerably sprung: a less perfect barrel, however, than is to be found in the Essex and Suffolk blacks. Loins wide and well covered; quarters often rather short and drooping—this is probably the weakest point in the breed. The tail is usually set lower than the hips, which gives a somewhat common character. The gammon full and deep; under-lines somewhat irregular; the flank often light. The carcase stands on short legs, and the bone, whilst stronger than that of the small sorts, is well-proportioned, and by no means stronger than is necessary. The strength and character of the coat varies according to sex and management. The effect of confinement and close breeding is to reduce the hair. We have a great objection to bristles, which indicate a thick skin, coarse offal, and slow feeding; but we also equally dislike the thin, weak, soft hair, which is a sure evidence of delicacy, especially in the boar; here, at least, should be plenty of hair, otherwise the offspring will be sadly deficient. In the sow fine long hair is desirable; too much and too strong hair is indicative of coarseness. But if the pig is required to work for its living, and to officiate as scavenger of the farm, there must be constitution; and we cannot have this without hair. The great merit of the Berkshire over most other breeds consists in the larger proportion of lean meat, and the distribution of fat and lean when properly fed; consequently a given live weight realises a larger proportion of available meat than any other breed."

As Mr. Coleman has said, the hind quarters are weak and drooping, sloping downwards from the hips to the tail, so that the top line is not level, as it ought to be, from the neck backwards; this fault, though much more marked than in other breeds, is not by any means a feature which cannot be removed, or at all events greatly reduced, by careful breeding against it. In the annexed engraving we give a Berkshire prize-winner, in which the fault we speak of does not exist, but the quarters, instead of sloping, are nicely rounded off, while the top line is as level as anyone can desire in a pig. As their name implies, the Berkshire pigs first became celebrated in one of the southern counties, but they are now, as the Short-horn cattle are, known in all the civilised countries of the earth; yet, so far as England is concerned, they are chiefly found in the southern and western counties, and are not at all common in the northern ones. Besides the Berkshires, there are several varieties of black pigs, most of which bear the name of the county in which they are a speciality, as the Essex, the Suffolk, the Dorset, &c.; but so far none of them have attained anything like so widespread a popularity.

The Essex Breed.—The old Essex pig had a "reach back, long legs, sharp head, and restless disposition"—four very undesirable qualities; it is now a shapely and valuable breed. While travelling in Italy some forty years ago, the late Lord Western saw and admired the breed of swine called Neapolitan, which "found its greatest purity in the beautiful peninsula, or rather tongue of land, between the Bay of Naples and the Bay of Salerno—a breed of very peculiar and valuable qualities, the flavour of the meat being excellent, and the disposition to fatten on the smallest quantity of food unrivalled." He brought over a male and female of this breed, and he grafted the stock on the Essex, and, it is said, on the Suffolk and Berkshire too, in so successful a manner that, as he said himself, "my herd can scarcely be distinguished from the pure blood." The improved Essex, which had great success at the agricultural shows, were produced by a further cross of Lord Western's Essex-Neapolitans on Essex sows, under the care of Mr. Fisher Hobbes, who became an even more famous breeder of pigs than Lord Western himself; for though all the improvements sprang from the Western herd, his lordship bred in-and-in to such a degree that his breed "gradually lost size, muscle, constitution, and consequently fecundity." After his lordship's death, Mr. Hobbes bought the best of the breeding sows at Western, and by their aid he continued to improve his own and the pigs of the county.
Another branch of the breed is said to have been improved by a pair of black sows which Mr. Coates procured from Turkey about the year 1846; these were bred to a Chinese boar, and the progeny in turn had the infusion of Neapolitan blood; lastly, they were engrafted on good specimens of the old breed of the country, and so the breed has been built up.

Early maturity and excellent quality of flesh are the leading merits of the improved Essex, and, while they retain the symmetry of the Essex-Neapolitans, they have more size and vigour, a stronger constitution, and an increased fecundity. Their only defects are: a lack of hardiness, that is probably owing to the climate in which they are bred; and a too great proneness to fatten, on account of which the fertility of the sows is often diminished, unless it is prevented by judicious diet and plenty of exercise. For crossing with and improving inferior breeds, the Essex swine of today are very valuable, and in the United States, as well as in various countries of Europe, they have made their mark; while in our own country the Berkshires, the Devonshires, the Oxfords, and the Dorsets have derived many of their merits from Lord Western's Neapolitan importations, whose influence, commencing in Essex, is now seen in every parish in the midland and western counties where black pigs are found. The old Essex pigs had more or less white on them, but now they are invariably black; their heads are perhaps come as near being handsome as a pig's head possibly can; they are moderately fine in bone and short on the leg; the quarters are well-proportioned, and they are symmetrical withal. They attain great weights at an early age, and have a small percentage of offal. The engraving gives a good representation of an improved Essex sow.

The Devon and Dorset Breeds.—These two counties are now proud of their pigs, and with reason, for they have really excellent varieties of the porcine family. Whatever differences there may be between the pigs of the two counties are to be attributed to merely local influences, for both have derived their chief improvements from one and the same source—the improved Essex.

Though the pigs of one county may be somewhat inferior to those of another, in the eye of an impartial judge, yet there is reason enough for each one thinking its own the best—the best, that is, for its own use. This, however, is merely a question of climate, and it is reasonable to infer that the pigs that have been bred for generations in a given climate are the best for that climate, providing they have been improved equally with other pigs. The Devons and the Dorsets may not be so shapely as the Essex and Berkshires, yet have they much in common, so far as quality is concerned, and they are all of the same colour—black. As a rule, it may be taken for granted that we can take the old stock of a county, and so improve it by careful selection and by judicious infusion of distant blood, that it will become as valuable for practical purposes as any wholly alien breed could possibly be; yet this is a rule to which, as in the case of horned stock, there are possibly one or two exceptions. The Berkshires and Yorkshires among pigs, like the Shorthorns and Herefords among cattle and the Leicesters and Shropshires among sheep, are probably better stock than most others which they could possibly supplant; yet, at the same time, it would be better in the case of such pigs as the Devons and Dorsets to seek to improve them by crossing rather than supplant them altogether, and especially so when we remember that cross-breeds are usually more vigorous than pure-breeds, and generally more profitable to feed for the butcher.

The Shropshire Breed.—This breed is not famous for symmetry or beauty of any kind, but it is a good practical sort, with no pretensions to fancy. The colour is various, but generally a dark red-and-black. These pigs are extensively sold in the markets of the adjoining counties; bred in Shropshire, they go in large numbers to be fattened in other counties. The Welsh pigs have much in common with the Shropshires, and are sent about the country for the same purpose.

The remaining sub-varieties of pigs in the British islands are mostly of a nondescript character, in each case more or less resembling the distinct breeds which have helped to improve them; and they are known less for any distinct merits or
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characteristics than by the name of the county to which they happen to belong. As in cattle and sheep, so in pigs, a great improvement in breeding has been brought about during the past half century, so that all our varieties are now much better than they formerly were, while between the best of them there is so little to choose on the score of usefulness that it becomes a mere matter of fancy which of them a farmer had better own. The Yorkshires, Berksheires, and Essex are held in high estimation in America, and in that country there is also a very good breed, called the Poland-China, of which we give an illustration (Fig. 373, Poland-China Hog). This breed is the result of a cross in which the Chinese blood figures prominently; we are not aware, however, that it possesses merits equal to those of the best English breeds.

Poultry on arable farms and pigs on dairy-farms are very useful to pick up various odds and ends of food that would otherwise be wasted. In this way many of them find the greater part of their own living, which is so far a clear gain to the farmer. Pigs are, in fact, members of that humble, though necessary, fraternity called scavengers, doing in their way a lot of dirty work, and consuming many of the coarser products of the farm and garden which could not else be made use of, except in the rough-and-ready way of using them as manure, and sometimes not even in that. What use, for instance, could be made of diseased potatoes and the surplus garden stuff, of the animals that die now and again on the farm, or are for other reasons unfit for human food, of the slops and broken victuals of the house, and the whey and buttermilk of the dairy—were it not for the pigs? Where all the food they eat has to be bought for them, it is doubtful if pigs will yield a profit, unless a man has a famous breed of them, is successful in his management of them, and can sell the young ones at fancy prices. But when they are half kept on waste materials, or, rather, on food that no other animals would eat, it is possible with good management to make a fair profit out of the breeding, rearing, and even fattening of pigs on a dairy-farm.

As a rule, certainly, dairy-farmers in England complain that pigs are not worth keeping; others, again, limit the profit to the fertilising matter contained in the excreta; while yet others say that breeding only pays, and that buying pigs to fatten seldom results in anything but loss, look at it which way we will, and that it would pay the dairy-farmer better, or, rather, be less loss to him, if he ran out his whey on the land along with the liquid manure. Many dairy-farmers keep very few pigs—just enough for their own bacon—because they believe there is no profit in fattening them for sale, and they rear instead a number of calves to drink the whey, or they give it to the dairy cows to drink. It is true that many cows get very fond of whey, and that when slightly acid it is a capital thing for the production of a large quantity of milk; yet, if it is very sour we consider the milk produced by its acid keeps sweet a shorter time, and such whey ought not to be used without discretion.

It is true that the feeding of pigs for sale will not always pay. It happens sometimes that corn is too dear; at others that store pigs are, while the price of pork and bacon is low, and so fattening cannot pay; yet, when both corn and store pigs are moderate in price, and fat pigs are selling fairly well, the business of fattening can be made to pay very well. A good deal depends on the sort of pigs we fatten; we might as well try to fatten a hurle as some of the sharp-backed, lanky, long-legged, and longer-snouted animals we see, whilst others fatten readily and rapidly on a small quantity of good food. We have had pigs that gave us a clear 2s. 6d. a week for the whey and trouble over and above the corn they ate, and having the manure as extra profit; and we have had others that did not pay for the corn, the whey and trouble being quite thrown away.

Some think it is best that a farmer should breed all his own pigs and fatten them, and this plan, no doubt answers well, if a man is lucky; but it sometimes happens that a man has no luck at all with breeding sows—his buildings are poor, his pigs the wrong sort, or he has no gift of management—and in this case he had better buy his pigs as he wants them for fattening. In buying pigs
for this purpose, it is well to buy them lean, so that we can see their faults; and, indeed, we do not want to buy condition, but rather make it afterwards. In the first place, the pigs should have frame enough to fatten into good weights; they should be long-bodied, and not very short on the legs; the ribs should be well sprung, showing a broad chine, and giving plenty of room for the commissariat department inside; the back should be straight and long, and squarely joined to the quarters, which should not droop; lastly, the head should be short and wide instead of long and narrow, and the skin and hair should not be rough and coarse. A little experience in buying and fattening pigs will soon tell anyone the best sort to buy, particularly if he loses money a time or two in them; this, indeed, is the surest way of sharpening a man's judgment.

In the breeding of pigs, we may take it for granted that it is just as easy to have a good sort as a bad one, and that this point makes all the difference between profit and loss in the business. The best plan is to get hold of a couple of gilt s of a downright good sort for breeding, for pork or bacon as the case may be, for early maturity, for hardiness, and for ability to fatten on a small quantity of food; and there are plenty of breeds answering to this description. A boar of the same breed, though haply of a different family, should be used if it is desired to keep the breed pure, and he should come of as good, or even better, a family than the gilts; but if it is desired to breed pigs for the butcher only, purity of breed being a matter to which no importance is attached, it would be quite as well to use a good boar of a different breed, for a raw cross of this kind often produces the most vigorous offspring; and a similar result may be attained by using a boar of the same breed, providing the relationship, if any exists, is very distant: and, indeed, in this case purity of breed is maintained as well.

Early maturity is seldom found except in company with the other good points which all meat-producing animals should possess, and it embraces as well the property of early fecundity, which is one of no mean value among domesticated farm stock, especially among pigs. Gilts that come of a good stock in one or other of the improved breeds will usually be ready to put to the boar at eight months old, so that they will have their first litter at or before the time they are a year old; this result will, however, depend on their having been well reared on good food from the beginning, for, however well-bred a pig may be, its early maturity and early fecundity are both reduced if it is reared on short commons, or is expected from an early age to find its living in the lanes. If we have good blood to start with, the rest depends on a generous diet and kindly treatment. Nor are the offspring of very young animals at all inferior to those of older ones after a time, providing the parents are well reared from the start, and are well attended to when they are giving suck: it is a mere question of food and treatment; and when we think it over, we see no good in developing superior qualities in animals by careful breeding if they are afterwards thrown away by neglect. It must, however, be borne in mind that over-feeding, especially with carbonaceous or fat-forming food, is a common cause of barrenness, not in pigs only, but in all other animals.

During the time a gilt is pregnant she ought to be under rather than over-fed, at all events in the early period of gestation; later on she may be liberally fed, and during the whole of the period, except the last week or so, she ought to take a fair amount of exercise; she is, in fact, all the better if allowed to roam about almost at will, and the offspring will be the healthier for it. It is also a good thing during this period that she should be noticed and handled, talked to and made familiar with, an attendant being near, as this treatment makes her better-tempered and more manageable when she farrows. After parturition she must receive as much as she will eat of food whose quality is good, and this treatment must last until it is near time to wean the litter.

The shed or sty in which a sow farrows should be pretty roomy, with a sloping floor to carry all wet away, and a rail running round by the wall, nine inches from it, and nine or twelve above the floor; this latter contrivance is to prevent the young pigs from being crushed against the wall when the mother lies down—an act which she generally performs without much warning or ceremony. A boarded door some five feet square, that can be taken up and laid down at will in a corner of the sty, will be found useful, because it is warmer and drier than any other kind; but in any case there must be plenty of straw, which should be cut into six-inch lengths, to prevent the young pigs getting entangled in it,
and so the more easily trodden on, as well as to make a tidier bed; and all cold winds and draughts must be carefully guarded against. In cold weather it is best to take the little grunter away from their mother as they drop, in a basket, with a piece of flannel in it to cover them with, and keep them in a hamper lined with flannel of some sort, and near a good fire, until the sow has done farrowing; but when there is no danger from cold, and the sow is fit to be trusted, the young ones may be left with her “to founder for themselves,” the attendant looking in at them frequently to see that all is right. In other cases—as with a sow whose manners are dangerous, or when the cold is severe and cannot properly be excluded—it will be wise to have the young pigs in a hamper in a warm room for several days, frequently taking them to the sow to suck, but not leaving them with her until they are able to take care of themselves. As a rule, sows are very careless, particularly young sows and old ones that are fat and heavy, and they will with the grossest supineness trample or lie down on the young pigs if they are not prevented, and the little ones are unable to look after themselves.

At this period, and for some little time before it, the sow’s food should be such as will promote to a moderate degree the secretion of milk, and nothing is better for this purpose, and at the same time as cheap, as skim-milk with ground wheat, the latter scalded before it is mixed with the milk, and the whole given to the sow warm, say at a temperature of 70° to 80° Fahr., but never cold. There is more merit in this simple expedient of warming the food than many who had not seen it tried would be disposed to admit, and we can recommend it with confidence. In two or three days the young pigs will be well on their legs and the sow may receive any kind of food there is for her, providing it is both good and plentiful; skim-milk, buttermilk, or whey, thickened with a liberal allowance of barley, rice, or palm-nut meal, or a mixture of these, with perhaps a little pea or bean-meal added, and whatever oatmeal can be spared. We have heard objections urged against maize-meal as food for sows that are giving suck, on the ground that the young ones are liable to die; and, no doubt, there have been cases of this sort where the meal has been fed to the sow in a raw state, but we know it is perfectly safe to use it, providing it is well scalded with boiling water some time previously. Any kind of food for pigs—corn, that is—is improved by being scalded, and maize specially so; the mere cooking makes them easier of digestion and more nutritions. All this is simple enough, and well worth the trouble, which is not much, after all. Put the meal in a tub, and pour enough boiling water on it to soak the whole of it, and cover the tub with a thick rug, or a close-fitting cover of some sort, and leave it alone till the food is wanted.

It is seldom worth while to try to rear more young pigs than the sow has teats for, and it happens sometimes that she will have one or two more; in these cases the weakest go to the wall, and it is better to kill one or two of them at the onset, or else rear them by hand. There are, however, patented contrivances, consisting of a vessel from whose side india-rubber teats project, by means of which it is not very difficult to rear young pigs without any help from the mother; the food is placed in the vessel, and the pigs suck from the teats, after a little while, almost as freely as from the sow’s teats. Lambs and calves, and
even puppies, may also be reared in this way. In the section on Rearing of Calves, at page 61, we have given a illustration of Tucker’s feeding-pail; and there is no risk of spilling the food. The floors are of grooved bricks, non-absorbent, which carry off all wet and prevent slipping. The yards may have a light roof thrown over them if it is desired, as seen in Fig. 377, and the whole structure is strong, light, rigid, and easily taken to pieces for removal.

At the Hartington Cheese-factory, in Derbyshire, is a very useful set of piggeries, well suited to large establishments. There is a row of them, twelve or fifteen in number, and similar in form to those seen in Fig. 377, except that the communication from yard to yard in each case is close to the doorway under the shedded roof, and the door fits both openings, so that the pigs can be confined under the roofs and all the yards thrown open to each other, or, when the pigs have access to the sheds and yards both, the yards are closed each one from the other. The pigs of any particular pen can be got out in this manner by simply confining the intervening ones in their sheds for the time being. But the method of distributing the food to the troughs of each yard separately is what is chiefly remarkable. An iron pipe, some four or five inches in diameter inside, runs the whole length of the sheds, along the front of the wall outside, and a little higher than the troughs inside; an endless chain runs down the inside and up the outside of the pipe, and is worked by a windlass; a sponge or mop is on the chain, fastened to it in a
The farmer growing, rice used and yards. With the mindless. At the upper end of the pipe is a tub containing the whey, which runs down the pipe freely till it comes to the sponge, when it is diverted into the trough. When the feeding is about to commence, all the pigs are shut up in the sheds, and the corn is distributed in the troughs by the attendant, who afterwards fills the troughs with whey in the manner described, and when all are full the pigs are let out of the sheds into the yards. It is a labour-saving plan, very effective and very simple, and the credit of the invention is due to Mr. Naden, a member of the committee.

In the fattening of pigs the kind of food to be used is a matter of importance. Whilst a pig is growing up to the size at which we should commence to fatten him, it is advisable to give him nitrogenous food in order to develop frame and muscle; but when we come to fatten him, he must have food that is rich in fatty matters and starch. In the former case, beans, peas, and lentils would be very suitable, in conjunction with roots; in the latter, palm-nut, maize, barley, and rice meals would be well adapted. If the pigs are growing, it is desirable to keep up the condition they had when weaned, and to this end a mixture of the two kinds of food may be used with advantage. There is plenty of choice, and the farmer will be guided in a great measure by market values of different kinds of food; but in any case a mixture will be found to answer quite as well as, if not better than, any single kind. Many pig-feeders recommend that the food should be sour when fed to the pigs, and it is true that they feed well on food in this condition. Acidity is easily brought on by boiling or steaming the food, and letting it stand for some time before using it, stirring it occasionally. In this way potatoes, turnips, or cabbage may be boiled and then have a quantity of corn stirred among them, and left for a few days or a week; the corn would receive the cooking and softening which aid in its digestion, and it is probably true that acidity keeps the pigs' digestive organs in good tone. If roots are pulped and the corn mixed with them, and the mass allowed to lie for a few days, the fermentation that sets in answers the purpose of cooking the food, but is longer over it.

The less exercise a fattening animal takes the quicker it will fatten, and feeding pigs should be confined within as small a space as is consistent with health and comfort. The only pigs that ought to have exercise ad lib. are boars and breeding sows, and the young ones that are intended for these purposes. Confinement is against nature, and not conducive to health; but then obesity is a form of disease or degeneration of the system, and in the fattening of pigs there must be agreement between cause and effect; in addition to which, it is well to complete the process in the shortest possible time. The floors on which fattening pigs lie should be dry and clean, and the stybes should be warm, though well ventilated. We think pigs are better without straw or other litter to lie on, particularly if they lie on boards. They always keep a clean corner to lie in when they have no litter, and if the corner is boarded they crowd on it close together, and are dry, clean, and comfortable, keeping each other warm; but when they have litter, they are kept clean and dry only by a plentiful and frequent supply of it. The atmosphere of the place is certainly sweeter without the litter, for when straw becomes wet a slow ferment sets in and nauseous odours are evolved; in winter the litter may be useful to help in keeping the pigs warm, but in summer they are better without it, and in any case it only keeps warm the side they happen to lie on, which is always warm when the spot they lie on is dry and clean.

Fattening pigs grow all the faster if they are washed once or twice a week, and scrubbed with a brush each time, and they quickly learn to like it. This plan keeps the skin clean and its pores open, and lice cannot prosper. Some persons recommend that they should be "well groomed with brush and linseed oil," which will cleanse the skin and kill the lice; but we prefer washing with water rather than the oil, because it is cleaner and cheaper. Though commonly dirty when left to his own resources, a pig really likes to be clean, but he does not know himself how to set about it; and as the leading objects of pig-existence are to eat, sleep, and grow fat, cleanliness and warmth are means to an end.

For some time to come it will be found necessary to put rings in pigs' noses to stop their rooting. All store pigs should have plenty of
exercise, and should go out in the fields to eat grass, of which they are very fond, and which is good food for them, especially clover; in California it is a not uncommon practice to grow large plots of alfalfa, or, as we term it, lucerne, purposely for pigs to pasture on, and they even use it for pig-food in winter, as we use clover-hay for cattle. But pigs cannot be allowed to go out to grass without the nose-rings on, or they will soon make a terrible mess of the land. An effectual method of ringing pigs is seen in Figs. 379, 380, 381, and 382. Fig. 379 shows the pincers and ring when the latter is about to be inserted in the snout of the pig; the sharp points are easily pushed upwards, and when through, the ring is quickly doubled by closing the pincers. In Figs. 380 and 381 the ring is seen in both its open and closed form. In Fig. 382 is seen a pig-holder, which is simply slipped over the snout, enclosing, as will be observed, both the upper and the under jaws; the pig is easily held in this way by the left hand, whilst the ring is inserted by the right. The holder is a capital thing whatever sort of rings may be employed; it should be made of stout iron, and the form seen in the engraving should be preserved, so that it may slip easily over the nose, and be out of the way when the ring is inserted.

Fig. 379.

Fig. 380.

Fig. 381.

Fig. 382.

GOATS.

By the efforts of the Baroness Burdett-Coutts and others, goat-keeping has recently received a considerable impetus in England. But although this is a subject for congratulation, when we are pointed to the herds of goats upon the Continent as an example, it must not be forgotten that the circumstances are altogether different. Where there are large expanses of coarse and scanty herbage in mountainous districts, while flesh-meat is far less in demand than milk and its products, the goat may thrive and pay better than any other animal. But in a cultivated country highly farmed, it cannot possibly compete with the milch-cow, which can be fattened and sold to the butcher when she ceases to be profitable at the pail. To be brief, the quality of the flesh is an insuperable obstacle to the goat ever taking a place in England as regular dairy-stock, while its destructive propensities are another very serious objection. The male kids must be eaten very young, or are unearable at all; and the flesh of the female when past milking is practically of no value.

Nevertheless it is possible that in some cases a few goats might be a profitable investment, apart from the mere cottager and villa resident, to whom the goat would often be a great help, but with whom we are not here concerned. Whenever goats' milk is wanted, about half-a-crown per quart has generally to be paid for it; and as it is becoming more valued than formerly, there is a possible profit here. We do not of course mean that any one could in the least depend on selling milk at that price; if it were so the case would be clear enough. But where there is likely to be any demand, inquiry might be worth while; and it is needless to say that a far less price would yield very great profit. Again, while goats' milk makes bad butter, it makes excellent cheese; and it is just possible that it might answer to attempt imitation of the Roquefort and some other of the choicest kinds, which, it is well known, are made in part from goats' milk.

Goats differ as much in their milking powers as cows, if not more, and this must be kept especially in view in selecting any of such stock. A foreign Nubian variety is found to be much the best milker, and its crosses are also good at the pail, giving occasionally as much as four quarts per day. But whether such stock can be procured or not, such care as is possible should be taken to secure satis-
factory animals. They should not be allowed to breed until a year and a half old, or both degeneracy and early loss of milking power are apt to result. The natural breeding season is in the autumn, when the kids will be dropped in spring; but there is also a secondary spring season. The period of heat in spring is not, however, so long or so well marked as in autumn, and has to be watched for carefully if it is to be utilised; which is advisable for a portion, in order that they may be in full milk through the winter. The kids are often allowed to suck several weeks; but it is better to take them away very soon, as with calves, and bring them on as soon as possible to skim-milk, meal, and other food. Long-haired animals are to be avoided for milch stock, almost as a general rule.

Little need be said as to the general management of goats. They will do upon very coarse food, if there is enough of it; but unless the fences are very good, and there are no trees in the enclosure, must always be tethered to prevent their doing damage. Otherwise they may be fed and treated very much as other stock, giving as far as milk goes quite as much return for it—varying with good animals from three pints to over four quarts daily. They must, however, never be tethered out permanently in the open, as they do not stand rain well. In a stable with the run of a yard they will thrive capitaly; and it is very rarely the milk has any hirsine flavour; if it has, the breed had better be changed.

POULTRY.

In 1855 the eggs imported into England from France were only worth about a quarter of a million sterling; in a quarter of a century they have reached the value of about two millions—multiplied nearly eight-fold. In considering this, it must also be remembered that the French eat themselves many times the average number of eggs we do, as is the case in all Roman Catholic countries. It is at least certain that Paris alone consumes eggs valued at a million and a half sterling every year, and some one has calculated—we do not know how—that every Frenchman on an average eats about 160 eggs per annum. It is not wonderful that such facts as these have aroused much attention, and that in the recent long agricultural depression wistful eyes have been turned by English farmers towards the two millions annually sent out of the country for produce, some of which at least might be produced at home. We say some of it, because we have great doubts whether England can ever equal France in this branch of production. Our climate is not nearly as good for fowls; and poultry is especially a small-farm production. The fowls cannot be attended to wholesale, like sheep—and there comes the difficulty.

There is profit, however, as many farmers have found, in fowls and eggs; and this kind of produce is sold by so nearly the same machinery as disposes of the proper products of the dairy, that a few words at least should be added on the methods by which that profit may be gathered, in this short chapter on secondary or subsidiary stock.

The first thing to attend to, as in the dairy proper, is breeding, or what is equivalent to it. We have here in view no "fancy" procedure whatever, though the poultry-fanciers have produced, or at least preserved and developed, breeds it is a real misfortune farmers know so little of. But many farmers never even see that their stock is young, whereas no hen pays as a layer after she is two-and-a-half years old, except in a few cases. We knew a case where a farmer consulted a poultry-breeder about his fowls, which "ate their heads off." The breeder found many birds years old, and the first step was a general slaughter, after which young fowls were introduced. This one step alone altered the balance-sheet to the tune of £30. Again, hens vary in laying powers, even in the same breed, just as cows do in their yield of milk; and further still, the progeny of the best layers also make the best layers, in the same way. A dairyman who cares about his poultry will therefore take some pains to ascertain his best birds, and set eggs from them only; by which simple procedure he can soon gather a strain which will lay 110 to 150 eggs per year. It is needless to point out what a revolution such laying would work in the egg-return, on some farms.

If eggs alone are wanted, it will be best to keep only non-sitting breeds, of which Minorecas or Andalusians, Leghorns, Houdans, or Hamburgs will do well on the farm. If necessary the eggs may be hatched in incubators, which have now been much improved, and answer well in clever hands; or a few may also be kept of some sitting breed. If table-fowls are important, then the old English Dorkings, or Houdans, or a Brahma-Dorking cross may be tried. Pure-bred fowls useless for showing
DAIRY FARMING.

can now be easily obtained at a low price; and after all is said against "fancy" birds, as a rule they will pay better, selected with intelligence, than average farm mongrels. But any decently fine farm stock can be greatly improved by purchasing every year merely one or two young cocks of the breed selected. Thus, if the cocks are Minoreas, the farm stock will gradually be converted into hardy black fowls which seldom or never sit, near the Minorea type; while if Dorkings be used, there will soon be a splendid race of fine table-fowls.

Often, when there is any one on the farm who cares about it, it will be best to make up every year a special breeding lot of the finest birds. No farmer would expect to make his other live-stock pay unless he saw to such things; and he cannot expect fowls to pay either, unless he will give the same ordinary thought and care to them.

The next most important thing is, that the eggs laid be "realised." In a case we shall never forget, in which we were consulted about an absence of eggs which seemed mysterious, our final advice was to put a lock on the fowl-house, and keep the key. There was an ample supply at once! and it was plain the eggs had been sold. This was in a suburban garden; but it is almost needless to remark how, on many farms, half the eggs laid never reach the owner. They are not often sold, probably: but one farm hand and another takes home one now and then, and the final result is again unsatisfactory. But this is not the fault of the fowls. And such petty pilfering is far less likely to take place, if it is evident the owner really cares about his fowls, than if they seem left to care for themselves, with no one to think particularly about them. As to poultry "not paying" on many farms, what would pay treated as they are? But we have never known a farmer yet, with a carefully-selected stock, and who did care for them in the points we have mentioned, who did not consider he made at least some money by them.

The management of poultry in detail must be sought in some one of the many excellent works on the subject; but one or two other points need mentioning. To get a constant supply of eggs, a number of early pullets must be hatched in May or June, which will not lay in winter, but come on later when the others have exhausted themselves. A lot of March pullets will always give winter eggs if well reared; but they must have really good meal and grain frequently, and not be left, as we have seen on many farms, with a saucer of sour bread-sops to last half a day. For table-fowls also, chickens available from Christmas to spring are most remunerative. In some localities young ducklings pay best of all. But in any case, some thought should be taken so to arrange the breeding as to benefit by the highest prices of the year.

In the case of fowls, again, this depends immensely upon proper dressing, which appears unaccountably neglected by English farmers, while it is brought to perfection, like packing butter, by the French. We have known similar fowls in all respects, sent up to London, realise respectively 3s. 6d. and 6s. per couple, the nice preparation (which really cost no more) making the difference. This is at the bottom of a good deal of the uncertain "returns" some farmers have complained about: if they always sent up their birds artistically dressed, there would often be a different tale.

If a lot of fowls are housed next a green crop, with no other green food near, they will often eat it bare. What else could be expected? They prefer grass, however; and if a strip of turf, or a bank, is within nearer reach, that will take the brunt of the attack and save the rest. Newly-sown seeds, again, occasionally want guarding for a week or two; but if this is not grudged to birds, which return nothing, it ought not to be grudged to fowls, which do. Many must not be allowed, again, upon grazing pastures, though a few do not matter. The manure in the hen-houses is very valuable; and when mixed with twice its bulk of dry earth, ashes, or scor, is good for almost anything.

Poultry are perhaps best adapted, as a rule, for small occupations, where they can have a larger share of attention and get better looked after. But whenever they are selected with judgment, bred well, fed well, and properly looked after in other respects, they will pay the farmer, and work in well with the other practices of a dairy-farm.
CHAPTER XXXVII.

THE COMMERCE OF THE DAIRY.


The great bulk of English cheese and butter is still sold after the manner of past generations, with little or no improvement of the kind we see in most other branches of agricultural commerce. The cheese fairs of England, as a rule, are still held where they have been held for generations: in a wide street of the chief market towns. To some of the larger fairs—as that of Derby, for instance—farmers in some cases take their cheese long distances, say twenty or thirty miles, carting it all the way. The loaded carts are started from home on the day before the fair, some of them reaching the town the same night, others stopping a few miles short of it; others, again, that have not so far to go, leave home in the small hours of the morning, and streams of carts are seen pouring into the streets as the night gives way to dawn. The carts and waggons are ranged up each side of a street that is wide enough for the purpose, backing to the pavement on either side, and the shafts pointing across the street; horses that have travelled some distance with the loads are sometimes taken to where they can be fed and groomed, leaving the carts behind, while others are fed where they stand in the streets.

If the trade is dull there is plenty of time to feed the horses. The buyers stand here and there in knots, with a tantalising air of unconcern in the business of the day, while the sellers wait and chat together with ill-concealed anxiety; the buyers’ policy is that of masterly inaction, the sellers’ that of patient vigilance; the buyers sometimes saunter carelessly off to breakfast, and the sellers in no good spirits do the same; they return, and the armistice continues until a fresh batch of buyers comes in by train, or the letters or telegrams arrive, or some not yet determined wave of impulse starts the trade. But when the trade is brisk, when the demand equals the supply, and when prices are high, the bulk of the business is over before the townsfolk awake, and long strings of carts waiting their turn at the warehouses are seen when the blinds are pulled aside.

The fluctuations in a cheese fair are sometimes remarkable; the trade may start briskly and come to a sudden stop, or it may not start at all for several hours, and then go like wildfire; sellers sometimes refuse prices in the morning which they would only be too happy to get, but cannot, in the afternoon; at other times they offer their cheese at a given price to start with, and make several shillings more at a later hour; some bring their cheese home again, and sell it next fair at less money—or at more, as the case may be. Much depends on meeting with a customer who wants your particular line of goods; if you miss him, he buys elsewhere and wants no more. There is an art in selling cheese; one man will make a good price early, and another cannot get a bid in the day for the same quality of goods; so much depends on knowing your men and how to use them. But the dealers have two marked advantages over the farmers: they are constantly in the trade, and know the tone of it to a nicety, which farmers seldom do, and there is a sort of commercial freemasonry among them, which we never find among farmers; if the trade is dull, the
dealers combine to make it duller, and the farmers never do to make it brighter; if the markets are up, the dealers agree to hide the symptoms, and the farmers find them out too late.

But many farmers sell their cheese at home to a regular customer, and some of them have a queer way of doing their business. It is quite natural that a farmer should like to talk to his neighbours about the price he has made of his cheese—if he has made a good price, but not without; and it has been some men's practice to make the dealer a present of a five or a ten pound note providing he gives a certain figure for the cheese. They talk then to their neighbours, and the latter, thinking their cheese is worth the same, will take no less, and so miss a chance which they may never have again. Some years ago we went a round among the farmers with a Manchester cheese merchant; one of the farmers whose cheese he bought threw into the bargain three handsome store pigs, on condition that the price of the cheese was so much—a shilling or two more than the merchant had intended to give. Now, this sort of thing does a lot of mischief at times, and at best it is very childlish. Somehow or other, farmers are fond of throwing dust in each other's eyes, and seldom miss a chance of doing so; and the middlemen chuckle over it, and reap a rich harvest out of it. We are glad to believe, however, that farmers are becoming alive to the folly of divided interests, and to the expediency of bringing producer and consumer into direct intercourse.

Other farmers, again, who prefer not to take their cheese to a fair, send it in to the factor without a price having been agreed upon—send it in, in fact, half a ton or a ton at a time as it gets ready, or as the dealer happens to want it—draw money on account, and balance up once a year. This is a free and easy way of disposing of one's cheese, but as a rule it answers fairly well, which, indeed, is the condition of its going on. The system, however, if it merits the name of system, is satisfactory, as a rule, only under special circumstances: the farmer himself must have a taste for wearing leading-strings; the dealer must have tact enough to know how far he may go with safety; and the cheese must be of good and uniform quality, in which case the dealer can always place it to advantage: he has, in fact, regular customers for it, and have it he must. The system answers best of all when the cheese is consigned in this way to a cutter-up, without the help of a wholesale dealer; in this case the shopkeeper has his regular customers who like the cheese, and it is to his interest to supply them with it, as it is to the farmer's that it should continue to give satisfaction.

In recent years a practice has grown up in some places for farmers to consign their cheese to some firm or other who sell it on commission, and warehouses have been started to carry out the system. It has not, as yet, become very general, nor do we think it ever will. The chief drawback to it in the ease of dealers who act as commission salesmen is this: the farmer is never certain that his own cheese will be pushed as it ought to be into the notice of the best customers the salesman has; the salesman, in fact, having cheese of his own to sell, cheese that he has bought out and out, will naturally, however strictly honest a man he may be, wish to sell his own cheese to the best advantage, and it is requiring too much of human nature to expect him to push commission cheese while he has similar cheese of his own to sell. And, again, it is not by any means impossible that the commission cheese should be employed as a bait to push off some inferior cheese of the salesman's own at a better price than it would command alone. Further, it is unreasonable to expect a man to take as much pains in selling commission cheese as he would in selling his own, even though he sold them independently of each other; and it is straining the principle and instinct of honesty too far to expect a man to push commission cheese with vigour while he had cheese of his own that wants selling. The system, no doubt, will answer better in warehouses in which there is no other than commission cheese, and even here the salesman may have his favourites among those who send it in. It may be said that a farmer who sells in his cheese to a dealer without a price, and a dealer who receives the cheese on those terms, place themselves in the position of consignor and consignee in a commission warehouse; but there is this difference: the dealer gives no account to the farmer of the sale of the cheese, yet it is to his interest to sell it as favourably as if he had bought it out and out, so that he may be in a position to give the farmer a fair price for it and keep a good profit for himself.
The commission warehouses will do well, and be a great boon to the country, providing strict fairness between consigners is observed by the salesmen. No men, as a rule, are better qualified than farmers to make careful bargains, but in cheese-selling they are nearly always at fault, through not knowing the exact state of the trade, and it follows that a good salesman in a warehouse is in a position to sell ordinary farmers' cheese to greater advantage than they can sell it themselves. Yet we are not hard and fast in love with the system of farmers putting the sale of their produce wholly into the hands of other men, and we should like to see cheese exchanges in every county town in the dairying districts, where farmers and shopkeepers could meet on a stated day in each week to buy and sell cheese from sample, as wheat is sold. We think this system, which answers so well with cereals, would be a boon to the consumers as well as the producers of dairy goods. It may be objected that it is easy for a man to pick out a cheese or two that do not fairly represent the bulk, and that the system would lead to endless disputes; to this we would say, first, that it is easy to pick out a sample of almost anything that does not represent the bulk, and second, that if a man were to once become known in this character, it would be far more to his loss than any picking of samples could be to his gain.

Old-established firms of cheese factors have long had a hold on the goodwill of a large proportion of the farmers by giving them advances of money on the unripe, or even unmade, cheese. No doubt it is a temporary relief to a farmer to be able to get an advance of cash when he wants it, but there is more loss than gain about it, for he loses the control of his cheese, and is no longer in a position to make the most he can of it; so the factor gets it at a price which leaves him a very substantial profit: he must be paid somehow for his cash advances. The factory system of cheese-making is calculated to relieve the farmer from the need of prejudicing the sale of his cheese in order to obtain an advance of cash; it is one of the benevolent functions of the system to make advances to those who need them, free from discount, and without debiting the market value of the cheese: and, indeed, this is the best way of lifting farmers above the need of borrowing at all. And yet many of them will prefer to borrow at a loss, rather than that any neighbour should get to know how they stand at the factory; they prefer to get it from a factor on the sly, and pay dearly for it, than from an association for nothing. In this there is a good deal of false pride, and, as Mr. H. M. Jenkins has well said: "It is better for a farmer to have a factory for his bank than a factor for his banker." But it is difficult to uproot an old prejudice, however stupid and injurious it may be; and farmers pay dearly for the jealousy they only too commonly cherish against each other—a jealousy we should much like to see the end of.

If there has been but little change in the methods of selling cheese in England, there has been even less change in the selling of butter. It is true that in many towns market-halls have been built, and that butter is now sold in them where erstwhile it was sold in the open market-place, yet the selling itself is conducted as it ever was. But there are still important market towns where the butter is still sold out in the open, because no hall has been provided; the wives and daughters of the smaller farmers trudge long distances to the market, carrying their baskets of butter and eggs on their arms, and they hold them sometimes almost for hours in their hands, just resting on the thigh, and now and again setting them down on the bare stones of the street. In some cases wooden benches are provided, and all who can find room make use of them; but we have often seen, and still do see, the country women holding their baskets before them, with no support provided, and the snowy cloths are gently thrown aside, disclosing a sight of the half-pounds of golden butter neatly arranged, and perhaps a dozen or two of choice eggs in a corner of the basket. In the market-halls—as in the fine hall at Derby, for instance—are long rows of narrow benches, on which the baskets of butter rest, the saleswomen standing behind, while the buyers walk in front of the benches; and a very interesting scene it is.

We do not know that the mode of selling needs altering in a country like England, where local consumption of butter in very many places equals the supply, but market-halls should be built wherever they are needed, for it is no pleasant thing, on a cold winter's day, or in drenching rain, or when the dust is blowing about, to stand out in the open street, and on a hot summer's day the butter melts in the sun. In the northern counties the half-pounds of butter are usually moulded with
a special device—a cow, a thistle, a fox’s head, or anything we like, on the top; by this device each person’s butter is commonly known, and in a sense it serves the purpose of a trade-mark; but in many parts of the country the butter is made up into plain pound or half-pound rolls, with no distinguishing mark. Some persons are strong advocates for registered trade-marks for butter, one for each farm separately. We think this system would be confusing in the extreme, except in cases where large farmers make all their milk into butter; and, really, butter needs no mark but that of quality.

The chief butter market in Ireland is the city of Cork, and its Butter Exchange is said to be the most extensive of its kind in the world. Four hundred thousand firkins of butter, of an aggregate value of upwards of a million and a half sterling, pass annually through the Exchange, which is governed by a body called the Committee of Merchants, who frame and administer rules which make the exchange a close one, wholly governed by the dealers. The main object of these rules is to uphold what is styled the “quality brand,” which is awarded by competent inspectors according to an understood standard, which ranges from superfine to third quality in the mild-cured butters, and from first quality to sixth in the ordinary ones; the firkins are “scratch-marked” as the inspector decides on the quality of their contents, and are next weighed and marked with the net tare of the firkin; lastly, they are branded by hot irons with the gross weight, the tare, and the standard of quality which has been accorded to the butter inside. Through this ponderous process the butter passes after it leaves the farmers’ hands until it is finally sold, during which period it is entirely in the hands of the dealers, the farmers losing at one and the same time the possession of the butter and all control over its price and destination. The farmers, in fact, make the butter and send it to market, or consign it to a dealer; and this is all they have to do with it, except to receive the money for it afterwards.

But the most curious feature in the Cork Butter Exchange is this: at eleven o’clock each day a board of merchants are specially appointed to fix the prices at which the different qualities of butter shall be sold to the shippers and others during that day; these prices are determined on the simple bases of supply and demand, according to the judgment of the board, and no butter is sold during the day either under or over the price which has been placed on the quality or class to which it belongs; in this arrangement of qualities and prices the farmers have no voice, and they must either accept both decisions or take the butter away. The option of taking it away, however, as we shall proceed to explain, is denied to many of the farmers whose butter passes through the Cork Exchange.

In the south of Ireland exists a system known as “butter banking,” the origin of which is chiefly traceable to the impecuniosity of the small farmers. At the period—now many years ago—when the production of butter began to increase and its price to improve in the country, and when Cork began to rise in importance as a butter market, certain dealers had almost exclusive control over the butter of certain localities; their commerce lay in these districts, and they had cultivated the connection, as is commonly done, so that other brokers and dealers were kept out and confined to other localities, where in turn they had similar influence. The butter industry was looking up, and farmers were anxious to produce as much of it as possible, in order to which the cash to lay in a few cows in the spring time of the year was an important factor; and as this was the period when one half-year’s rent was due, following at the end of the comparatively unproductive winter season, farmers found ready relief in obtaining from the dealer an advance of cash, which was to be repaid later on in butter. In this way the dealer did the farmer, as it would seem, a compound service: he enabled him to pay his rent when it was due, to buy a dairy cow or two, and to hold on for fattening such barren cows as he might have been milking through the winter, instead of sacrificing at a mere store price. It was not to be expected that the dealer would help the farmer without helping himself at the same time, and he commonly stipulated to receive the season’s butter at a price considerably below what it would have made had the farmer retained independent control over it. No doubt the farmer saw the disparity, and strove to balance it by increased production, and by freeing himself as soon as he could from the need of mortgaging his butter in the future. But the dealers encouraged the banking system, because it gave them command over their clients’ butter, though they too, unless they were large capitalists,
had in their turn to borrow from their bankers a large portion of what they advanced to the farmers. The system is still common, but keen competition among buyers has diminished the profits which were obtainable in the early days of butter banking, benefiting both producer and consumer.

A curious method of dealing in butter is carried out in some parts of Ireland. Dealers attend the markets in the smaller towns, where they buy butter fresh in lumps from the farmers, who prefer to sell it weekly rather than pack it away in a firkin until the firkin is full. These dealers are known by the name of “slasher,” because they attend the markets with a cart on which is a large square tub, into which they slash the lumps of butter they buy. They take the butter home, where they wash it, first in cold water, to complete what has been imperfectly done by the farmer, and next in warm water, which enables them to mix up the different qualities into a mass of one uniform texture, colour, and quality; it is then salted, put into firkins, and left to harden as it cools. The effect of this manipulation is to do away with the granular appearance which good butter has when a piece of it is torn asunder, and to make it greasy to the touch, and of third-rate quality. It is difficult to imagine a more grossly improper way of treating so delicate a product as butter, and it has the effect of making the farmers themselves careless about producing an article of more than third-rate quality, for however good they may make it, they only receive a third-rate price for it; consequently they leave as much buttermilk in it as they can, to increase the weight, and this must be washed out by the dealers at home. Such butter, though wholesome and clean when the dealers sell it out again, is only fit for cooking uses, or for sale among the lowest orders of the people, and the system from beginning to end deserves no other than unqualified condemnation.

Formerly the chief markets for Cork butter were in foreign countries and our own colonies, and the butter for this trade required to be heavily salted to preserve it. But the high prices paid for butter in England have of late years diverted the trade to English markets, and now little or no Irish butter is sent to the colonies, and very little to foreign countries. The foreign trade, however, the little of it that remains, is profitable to the dealer of capital. His system is to fill his stores as early as he can in summer, when prices are at the lowest, and as autumn comes on he begins to sell out his summer butter, filling up all the time with autumn butter, as the buying and selling prices then nearly balance each other, and winter finds him with a large store of butter, not too long kept, for which he has paid only summer prices, but which he sells out at winter prices, when butter is scarce, which are some 20s. per cwt. above the summer ones, and when the low prices of spring again come round, his stores are empty, and he is prepared to repeat the process. In a trade of this kind, however, there is the risk of the butter turning rancid on the dealer’s hands—a point he watches closely; yet if the butter is well-made by the farmer, the buttermilk properly got out of it, and the proper quantity of salt well got into it, if it is packed nicely in good casks and stored in a suitable temperature, the danger of its “going off” is very small.

In many parts of Ireland it is the custom of small farmers as well as large ones, even of those who milk only one cow, to put their butter in a firkin. It will be easily understood that the small farmers are some time in filling a firkin of 70 lbs., that there may be some difference of quality between the layers which represent each week’s churning, and that the first layers require heavy salting to make them keep through several weeks in the heat of the summer. When the cask is full, Paddy, or his wife, or the two of them most commonly, jog off to the next market with the cask of butter in a donkey cart; and an Irish butter market of this description is one of the quaintest commercial sights in the British Islands. But the system is bad, the butter inferior, and the people poor; they can hardly be otherwise. The butter is bought by small dealers, who sell it to, or by local agents who act for the large dealers, and these have the trouble, which a better system of production and sale would avoid, of sorting out the different qualities, so as to present it uniform for sale to the shippers. Great efforts are now being made to induce the Irish cottiers to improve their methods, but the task is one which will require a generation or two to complete; and, as the matter stands, the number of cottiers is so great that local consumption does not help them as it does the small farmers in England, Scotland, and Wales.
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