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The
Cheese and Butter-Maker's Handbook.

THE
CHEESE AND BUTTER MAKER'S
HANDBOOK:

A PRACTICAL TREATISE ON THE ARTS OF CHEESE AND
BUTTER MAKING.

BY
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To
The Dairymen of Scotland,

THIS LITTLE VOLUME IS MOST RESPECTFULLY INSCRIBED,

IN TOKEN OF

THE AUTHOR'S

FEELING OF GRATITUDE FOR THE MANY KINDNESSES SHOWN

DURING HIS INTERCOURSE WITH THEM

AS INSTRUCTOR.

P R E F A C E .

THE title of this little volume clearly indicates its character. It is intended to be so written, that one desiring to learn the art of Cheese or Butter Making may learn everything he desires to know by reference to its pages. In learning these arts, as in learning every other art, there are some things we cannot hope to obtain from books; and he who expects to find here or elsewhere instructions that will take the place of experience will be disappointed, as no such instructions can be given. But, aside from this, we have endeavoured to omit nothing essential to be known in the arts of manufacturing Butter and Cheese.

The arts of Butter and Cheese Making consist in the utilisation of certain laws established by Nature for the existence and the government of matter; and a knowledge of these laws, beyond what is simply evident to the eye, is essential to even a fair practical knowledge of the business. We have, therefore, endeavoured to state briefly, but with clearness, the reason of our rules as well as the rules themselves. The whole process of Cheese and Butter Making

will be found to consist of a series of acts, many of them simple, and, to the uninitiated, of seemingly small importance; but experience has proved that the importance of these acts is not to be estimated by the ordinary intelligence, but that those things which, to the mere onlooker, seem without reason and superfluous, are really such as cannot be omitted without endangering the result.

“Think nought a trifle, though it small appear;
Small sands the mountain, moments make the year,
And trifles life.”

We have, therefore, taken care in these pages to treat what may be termed little things with the consideration proportionate to their power as factors in these arts. We have also endeavoured so to arrange and divide our subject as to facilitate reference, and carry the mind by the most natural and obvious course from the beginning to the end of the subject.

As the title indicates, this work teaches two distinct arts, Cheese Making and Butter Making; and in doing so, it will be found that we have so handled the subject as not to confound the two, but, so far as practicable, have kept them separate and distinct.

As the results of the experience of a single individual would hardly be satisfactory to our readers, we have not confined ourselves to our own scanty harvest of material;

but we have freely availed ourselves of whatever light was to be gained from a liberal reference to the best current literature of two Continents. Especially would we acknowledge having made liberal use of the publications of Professor L. B. Arnold, whose name is entitled to special emphasis by all dairymen; and it is to him that we are indebted, not only for a number of valuable suggestions on the execution of this work, but for many acts of kindness as well. His name can only reflect honour upon these pages, and give currency to the truths they teach. But for him many a valuable fact now carefully garnered in the great storehouse of dairy information, would still be hidden away among the mysteries of unexplored truth.

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THE CHEESE AND BUTTER-MAKER'S HANDBOOK.

CHAPTER I.

MILK.

THE work of the cheese and butter-maker commences upon milk, therefore milk is entitled to our notice first in the order of topics herein to be considered.

From time immemorial the milk of domestic animals has been used as food for man, and its value as a wholesome and rich diet has been recognised from the earliest records, all the way down to the present date.

The cow has been the chief animal from which to derive milk; but the sheep and goat, the ass and horse, the buffalo and deer, have each also been drawn upon to furnish, for the gratification of the human palate and the support of human life, the pabulum nature designed for their offspring. The milk of these animals is still largely employed as food by different nations; but in American dairying, only cow's milk is used, and but very little milk from any other animal is ever used by, or even familiarly known to, the people of the United States. Cow's milk is, therefore, only treated of in this work.

Butter and cheese came later into use, but their origin, too, reaches so far back, that its precise date is lost in the dimness and obscurity of the distant past.

It is not necessary to waste words in describing the appearance of milk. Every dairyman knows well enough that it is an animal secretion common to all mammalia for the first food of their young. He is also acquainted with its physical qualities, its colour, its fluidity, its nutritious and wholesome properties as food for man as well as for

the young mammal for which it was by nature especially prepared. While there are many things about milk which are obvious enough, there are many other things which are not so readily apparent, and which require careful observation and attention to become acquainted with. Indeed, the study of milk is a long, and, in many respects, a difficult one; it has, so far, proved too difficult not only for the practical man, but even for the most critical observer. There are many things about cow's milk and its production, with which we are all in some respects so familiar, which yet the most careful students have not been able to explain or comprehend. There are so many things in regard to it which are still unknown, that I could not, if I would, make a complete account of it.

In this little work I shall attempt nothing more than to point to such facts as have a practical bearing, leaving a more full and minute statement to some other hands, or for some future occasion.

Milk, as an agricultural and commercial product in this country, is derived from the lactiferous glands of the cow, stimulated into activity by sympathy with an active state of the generative organs developed in bringing forth her young.

ALBUMINOIDS IN MILK

In cow's milk, about four-fifths of the flesh-forming material is caseine and one-fifth albumen; the former is coagulable with rennet, the latter is not. The albumen, however, coagulates when heated, if the milk or whey holding it is acid. The relative proportions of caseine and albumen vary greatly with the food and health of the cow.

CASEINE is one of the great forms of sanguineous matter found both in the animal and vegetable kingdom. In the animal kingdom it is chiefly found dissolved in milk, and is the curd or coagulable part of the milk from which cheese is made.

ALBUMEN is a thick, viscous substance which forms a constituent part of both animal fluids and solids, and which exists nearly pure in the white of an egg.

Albumen, combined with fibrin, is that part of blood which coagulates or solidifies when exposed to the air.

The following table will show how the various elements of which milk is composed vary in some of the different animals :—

	Woman.	Cow.	Ass.	Goat	Ewe.
Caseine (albuminoids).....	1.52	4.48	1.82	4.08	4.50
Butter.....	3.55	3.13	0.11	3.32	4.20
Milk Sugar.....	6.50	4.77	6.08	5.28	5.00
Saline matter.....	0.45	0.60	0.34	0.58	0.68
Water.....	87.98	87.02	91.68	86.80	88.62

This table is supposed to show the constituents of milk from the different animals in its average normal condition.

It will be seen from the above table that the great bulk of milk is water, and that but a very insignificant portion of it is saline or mineral.

As caseine and albumen are the elements in milk of prime importance to the cheesemaker, so what is designated in the foregoing table as butter, but which is sometimes called fats, are the main elements with which the butter-maker is concerned.

The fats in milk are in a solid state, and are the only solid matter usually found in milk; they exist in the form of very minute globular atoms, and are known as butter globules. These butter globules, or, as they are by some called, the milk globules, are suspended in the liquid mass and float about in it freely, whitening every part with their presence. They ordinarily appear round, or egg-shaped in form, but in size they are very unequal, varying from $\frac{1}{1500}$ down to $\frac{1}{4000}$ of an inch in diameter. When viewed under a microscope, with a magnifying power of 300 diameters, newly drawn milk has the appearance represented in the above figure.

Fig. 12.

Upon the structure and treatment of these infinitesimal bodies depend the dairyman's success in butter-making, and it is therefore important that he should be as familiar with them as possible. A clear knowledge of a few leading

facts in regard to them will be found more efficient in leading to desired results, than the haphazard labours and blind imitations of rules made by parties ignorant of the structure and properties of the things they are handling, though the operators may boast of long years of experience.

Examining milk with a strong magnifier we discover that globules of fatty matter, of unequal dimensions, float mechanically in the watery mass, and further investigation has shown that these little bodies, minute as they are, are made up of atoms of several kinds of fats, in a state of combination with a little nitrogenous matter and water, the whole enclosed in a very thin pellicle of membranous material. If the reader can imagine that the little circles which he sees in figure 12 are sectional views of the milk globules, they being divided through the centre as one would cut an apple in halves with a knife, the black lines that indicate their circumference will represent a section of the pellicles or sacks, and the interior will represent the fats which they enclose. Now, let him bear in mind that the little atoms of fatty matter thus enclosed are composed of white and yellow fats, and several varieties of volatile oils, all mingled together, and that the real diameter of the circles is only a three-hundredth part of their size as represented in the foregoing figure, and he will have something near a correct view of the size and structure of these little globules, which play such an important part in dairy husbandry, and which contribute so largely to the luxuries of the table, in all the civilised countries of the world.

The fatty matter which enters into the composition of these butter globules consists of four varieties. The hardest of them is stearine, which, when separated, is a hard, white, flaky-appearing fat. The second in consistency is palmitine, which resembles palm oil; most of the colouring matter in butter is connected with this fat. The third is called oleine, from its thin, oily consistency. The fourth consists of essential oils of the food of the cow, and which, probably, are as numerous as the varieties of food she consumes. These constitute the fats of which butter is made. Their origin is not perfectly clear; they are all ultimately derived from the food of the cow, but how much of them is derived directly from the food, and how

much is elaborated in the body of the animal out of other elements of food, is not well established. Their characteristics change with the condition and quality of food and with the constitutional peculiarities of cows. The fats from different cows living on the same food are often quite unlike, and in the same cow they change their colour and their density with the variations in the food as to age, succulence, and abundance and scarcity of fats in it. Young food generally gives a higher flavour and colour to them than that which is mature or approaching maturity.

When in combination, the specific gravity of the whole is about 940, water being 1000. The several fats, when separated, have not any fixed standard of specific gravity. The essential oils which enter into the composition of the globules is, of course, very light; the solid fats vary very much in their gravity. They are usually heavier in the following order:—stearine, palmitine, oleine, but I have seen this order reversed.

Besides the fats and oils enclosed in the globular bodies described, the liquid mass of the milk is charged with numerous oils, so light and volatile as to escape easily by exposure to the air, or by raising the temperature of the milk. These give flavour to the milk and its products, and act an important part in the digestion of the milk when used as food, and also in varying the butter and cheese made from the milk that contains them. Among these volatile oils is the one imparting the animal odour. They consist of essential oils in the food of the cow, which have not entered into the combination of fat in the globules, but remain loosely mingled with the milk.

SUGAR OF MILK.

The most weighty element in the dry solids of normal milk is sugar; it constitutes about $\frac{1}{3}$ of their weight. When separated and clarified it is perfectly white, and forms into very hard crystals, much harder than those of cane or maple sugar. It is harder than any of the vegetable sugars, and has less saccharine flavour.

The sugar of milk is remarkable for its very low sweetening power and for its stability. It is said, when pure, to undergo no change either in a crystalline or liquid state; but as it exists in milk it is very susceptible to change—

more so, probably, than any other element in milk; by absorbing oxygen it is with great rapidity and ease converted into lactic acid, and is thus the cause of the sourness of milk. The rapid changes in milk, and its unstable character, are due to the ease with which this sugar ferments. In Switzerland it is largely separated for commercial purposes, but in this country it is not separated, but goes as food for swine.

SALINE CONSTITUENTS OF MILK.

Like all the other solids in milk the saline constituents are very variable, ranging from two-tenths to one per cent. of its weight, the average being about seventy to seventy-five hundredths of one per cent. The most prominent ingredient in the ash of milk is phosphate of lime. This constitutes about one-half of the whole ash. The next largest is chloride of potassium, which amounts to about one-fourth of the ash, so that three-fourths of the ash of milk, or thereabouts, are made up of these two minerals.

A cow giving 4000 pounds of milk a year exhausts the soil of twenty-eight to thirty pounds of mineral matter, one-half of which is phosphate of lime, and one-fourth chloride of potassium. The rest of the ash is made up of soda and chloride of sodium, and the sulphates of iron and magnesia.

Prof. Jas. F. W. Johnston quotes from Haidlen two analyses of the ash of milk, which will show how milk production exhausts the soil, and how to restore the exhausted minerals. The analyses are as follows:

THE ASH OF 1000 LBS. GIVES	1.	2.
Phosphate of lime.....	2.31 lbs.	3.44 lbs.
Phosphate of magnesia.....	0.42 "	0.64 "
Phosphate of peroxide of iron.....	0.07 "	0.07 "
Chloride of potassium.....	1.44 "	1.83 "
Chloride of sodium.....	0.24 "	0.34 "
Free soda.....	0.42 "	0.45 "

In considering milk thus far, we have spoken of it only in its normal or healthy condition; but as the cheese and butter-maker are frequently called upon to deal with it in a diseased and faulty state, something should be said of it when out of condition, and the causes which are known to produce troublesome effects. Of these the first which we

will mention is called the colostrum. This, to describe it without any particular attempt at scientific or professional accuracy, is the glandular cells of the animal floating in the substance of the milk—a condition of things which may always be seen when the milk has been saved too soon after calving.

At birth, or a little before, the liquid part of milk begins to be secreted, holding sugar, caseine, albumen, and certain mineral matter in solution, and to accumulate in the udder when the gland cells begin to shed off, sparingly in heifers, but more freely in old cows. At first the cells appear to break off very frequently in clusters, peeling off some of the membrane of the follicle with them. When examined, the first milking of the cow whose udder has just been described showed some large and many irregular pieces of membrane, with more or less cells attached, which, from the feverish condition of the bag at that season, sloughed off with the cells before they fully became milk globules. As the inflammation abates and the action becomes more regular, the membrane disappears, and the cells only are mingled in the milk. When these clusters no longer appear, the milk is considered fit for human use, or for manufacture into butter and cheese. Some dairymen are in the habit of saving the fifth milking; it is sometimes good, but oftener not. The fifth milking of this cow, in which specks of colostrum were seen, seemed to be fully as well as cows generally are at this time. It often requires five or six, or more days, before they entirely disappear, according to the health of the cow and the extent of inflammation in the udder. When the milk will boil without curdling, it may be regarded as fit for use. This is an efficient and convenient test of fitness for use.

The analyses of colostrum vary very widely in their per cents. of fat as well as other elements. These differences are doubtless owing more to the particular condition of the udder at the time of coming in than to any other cause.

The treatment of the cow at and previous to the birth of her offspring has very much to do with the condition of her udder and the quality of her first milk. There can hardly be a doubt that an abundance of fat in the blood stimulates the formation and multiplication of gland cells,

and hence milk globules, and that a paucity of fat diminishes the extent of their formation. It has been my observation for years, that where cows are fed chiefly on unstimulating and flesh-forming food before coming in, such as clover hay, pea meal, bran, or shorts, the bag remains pliable and soft, and if the milk is drawn out in season, there is not a very wide difference between the first milk and that which comes afterward. But if corn meal, oil meal, cotton seed meal, or other food very rich in fat, enters freely into the diet of cows before calving, their bags swell up to a very large size, and are hard and inflamed, the follicles become distended because of the greatly increased number of cells which the rich food has stimulated while they are still adhering, and they become hard and inflamed, and it is difficult to reduce the inflammation afterward; the colostrum is high-coloured and thick, and full of cells with pieces of membrane attached, and they continue in the milk for a long time. It is not very uncommon for cases of garget, which ruin a part or the whole of the udder, to follow high feeding with food too rich in fat, before cows come in, especially in young heifers.

The feed before coming in should be generous and nutritious, but it should abound in flesh-forming rather than in fat-forming elements. Early cut clover is one of the best things I have fed at such times, and corn meal and oil meal have proved the most dangerous. After cows have been in milk awhile and their bags have become reduced, corn meal and similar food may be fed with altogether different results. The fat then goes rapidly into the milk, avoiding the accumulation of cells in the udder and the inflammation which would otherwise follow. Previous to birth the same food would accumulate fat in the gland cells, swelling out and crowding the follicles, because at this time the cells, though forming rapidly, are not shed.

From what has now been said it will be seen that too much care cannot be exercised in the care and feeding of cows just prior to gestation, and in the saving of milk afterward. In some instances it appears that no harm would arise in using the milk either in butter or cheese-making at the fifth milking; while in others it would be unwise even at the seventh.

SOURING AND OTHER CHANGES IN MILK.

Milk, it is well known, is an unstable compound. It is constantly undergoing changes from the time it is formed in the lacteal glands until it is manufactured or consumed. The moment it is secreted by the milk glands, and passed into the tube of the udder, it is attacked by thousands of busy absorbents, that begin at once to suck up and carry away, into the general circulation, the nutrient properties it contains. Milk twelve hours in the udder is a very different thing from milk when first secreted. Exposed to the action of the absorbents that line the milk tubes, it steadily loses, as it passes along, a portion of its fat, its albuminoids, its sugar and water, and probably, also, a portion of its saline ingredients.

When relieved from the action of absorbents within the udder, and brought into contact with the air, other agencies begin at once to act upon it, inducing the changes which afterward occur. Unstable as milk appears to be, it does not perish from anything in the nature of its own elements, but is destroyed by influences foreign to its own necessary composition.

If milk is drawn from the udder without being exposed to the air and sealed up tight, it neither sours nor taints, provided it is healthy and sound when it is drawn. But if exposed to the air it sours and decays.

It is what the air contains, and not the air itself, that injures or destroys milk. Milk absorbs from the atmosphere the seeds of a fungus plant which grow and multiply and fill it with their presence, and produce the souring. The seeds of the fungus that are concerned in the process of souring are very small, and are always floating in the air unseen and unsuspected. When developed they are of considerable size, so that they are readily seen with a magnifier of moderate power.

They have a distinct cylindrical form, and are known as *arthrococcus*, or jointed cells. Cold checks their growth, but never kills them. They are not injured at all by freezing and thawing, or wetting and drying. Nothing but heat kills them. One of these cells, adhering to the sides of a milk pan, or in a crevice, may be dried in the most thorough manner possible and lie there for a week

a month, or even a year, without injuring it in the least. The moment it is moistened with warm milk, it swells up and springs into active growth, and in a short time its progeny may be counted by the million. Premature souring of the milk is the result. They grow most efficiently at blood heat, and nothing short of boiling heat is sure to kill them.

Operating conjointly with the *arthrococcus* is the *micrococcus* cells, which enter the milk through the body of the cow—the former inducing acidity, and the latter decomposition. These *micrococcus* are exceedingly minute, and are everywhere abundant.

The influence of the air upon milk is not confined to the absorption of the spores which produce acidity; spores of every other kind are taken in as well. Nor does the absorptive power of milk end with absorbing living germs; it takes in odours as freely as infectious germs. It is a fact which cannot be too strongly impressed upon the mind of every one connected with the care of milk, or the manufacture of milk products, that milk takes in every odour as well as the seeds of every ferment that blows over its surface.

This absorbent power is not peculiar to milk alone. It belongs in common to all liquids. Water, placed in a cellar containing decaying vegetation, soon tastes and smells of the decay, and becomes unwholesome to use. But milk, being full of oily matter and holding albuminoids and sugar in solution, offers to every species of ferment just what is most desirable for it to flourish in. Every odour that comes in contact with milk is grasped and taken in at once, and its grasp is never slackened. Once taken in, it is there permanently; and the seeds of every ferment that touches its surface find such a fertile soil to flourish in, that they spring at once into vigorous growth, and multiply, and quickly "leaven the whole lump." The *London Milk Journal* cites instances where milk that had stood a short time in the presence of persons sick with typhoid fever, or been handled by parties before fully recovered from the smallpox, spread these diseases as effectually as if the persons themselves had been present. Scarletina, measles, and other contagious diseases have been spread in the same way. The peculiar smell of a

cellar is indelibly impressed upon all the butter made from the milk standing in it. A few puffs from a pipe or a cigar will scent all the milk in the room, and a smoking lamp will soon do the same. A pail of milk standing ten minutes where it will take the scent of a strong-smelling stable, or any other offensive odour, will imbibe a taint that will never leave it. A maker of gilt-edged butter objects to cooling warm milk in the room where his milk stands for the cream to rise, because he says the odour escaping from the new milk while cooling is taken in by the other milk, and retained to the injury of his butter. This may seem like descending to little things, but it must be remembered that it is the sum of such little things that determines whether the products of the dairy are to be sold at cost or below, or as a high-priced luxury. If milk is to be converted into an article of the latter class, it must be handled and kept in clean and sweet vessels, and must stand in pure, fresh air, such as would be desirable and healthy for people to breathe.

Many other changes than those enumerated occur in the milk room. The souring process once begun, continues till the sugar is converted into acid. The whey begins to searate from the thickened milk, and the vinous fermentation sets in, slowly forming alcohol, which takes up the volatile oils, and the strong acid ferment preys upon the solid fats, to the detriment of the quality and quantity of the butter. If still permitted to stand, the alcohol is converted into vinegar, aggravating results. While these changes are going on, the *micrococcus* cells will be slowly decomposing the cheesy matter, and carrying it on to putrefaction.

These are some of the changes which are ever progressing under the eye of the dairyman, and he who can most successfully direct and control them is the one who reaps the best reward.

SPONTANEOUS COAGULATION.

It has happened every now and then, in cheese factory practice, that milk has been found to coagulate without the presence of any sensible acidity. Well authenticated cases of this kind have occasionally appeared in the agricultural papers, and they have also been mentioned by

dairymen at their meetings for public discussion. Their occurrence has been the occasion of surprise, and a good deal of wonder as to the cause of such a phenomenon, but no light has been shed upon the subject further than to find that there is always something the matter with the milk so affected.

A change in the proportion of the elements is always discoverable in such milk. This change is usually brought about by a feverish condition of the animal from which it is drawn, produced, doubtless, by bad water, too nutritious food, or the unwise use of a dog.

MICROSCOPIC EXAMINATION OF MILK.

The examination of milk with a magnifying glass serves a purpose in dairy practice which is of no small account. It enables us to distinguish between healthy and diseased milk.

In all the examples of diseased milk, and illustrations of diseased milk met with, the pellicles of the milk globules have appeared viscid and adhesive, as seen in the annexed illustrations, where the circles appear in clusters, leaving spaces between them nearly vacant.

Fig. 27.

Figure 27 represents a sample of slightly tainted milk, made so by a little fever in the cow.

One of the very first effects of disease is to begin to decompose and soften the coats of the globules, rendering them adherent. This effect appears long before the cow

exhibits any signs of disease—at least any that would be likely to attract the notice of the ordinary observer. In more advanced stages, the globules become broken down and destroyed, and assume a variety of new appearances.

Milk, when tainted by drinking impure water, contains seeds and other organic germs, which make the cows feverish and the milk globules very adhesive. The seeds pass through the body of the cow into the milk, and after

a day or two grow, and the stems of the plants, well developed, may be seen in the milk.

Figure 29 exhibits an aggravated case of diseased milk. It was drawn from a sick cow in a distillery stable in Williamsburg, at the time of the notorious swill milk *exposé* in the city of New York, in 1858 or 1859. The view is taken from a microscopic representation made by Dr. S. R. Percy, of New York city, as it appears in the annual report of the New York State Medical Society for 1860.

Fig. 29.

The cow had very high fever and inflammation of the bowels. The milk was scanty and blue. Under the microscope it showed the milk globules cohering, and also little bunches of them broken down and decaying.

From the first two kinds of tainted milk, butter could be made, though it would churn with a good deal of difficulty. From the last, butter could not be derived, though it should be churned a week; but they would all work into cheese, though a less amount would be produced than if the milk were sound.

Other and more detrimental agencies, in the form of organic germs, sometimes get into milk through the food and drink, or the breath of the cows. One sample when examined showed some that had got into the milk through bad water which the cows drank. They consisted of two species of microscopic algæ, often called "frog spittle." They were not seen in the milk when first drawn; but, after standing a while, they grew from the seeds contained in the milk, and developed into visible plants. They affected the health of the cows, producing slight fever, and the milk had all the peculiarities of what factory men call "tainted milk."

Figure 31 is a view of milk which contains a plant resembling what is known commonly as "frog spittle"—a green, stringy-looking plant which grows in stagnant or

very slowly moving water. In the lot where the cows fed was a sluggish stream with stagnant eddies extending

Fig. 31.

out some distance from the brook, and these eddies were green with the frog-spittle (algæ). From drinking this stagnant water the microscopic species here exhibited was

Fig. 32.

taken into the stomach of the cow and passed through the blood-vessels into the milk, where it developed and grew in the manner seen. It could have got into the milk in no other way. It is but a diminutive thing, its whole length being only $\frac{1}{100}$ of an inch, and its diameter less than that of a spider's web, but it is enough to show the excretory power of the milk gland

which cast the seed out of the blood.

Figure 32 shows what came in by feeding distillers' slops. It is another sample of the same kind of milk

illustrated by figure 29. The growth was made in 24 hours, the milk being closely corked. The organisms were in immense numbers. Every drop of milk contained from 5000 to 10,000 of the full-grown plants.

EFFECT OF TREATMENT.

The influence of mental and physical treatment received by cows has a decided influence in changing the character of the secretion, and upon its keeping quality afterward. The bovine is not unlike the human mother in this respect. Starvation or brutal treatment, worrying or fright, changes the composition of milk so much as to sicken the nursing offspring, and in extreme cases it amounts to an absolute poison. These effects are of common occurrence with nursing mothers, and occasionally brutal severity and fright affect a cow so much as to sicken the calf which sucks her milk. In all such cases milk spoils very rapidly, and its composition is changed. But little fat is formed in it, and sugar and caseine almost entirely disappear. Their place is supplied with an imperfect secretion of albumen. In the earlier stages of the milking season these influences do not appear to be so potent as at a greater distance from the time of coming in, but the effect is always visible. Milk is not only the most healthy and perfect, but keeps best when the cow is well fed and healthy and quiet.

THE ODOUR OF NEW MILK—ANIMAL ODOUR.

All who have been accustomed to handle or use milk, when first drawn from the cow, are aware that it has an odour peculiar to it at that stage, but which soon passes away if the milk is thinly spread out and exposed to the air.

New milk of the cow smells so much like her insensible perspiration that it is often spoken of as a "cowy odour." When milk, freshly drawn, is confined in covered receptacles, this odour will be found to be a disturbing element; indeed, the longer it is so confined the more putrid and offensive it becomes. In the United States and Canada, where the factory system prevails, the evil effects of animal odours are a constant source of annoyance. Covered cans are universally in use for the transportation of milk from

the farm to the factory, and these, often imperfectly ventilated, confine the odours so that they are held upon the milk for two and, perhaps, three hours; the consequence is defective-flavoured cheese.

The influence of animal odour upon butter is as deleterious as upon cheese. If the odour of new milk is carried into cream, and thence worked into butter—as it often is by cooling new milk too low and too suddenly—the butter has a modified flavour in consequence. The fine aromatic, and clear, and delicious taste of the oleine and its essential oils, which are developed in butter from milk free from such odour, are obscured and modified so much as not to be recognised, and a strong and indistinct flavour, as if something foreign and impure had been mingled with the butter, takes the place of the naturally agreeable taste.

In like manner, butter made from milk which has become affected with odour from a feverish condition of the cows, or from carrying closely covered, takes on an unnatural, strong, and unpleasant taste, and a greasy appearance, unless the odour is removed before the cream is raised.

We do not presume in this work to define what animal odour is, nor to enter into any lengthy discussion with regard to the particular manner in which, when kept with milk, it produces its deleterious consequences. We point it out, however, as a dangerous enemy, and we shall attempt later on to describe a method by which its baneful influence may be partially neutralised. We close this branch of our subject with a word of caution to all engaged in handling milk against any and every species of noxious odours:—"Keep them at a distance."

CHAPTER II.

TESTING.

IN the preceding chapter we have endeavoured to give the reader some idea of milk and the natural elements of which it is composed. We have also attempted briefly to explain the particulars in which diseased milk differs from that fluid in its normal condition. With the facts thus given, the cheese or butter-maker desiring to become master of the trade he follows will be able, by the use of the microscope, lactometer, per cent. glasses, and a variety of other scientific apparatus now in use, to investigate the subject for himself, and learn by personal observation the various characteristics of this singular compound.

In a volume of this character it would be hardly profitable to attempt to set forth directions for the use of the microscope, as printed directions are generally furnished with that instrument; and as we speak of its use only in connection with milk, a person of ordinary intelligence will be able readily to familiarise himself with its use sufficiently for an examination of that substance.

THE LACTOMETER.

The Lactometer is a well known instrument, so constructed as to be a perfect test or measure of the weight or specific gravity of milk. It is usually constructed with a small bulb at the lower end, in which sufficient weight is placed to keep it in a perpendicular position when immersed in milk. Next above the weight is another enlargement or bulb, of sufficient size to displace about four cubic inches of milk when immersed in it. This last bulb terminates in a stem about five or six inches long, and about 3-10 inches in diameter, which is graduated for pure milk near the lower end, and for pure water near the upper end.

HOW TO USE IT.

Every sample of milk to be tested by the Lactometer MUST be brought to the same degree of temperature, as every variation of temperature will cause a variation in its specific gravity by the Lactometer. Those Lactometers which are graduated for milk at 80° Fahrenheit are the most convenient for use at butter and cheese factories.

Whenever milk shows by the Lactometer a less specific gravity than pure milk, one of two things may be suspected:

First. That the milk contains an unusual amount of cream, which can be easily determined by comparing it with an equal quantity of pure milk set in two equal cream guages a sufficient length of time for the cream to rise. If the suspected milk has more cream than the pure milk, all right; but if less cream, the second suspicion ought to be, that the milk has been watered, and perhaps skimmed. Then to ascertain how much water has been added, take a sample of milk known to be pure, and from the mixed milk of several cows, and put it in a per cent. jar, filling it up to guage mark 10; then fill another per cent. jar to the same mark with the suspected milk, and one with water to 0, or zero. Place all three jars side by side, so that they will be of the same temperature, and subjected to the

same atmospheric influences until the cream has time to rise.

Note the per centage of cream on each sample of milk, before removing or disturbing it. Then after removing the cream from both jars, insert the Lactometer in the suspected milk, and note the point to which it sinks. Then place the Lactometer in the pure milk, and from the per cent. jar turn in water until the Lactometer sinks to the same point at which it stood in the watered milk. Place the jar of water where it will stand level, and as soon as it comes to a rest, read from it the per centage of water added. The value of the cream taken from the milk can be estimated from the amount left, by comparing it with the amount furnished by the sample of pure milk. In all tests of milk, which may affect the reputation of the man or woman delivering it, sufficient care ought to be used to make it reliable.

Another useful instrument in the hands of the operator—indeed, an indispensable auxiliary in cheese and butter-making—is the Thermometer. This is an instrument for measuring temperature, founded on the principle that changes of temperature in bodies are accompanied by proportional changes in their volume or dimensions.

From the beginning to the end of the process of manufacturing cheese or butter, this little instrument plays a part so important that without it everything would be left to chance and haphazard. Its use is too simple to require any explanation.

In my experience as a cheese instructor, during which I have visited many hundreds of dairies and cheese factories, I have found great numbers of these instruments grossly imperfect, through a want of care in their construction. When such is the case, the amount of mischief they are capable of executing can hardly be estimated. Great care, therefore, should be exercised in selecting them, and I would recommend that only such be used as have been properly tested and approved.

THE GERMAN PIOSCOPE.

To makers in factories and creameries this little instrument is invaluable, on account of its accuracy and simplicity. Its purpose is to determine the value in fats of the various messes that are brought in. It is a circular disc of vulcanised rubber, of perhaps two inches in diameter, one side

of which is smooth. Corresponding to this in size, is another circular disc of glass. Within a small circle, described in the centre of the latter, the glass is clear and transparent. Radiating from this circle to the outer edge of the disc, lines are drawn dividing the surface into six divisions, each of which is coloured to correspond with the appearance of milk in the following conditions, viz.:—"Cream," "Very fat," "Less fat," "Normal," "Poor," and "Very poor." When a drop of milk is placed upon the surface of the rubber disc, and the glass laid upon it, like the placing of one coin upon another, the milk is spread out in a thin sheet, the texture and colour of which can be seen through the transparent spot in the centre of the glass. If the milk be very poor, its colour will exactly correspond with that section of the glass so named; if only poor, it will correspond with that section; and so on through its various conditions up to cream. As an indicator of quality, I regard the pioscope as an excellent invention. When by this means poor milk is detected, recourse may be had to the Lactometer cream gauges, and other tests, to ascertain the true character of the defect.

There are other instruments now in use which have been invented to aid investigators in their work of increasing our store of knowledge with regard to milk, and to assist cheese and butter-makers in their efforts to improve the quality of their products, and to detect frauds and impositions to which they are constantly exposed; and these in number and accuracy, thanks to the progressive character of the age, are rapidly increasing. Let makers see to it that they keep pace with progress, and avail themselves of every new ray of light as it is brought to bear upon the subject.

CHAPTER III.

HEAT—RENNET—SALT—THE ATMOSPHERE.

IN addition to milk, there are other natural agents used in the manufacture of cheese; these are—heat, rennet, salt, and the atmosphere, which, working together in a harmonious partnership, produce upon milk that change from a liquid to a solid form called cheese-making.

HEAT.

Of these the first to be considered is heat. Cheese-making is a digestive process, and corresponds as nearly to the operation which takes place in the stomach of animals when milk is introduced as human ingenuity can make it. In the natural process of digestion heat is really the first agent employed, the normal condition being 98° . A study of the anatomy and physiology of the animal organism will show with what evenness and regularity this agent is applied, and in this respect especially ought the cheese-maker to imitate nature as closely as possible. But for the presence of that element in milk called albumen, of which we have already spoken, milk might be coagulated without the use of this agent, for, as we have said, caseine will coagulate when cold. In order, therefore, to secure a simultaneous coagulation of the caseine and albumen, a slight acidity is brought on and the temperature raised. The degrees of heat applied vary at different stages of the process, as will be explained when we reach that branch of our subject which describes the manipulation of milk in making cheese.

To secure as nearly as may be that uniformity characteristic of natural digestion, many devices have been employed. Of the apparatus by which it is applied, we shall speak in another place; at present we are only concerned with the natural means by which it is conveyed.

Heat direct from fire, unmodified by any intermediate agent, cannot successfully be employed, for the reason that its effect is too summary and powerful; therefore from time immemorial some diffusive agent has been interposed to modify and distribute its influence. This agent has been either water or steam. The latter is now almost universally in use because of its peculiar softness or docility, and the ease with which it can be applied.

RENNET.

The second agent employed by nature in the process of digestion is rennet. Rennet is a natural secretion from the walls of the stomach, otherwise known as gastric juice. To be effective as an agent in cheese-making, it must be taken from the stomach of some milk-feeding animal—that secreted from the stomach of a puppy or a sucking pig answering the purpose very nearly, if not quite as well as that obtained from the calf. For many reasons, however, the rennet obtained from calves is universally in use, and right here we will say a word with reference to the selection of stomachs. There is a practice too prevalent among dairymen of saving the rennet of calves born dead, or of such as have never digested milk; such rennets are not fit for use, and the individual using them ought to be dealt with at the bar of public justice.

It is a fact that the character of this secretion changes with the character of the food taken into the stomach, and that stomach which has never digested milk will not furnish an article fit for use as a coagulating agent. Again, stomachs which have become inflamed through starvation or any other cause ought to be discarded, the reason being too obvious for discussion. Such rennets may be easily detected by their red colour when cured.

To obtain the best rennets, such calves should be selected as have subsisted on milk at least three days; five, however, would be better. It is a good practice to feed a liberal allowance of milk twelve or fifteen hours before killing. The animal should be allowed to live until the process of digestion is nearly complete, but no longer, as it is then that the supply of juice is the greatest. As the curd disappears, the coagulating agent accumulates, not in the cavity of the stomach, as might be supposed,

but in its walls, forming a delicate coating, faintly flesh colour, and very tender, which breaks off in thin flocculent scales upon slight friction. As this coating contains the concentrated strength of the rennet, it is desirable to preserve as much of it as possible. To this end, the sack, when taken from the calf, should be handled with great care. The contents should be emptied out carefully, sack turned inside out, and any specks of dirt or hairs that may appear on it picked off. If further cleaning is necessary, it may be carefully wiped with a moist cloth; water should never be used in cleaning. Being now lightly salted, it is ready for drying, which may be done in any convenient way, so that it shall not waste by dripping nor injure by tainting. It may be stretched on a crotched limb, its ends may be tied and inflated, or it may be cut open and laid on a dry board, which will aid in drying and absorbing its moistures. These modes of preserving are much better than salting in pickle, or filling with salt. If exposed to much heat, rennets lose strength; 120° Fahr. will kill the strength entirely; therefore, they should never be dried on plates or tins around the fire.

To extract rennet properly, or, to speak with greater accuracy, to separate the coagulating principle from the animal tissue in which it is confined, the following directions should be carefully observed:—

Take a clean oak cask, of any desired capacity, and in the spring of the year, while the weather is yet frosty, place in it a quantity of stomachs sufficient for the season's consumption, taking care in doing so that they are scrupulously clean. To these add of pure water one quart to each stomach. It is a good idea to boil the water before using, in order to destroy whatever germs of organic life it may contain, and to rid it of other impurities. Do not, however, add the water until it has become cold. If the weather be cold enough, it is not necessary at this time to add salt; but if, on the other hand, the weather be warm, sufficient salt should be added to preserve the liquid. After a week's soaking, during which time frequent rubbing, stirring, pounding, wringing, &c., should be resorted to, in order that the separation may be as complete as possible, the stomachs should be taken out, and deposited in another receptacle, in the same

quantity of water, where they will be allowed another week's soaking, rubbing, pounding, &c. Now remove the skins, taking care in doing so to rinse and wring them out, in order that nothing be lost, and unite the contents of the casks.

Now prepare a filter, consisting of (first) a layer of straw; next, a layer of very coarse, clean gravel; then another of washed charcoal; and, finally, another of washed sand. It is a good idea, however, before filtering to strain the liquid through a cloth, in order to remove the bulk of the animal fibre. After filtering, the liquid will be found clear, like alcohol, though, perhaps, not so colourless. Now return it to the cask, which has been thoroughly cleansed for the purpose, and add a little more salt than will dissolve. After which, rack off into jugs, kegs, or other close receptacles, and set away in a dark, cool place for future use.

With the exception of the proprietary extracts now quite extensively in use—Arnold's, Hanson's, Carter's, and others—all of which are excellent, rennet prepared as above is the only coagulating agent fit for use.

The practice resorted to, somewhat too extensively among ignorant makers, of soaking stomachs in whey is too contemptible to deserve discussion in any work devoted to cheese-making.

Still, continuing to consider our material as agents in the natural digestive process, it will be proper in this connection to consider the office which rennet performs in that operation. It is called coagulation.

By coagulation we mean that change which, in pursuance of a law of nature, takes place in the caseine of milk when brought into contact with rennet and some other acids, and a corresponding change in the albumen under the influence of heat. By the operation of rennet the particles of caseine which float about in the water of milk are brought together and made to adhere, whereupon, under the influence of heat, these particles contract, and by this contraction the water which lies between them is expelled.

When milk is taken into the stomach, that organ begins immediately to pour out the digestive fluid, and puts itself in motion in a way to cause this fluid to mingle evenly and rapidly with its contents.

So the cheese-maker, following the example set by this organ, should distribute his rennet as evenly and rapidly as possible, seeing to it that every particle of caseine has its share of the coagulating agent.

Nature, wiser than most cheese-makers, determines with unmistakeable certainty, without having to resort to any test, the quantity of rennet necessary to coagulate a given quantity of milk; and she uses no more and no less. Man, however, can acquire this knowledge only by experience; he must resort to a test. For this purpose take an ordinary tea cup holding a gill, and into this full of milk introduce a given quantity of rennet, say a drachm; now note the time employed in coagulation, and you will have the necessary factors with which to compute a result, thus: If one drachm of rennet is found sufficient to coagulate a gill of milk in a given time, then by a plain, arithmetical proposition, a greater amount of rennet will coagulate a proportionately greater amount of milk in a proportionate time. If the maker has on hand rennet, with the strength of which he is familiar, he may readily compare with it a fresh supply by a comparison effected by the use of two tea cups, in one of which he coagulates with the old, and the other with the new. If the old is found to perform its work in twenty seconds, and the new in thirty, then it follows as a natural sequence that a third more of the new must be used.

In closing this branch of our subject, we desire to say a word about cleanliness in the preparation and use of rennet. In the manufacture of cheese much depends upon the flavour; and as weeks, and sometimes months expire before that article comes under the inspection of the purchaser, if a quantity of animal tissue be distributed through its substance, by the action of heat and other influences, to putrify and decay, it can hardly be expected that a fine flavour will be retained, and yet there are cheese-makers who, in the use of rennet, perpetrate upon themselves, their employers, and the public, just such a foolishness. Infinitesimal particles of the substance of the tissue from which rennet is extracted are allowed to remain in the liquid in countless numbers, in which they are transferred to the milk to perform their legitimate work. When it is remembered that rennet creates texture

in cheese, and enters into the structure of that material to perform its natural office there until the product is consumed or decays, never losing its strength or diminishing in volume, the necessity for using a perfect article becomes apparent. And it follows, as naturally and certainly as the night follows the day, that a really good cheese can never be made from impure and faulty rennet.

SALT.

Salt, or, in other words, chloride of sodium, a substance found native in the earth, or produced by evaporation and crystallisation from water impregnated with saline particles, is used for seasoning certain kinds of food, and for the preservation of meats and other organic substances.

In cheese-making it performs both these offices, and should be used understandingly, as the work it performs is more important than may at first thought appear.

Rennet no sooner unites and gives solidity to curd than it turns about and begins a work of disintegration and decomposition—a work which would speedily result in the total destruction of that substance were it not for the presence of salt. Salt, therefore, acts as a check upon rennet, and should be so used as to establish a healthful balance between the decomposing and preserving agencies, with some view as to the length of time during which this balance is to be kept up.

We shall not attempt in this connection to prescribe rules for the use of this material as to quantity, time of using, &c., as such can more appropriately be given in our chapter on the manufacture of cheese.

Where an analysis is not accessible for judging of the purity of salt, a good test can be made by observing its behaviour in damp weather. If, when the weather is damp, salt will attract moisture enough from the air to appear wet, it is unfit for putting into butter or cheese. Pure salt remains dry in wet weather. It may stand in a cellar all summer without being sensibly moist. It is the impurities in salt (notably the chloride of calcium) which attract moisture and make it appear wet; hence salt which will vary with every change in the hygrometric condition of the air should be rejected by dairymen as impure and unfit for their use.

In salting butter regard need only be had to seasoning. For this purpose the quality is varied from one ounce down to one-half an ounce to a pound of butter, to suit the taste of different individuals and markets of the country. No increase of salt need ever be added for preserving butter. The smallest amount used for seasoning is always more than enough to do all that salt can do toward preserving butter. Its keeping depends chiefly on other conditions than salting.

THE ATMOSPHERE.

In cheese-making, the atmosphere comes in for its share of our attention, as in making as well as in curing its condition may serve to facilitate or retard our efforts. That natural process which takes place in milk, and for which there is perhaps no better word than ripening, depends quite largely upon the condition of the atmosphere. Ripening is the action of that germ deposited in milk from the air which eventually produces souring; as we have already described in our chapter on milk, it is the initiatory step to that change. If the night has been cold, and the atmosphere in the morning still remains at a low temperature, the maker will find that nothing in the way of ripening has been accomplished; if, on the other hand, the weather has been warm this process may have gone on to a considerable extent; in the latter case he may commence his labours at once, while in the former something must be done to bring about this change. Some makers, as a whip with which to arouse dilatory nature to the performance of her duty, are in the habit of resorting to a bucket-full of sour whey, a practice in the highest degree ridiculous and absurd. The better practice is to raise the temperature in the milk to a degree in which the germ naturally begins its work. The make room should always be kept at a temperature of from 75° to 80° , or at least sufficiently high to protect the surface of the milk or curd from the obstructive influence of cold. For this purpose make rooms should be well constructed, especially for spring and fall work.

Again, there are times in the manufacture of cheese when the atmosphere plays an important part as a corrective to some of the disturbances brought in by tainted

or diseased milk. Pure air, when brought into contact with curd, expels to a great extent, if not entirely, all objectionable taints and gases; so that when, by reason of bad water, fever in the animal, or noxious odours contracted by the milk while standing, there appears in the curd a condition of things liable to result disastrously to the flavour of the product, careful stirring and a thorough exposure to the purifying influence of the atmosphere will do much towards a restoration. So also in curds in which there is no intimation of taint; pure air must be allowed a liberal access, because by so doing the most delicate, as well as the most desirable, element of flavour is obtained.

In curing, everything depends upon the condition of the atmosphere. Below a given point, and the process is arrested altogether; above, and it proceeds too rapidly, inducing a separation of the elements akin to malting; while dampness induces mould and other evils. A uniformly warm and dry atmosphere is essential to the proper curing of cheese.

CHAPTER IV.

BUILDINGS AND UTENSILS.

NEXT in our order of arrangement comes the mechanical contrivances which men have invented to be used in the manufacture of cheese; and here we shall proceed not to consider particularly the inventions which have been patented to accomplish special purposes, but to take a general view of the ordinary and necessary materials commonly in use in dairies and factories.

To those contemplating the inauguration of a factory system, such as prevails in the United States and Canada, and the erection of a cheese factory, our description of such an establishment, with appurtenances, given in a subsequent chapter, entitled "The Manufacture of Cheese for the English Market," will be found interesting. In that description the hints thrown out with reference to the construction of factories are worthy to be considered in the erection of private make and curing rooms; indeed, nothing further, it seems to us, need be said in this connection upon that subject.

Taking it for granted that every dairyman is sufficiently acquainted with boilers and the connecting apparatus for the generation of steam, we shall begin our description with the vat, or other receptacle, in which the milk is heated, and the most important part of the process is performed. The vat, in cheese-making, corresponds with the stomach in digestion. It is there that the heat is applied, the ripening process effected, the rennet introduced and mingled, coagulation secured, the curd broken, and the whey separated. Of course, the vat, in point of operation, is but a clumsy imitation of the organ used by nature, but it is the best which the ingenuity of man has yet succeeded in producing. Used in connection with a boiler, it is so constructed that heat is distributed to five

sides of a rectangular body of milk, from which, by stirring, it is made to permeate the mass with an evenness fairly approximating to that supplied by the stomach. They are of any desired capacity, varying from one to six hundred gallons. They are rectangular in form, and about three feet high, and stand either upon legs or a rocker. This form has been found the most convenient in cutting and heating, while the rocker affords an easy means of tilting in draining. The accompanying cut will convey to the mind of the reader a good idea of the appearance and

general structure of the vat, minus the rocker, and its internal arrangements for heating. Between the metallic pan holding the milk and the outer shell, or frame, there is a space in which is coiled a pipe, which, turning at right angles, traverses backward and forward four times the length of the vat. This pipe lies along the bottom, and is sometimes submerged in water, and at others it is perforated along its sides with small holes for the emission of free steam, when heating is accomplished by steam alone. By this means heating is effected in a very satisfactory

manner, and without the noise always produced when the pipe traverses the vat but twice. Prior to the introduction of the vat, and even at this late day, in some localities wooden tubs, or circular metallic cisterns, are in use. Of these, such as have been constructed in this form for convenience in the use of machinery, we say nothing; but, when such is not the case, and a circular receptacle is used, if large, they are open to at least one grave objection. We have seen tubs or cisterns of this description of a capacity of 350 gallons, of which there was a space in the centre quite out of reach, and of which, to reach the bottom, the operator must needs bend until his hands are brought down on a level with his feet—a position, it is needless to say, very laborious and uncomfortable, and quite unnecessary. In the vat we have described these objections are obviated, their bottoms standing at least a

foot from the floor, and their depth and width being such that their entire contents are brought within easy reach of the hands with the form moderately bent. The tubs were 30 inches deep; the vats are only 20. The tubs were sometimes 6 feet in diameter; the vats never over 3 feet 10 inches in width.

In heating these circular receptacles, we would say that the best method we ever saw was in no way to be compared with that used in heating the vat; for in those cases where they are of wood, the application of heat externally is out of the question, and when of tin the heating

surface is confined to the bottom, leaving much too extensive a surface about the circumference exposed to the obstructing influence of cold.

Of curd knives we shall consider but one variety, and that such as are used in the United States and Canada

They are constructed in pairs, a perpendicular and horizontal, as shown in engravings on preceding page. The perpendicular consists of a cluster of blades, corresponding in length with the depth of the receptacle in which they are to be used, standing parallel to each other, and attached to a horizontal bar, equi-distant from each other $\frac{3}{8}$ to $\frac{1}{2}$ inch; to the centre of this bar the handle is attached. The blades are 1 inch in width, made of steel, and sharp at either edge.

The horizontal are the same length as the perpendicular, and of any convenient width. The handle is attached in the same manner, but the blades are arranged horizontally, being attached at the ends to perpendicular bars the same distance apart. These tools are very convenient, and perform their work with great ease and accuracy.

To stir the curd I have found no better hand implement than an ordinary hay-rake, with teeth 3 inches apart, and 6 inches long, smoothly made of hard wood, and as light as can be used.

The system of cheese-making taught in this volume requires the use of a curd-mill, or curd-cutter, as it is sometimes called. At a certain stage in the process the curd is allowed to settle together and drain; it then becomes a solid mass. As soon as it becomes sufficiently adhesive to hold together, it is cut into chunks convenient to handle, and turned over.

When sufficiently ripened, the curd becomes tough and stringy, and, when pulled apart, splits instead of breaking, showing a fibrous structure similar to that which may be seen in pulling apart the muscular fibres in lean beef when boiled. At this stage it assumes a distinct and peculiar odour which it is difficult to describe. It has something of the sickening smell of animal odour, but is more like that of the cow's breath than anything else I can compare it with.

It is at this point that the mill comes into play. In the absence of a mill the mass may be torn apart with the hands, but this, where large quantities are being operated upon, would be a work much too laborious and expensive to be practicable, and, when done, would not be nearly so perfect and satisfactory as when performed by some mills, for the reason that the rough, ragged surfaces speedily

adhere again, whereas it is sometimes desirable, for the purpose of airing, that the mass remains loose for some time before salting.

The mill shown in the annexed engraving has some

advantages which recommend it to the attention of all cheese-makers. In the first place, it performs its work rapidly, being able, in ordinary hands, to dispose of 100 lbs. of curd per minute; secondly, it cuts evenly through

meshes $\frac{3}{8}$ -inch square, thereby securing a uniform salt permeation; thirdly, it gives to the curd passing through it a set of smooth surfaces which do not so readily adhere as when the curd is broken or torn apart, thereby facilitating the airing often indispensable, but which does not in any manner interfere with the pressing; again, and finally, it accomplishes its work without bruising, no greater pressure ever being brought to bear upon the curd than enough to force it between the sharp knives, thus the serious objection chargeable to the peg mill, that it bruises the curd and starts the butter, is avoided.

DIRECTIONS FOR USING.

Put the machine across the sink or vat and secure it in its place by means of an iron hook, one end of which takes hold of the thumb-screw of the machine, and the other by a square turn to the bottom of the sink or vat. In operating, raise the lever with the right hand, and with the left, by means of the wire adjustment attached to the lever, draw the follower into the position as seen in the cut, and rest it upon the posts; now fill the hopper, taking care to put in only such an amount as will press through with ease; then raise the lever and the follower will swing into position, when a single downward motion empties the hopper.

SINKS.

One of the most important auxiliaries in cheese-making is the sink, of which mention is made in our lecture on manufacturing cheese for the English market given in another chapter. Indeed, so highly do we value it that we cannot refrain from expressing here, as we have often done elsewhere, our belief that a large share of the success achieved by Canadian makers is due to its use.

It is made of any size suitable to the place where it is to be used. Imagine a water-tight, rectangular, wooden box, about seven inches deep, with a moveable slat work in the bottom, the bars of which are a quarter of an inch apart, so adjusted as to leave a space between it and the bottom of perhaps one inch, and you will have a fair idea of the sink. It may be supported on legs with castors, horses, or any other convenient support. Over this box a strainer cloth is thrown, and the curd dipped into it. The

advantages of such an arrangement to those unaccustomed to its use can hardly be appreciated; in no other way can the work of draining, malting, milling, airing, and salting, be accomplished so easily and perfectly as in the sink. Sometimes when the weather is cold, and the curd tardy in reaching a proper state of maturity, a sink constructed as above described will be found very convenient, as by filling the space under the slat work with warm water, and covering the whole with a cloth, the temperature may be kept at a proper status.

There are a host of tools of minor importance convenient about a make room, such as pails, dippers, syphons, faucets, &c., &c., with a description of which we will not weary the reader's patience, but will conclude by saying that cheese-makers, like other mechanics, may be known by the condition of their tools. As the carpenter whose planes, saws, chisels, &c., are dull and ill-used, will quite likely be found wanting in respect of a good job; so the cheese-maker whose pails, dippers, &c., are dirty, leaky, and out of place and order, may be readily set down as a poor workman.

CHAPTER V.

THE FACTORY SYSTEM, AS PRACTISED IN THE UNITED STATES AND CANADA.

BEFORE entering upon the details of cheese manufacture, we deem it proper to say a few words about the factory system, as we have no doubt that to those dairymen unacquainted with that system a brief description of its workings will be found interesting.

The factory plan is based upon the very excellent idea that "time is money;" indeed, as a time-saving expedient it may reasonably be compared to anything in the business world.

To illustrate: There are many factories which make up the milk of 1200 cows, supplied by at least 100 farmers. If done at home, to make the cheese from these dairies would require the work of one person for each dairy one day, making in all one hundred days. Made at the factory, the work is performed by six persons in one day, making but six days' work—a saving of 94 days. This for the season of, say, 150 days, leaves a grand total of saving for a single season of 14,100 days, minus the time spent in drawing to the factory, 375 days, which still leaves a magnificent balance of 13,725 days.

A second great advantage arising from the factory system is a heavy aggregate value in respect of talent and experience. As in the above illustration, the foreman of such a factory is always a select man—a person of known capability and intelligence—whose experience in the business is made to take the place of the inexperience and fallacious practices of one hundred recruits, and the balance in favour of the factory plan is immense. Indeed, when we consider this one item of advantage growing out of co-operative cheese-making, it seems to us quite impossible

that the old individual method can ever be brought to compete with it successfully.

Factories are established in two ways—the individual and the stock company. Any person having sufficient capital may start a factory. Selecting a favourable location, he interviews the dairymen of the neighbourhood, and secures the promise (in writing or otherwise) of as many of them as he may be able to patronise him. If in this he succeeds in securing a profitable number of cows, he erects his building, puts in his machinery, and at the proper time, say April, commences operations.

The patrons now supply themselves each with a sufficient number of cans in which to transport their milk to the factory, and either draw it themselves or procure it to be done by the trip, season, or at a given price per 100 lbs.

Each factory is supplied with a platform scale, upon which sits the receiving can into which the messes are dumped and weighed as received. These weights are tabulated in a book kept for that purpose, from which, during the season when sales are made, each patron's dividend is computed. It is customary among the patrons of these factories to meet some time prior to the commencement of the season, and appoint from among their number a salesman whose duty it is to visit boards of trade or other markets, and negotiate all sales. A committee is also appointed, generally of three persons, whose duty it is to examine into and settle whatever controversies may arise between the patrons with reference to the business of the factory. When the salesman has effected a sale, which he usually does weekly, bi-monthly, or monthly, he proceeds from the tables above-mentioned to compute each patron's share, and to make out for each person a written statement showing the amount of milk delivered by that person during the days included in the sale, the number of pounds of milk which has been used for each pound of cheese, the price for which the cheese was sold, the total weight of the whole milk, the total weight of the cheese, the total value of the sale, and the patron's share in money, minus cost of making. For this purpose a printed blank, substantially in the following form, is supplied:—

H. H. BENT'S FACTORY, No.....

STATEMENT No..... To.....

From.....to.....188 , each day included.

Amount of Milk for pound of Cheese,..... You had.....
pounds of Milk.

Cheese sold for.....cts.

You have had.....pounds of Cheese. Amount in
Treasury, dols.....

It is the duty of the maker to examine the milk brought in, with a view to the exclusion of such as may be unfit for use, and to guard against imposition and fraud. For this purpose he is supplied with a set of apparatus, among which are some of the instruments described in a former chapter. In the discharge of this trust he should be vigilant and fearless. To guard against taint he will sometimes find it necessary to go outside and sniff the odours emitted from the cans before the milk is emptied. He will also have a set of testing-glasses, in which a portion of each patron's milk is retained, and in which such developments as premature souring, spontaneous coagulation, watering, skimming, saving strippings, &c., may be looked for. When in some of these glasses abnormal conditions are disclosed, the maker immediately resorts to other instruments or tests in order to ascertain the true nature of the difficulty, and as soon as it is known he calls in the committee already mentioned and lays the case before them, in order that the delinquent may be properly dealt with. In the United States and Canada the Legislatures have, by competent legislation, surrounded the factory system with abundant safeguards, and whenever there occurs an infringement or violation of the Statute whereby a loss accrues to the honest patron, which is not often, the committee usually succeed in effecting a settlement with the transgressor, without recourse to the Courts, by which ample compensation is secured. The following is a transcript from the Canadian Statutes upon the subject:—

“AN ACT TO PROTECT BUTTER AND CHEESE
MANUFACTURERS.

“*Assented to March 4th, 1868.*

“Whereas it is expedient and necessary to Encourage and Protect Butter and Cheese Manufacturers in this Province: Therefore, Her Majesty, by and with the advice and consent of the Legislative Assembly of Ontario, enacts as follows:

“1. Whosoever shall knowingly and fraudulently sell, supply, bring, or send to be manufactured to any cheese or butter manufactory in this Province, any milk diluted with water, or in any way adulterated, or milk from which any cream has been taken, or milk commonly known as ‘skimmed milk;’ or whoever shall keep back any part of the milk known as ‘strippings;’ or whoever shall knowingly and fraudulently sell, send, bring, or supply milk to any cheese or butter manufactory that is tainted, or partly sour from want of proper care in keeping pails, strainers, or any vessel in which said milk is kept, clean and sweet, after being notified of such taint or carelessness, either verbally or in writing; or any butter or cheese manufacturer who shall knowingly and fraudulently use, or direct any of his or her employees to use for his, her, or their individual benefit, any cream from the milk brought to any cheese or butter manufactory without the consent of all the owners thereof, shall, for each and every offence, forfeit and pay a sum of not less than one dollar, nor more than fifty dollars, in the discretion of the presiding Justices before whom the case shall be heard.

“2. Any two or more Justices of the Peace, having jurisdiction within the locality where the offence has been committed, may hear and determine such complaint upon the oath of one or more credible witnesses, and shall have power, in case the penalty awarded by them be not forthwith paid, upon conviction, to levy the same by distress and sale of the goods and chattels of the offender by warrant under their hands and seals, or the hands and seals of any two of them; and the penalty, when recovered, shall be paid over by such Justices, one-half to the person complaining and one-half to the treasurer of the municipality, district, or place where the offence shall have been com

mitted; and, in default of payment or sufficient distress, the offender may, by warrant signed and sealed as aforesaid, be imprisoned in the common gaol for a period not less than one day, nor more than twenty days, at the discretion of such Justices, or any two of them, unless such penalty, costs, and charges of the commitment, be sooner paid.

"3. Any party aggrieved by such fraudulent conduct as aforesaid, may, at his or her election, sue the offender in any civil court of competent jurisdiction, and recover from him the amount of damages sustained, and levy the same, with the costs, according to the ordinary practice of the court in which such suit shall be brought.

"4. Provided always, that no Justice or Justices having any pecuniary interest in any such butter or cheese manufactory, as aforesaid, shall hear or determine any such complaint.

"5. In case of summary proceedings under this Act, any person, complainant or defendant, shall have the right of appeal as provided in Chapter one hundred and fourteen of the Consolidated Statutes of Upper Canada."

It is a recognised fact among dairymen, that dairies differ considerably in the cheese and butter-producing quality of milk, but throughout the whole extent of the factory belt of dairy country visited by us while acting as cheese instructor we remember no case where any attention was paid to it. A careful consideration of the question will disclose the fact that in those cases where by reason of better feeding, breed, or any other circumstance, one man produces better milk than his neighbour, or the best among his fellow patrons, that even such an one is a gainer by availing himself of factory advantages; for no one familiar with the system will contend that any dairyman can supply himself with a cheese-manufacturing outfit and make his own cheese as cheaply as he can procure it to be done at the factory. Moreover, at the close of the season, he will find that he has received pretty nearly, if not quite as good a yield as he could have produced by home manufacture; that by reason of better machinery and better talent his cheese is better; and that by virtue of uniformity (a circumstance not to be despised in the cheese market) he is a gainer by the factory system

If, however, it still be contended that there is an injustice in allowing the producer of poor milk to share equally with the producer of rich, we will say that by the help of modern appliances the quality of milk can be accurately ascertained, and the relative values may be made to become a part of the proportion by which the proceeds are divided with perfect justice to all concerned. To illustrate. If A's milk falls below the normal to the extent of 5 per cent., and B's stands 5 per cent. above, a discrimination of ten per cent. should be made between the two. We think, however, that when any fair-minded community contemplating the inauguration of a factory system have carefully weighed the advantages arising from it, they will not hesitate on account of this minor consideration, and we base our opinion on the fact that no race of men are more punctilious in questions of dollars and cents than the American, and they do not hesitate.

The price of making is different in different localities, running all the way from one dollar to one dollar fifty cents per 100 lbs., including rennet, salt, bandage and boxes.

Stock companies for cheese-making are organised in the same manner as other corporate bodies for business purposes. The Legislature enacts a general law under which such organisations may be created. A number of dairymen favourably located unite and subscribe to a common fund until the prescribed amount is secured, when a meeting is held and the officers chosen. These commonly consist of a president, secretary, and treasurer; besides these, committees for various purposes are chosen. After the organisation of the company, certificates of stock are issued to a given amount. The management of a stock company factory does not differ materially from that already described, except, perhaps, in the matter of drawing milk and the employment of a maker—the former being usually done by the route to the lowest bidder, and the latter by the 100 lbs. in the same manner.

For the benefit of those desiring some knowledge of the manner in which stock companies close up a year's business, and to give some idea of the financial status of these companies, we clip the following from *The Ingersoll Chronicle and Canadian Dairyman* of Thursday, February 26th, 1885:—

"CHEESE FACTORY MEETINGS.

"The Brownsville Cheese Factory held their annual meeting on the 14th inst. The meeting was called to order by electing Mr. E. York chairman, and Mr. B. Hopkins secretary. From the report it appears that the receipts of the company from all sources were 71,493 dols. 76 cents.; the amount paid to patrons in Brownsville was 24,768 dols. 55 cents; to Bayham Factory, 17,555 dols. 20 cents; to Tilsonburg, 16,281 dols. 90 cents; the expenses for drawing milk amounted to 3716 dols. 50 cents; for manufacturing cheese, Brownsville, 2144 dols. 87 cents; Bayham, 1578 dols. 30 cents; at Tilsonburg branch, 1567 dols. 89 cents; the expenses in repairs in Brownsville and branches amounted to 511 dols. 90 cents; the dividend on shares (276), at 3 dols. per share, amounted to 828 dols., which, with the other expenses, such as salaries, &c., being deducted from the amount received, leave a balance on hand to carry over to the incoming season of 1020 dols. 55 cents. The amount of milk received amounted, in the whole three factories, to 6,638,083 lbs., which, manufactured into cheese, made 640,700 lbs., equal to 320 tons and 700 lbs.; the average amount of milk being about 10.36 lbs.; the average price per pound being about 11.01 cents; the total number of standard cows, 2135. The directors for the next year are—E. B. Brown, N. Cuthbertson, A. L. Cook, B. Hopkins, and J. Allison; the auditor chosen by the company was W. Sherwood; the directors appoint theirs at their first meeting. The subject of making cheese on Saturday night was then taken up. After considerable firing and cross-firing, that all milk on Saturday evenings shall be on the company's ground by, and not later than, six o'clock p.m., and any milk arriving after that hour shall not be received by the cheese-maker, some remarks were made of the carriage of whey in cans, and the necessity of emptying them as soon as possible, to keep the milk good in the next delivery. Mr. Steinhoff, the maker of the past year, is employed for the coming year.

"At the annual meeting of the Harrietsville (North Dochester) cheese factory, the auditor's report showed that there had been 3,374,094 pounds of milk received, which made 320,568 pounds of cheese, which sold for 36,273 dols. 03 cents. It took 10.52 pounds of milk to make a pound of cheese. The average price at which the cheese was sold was 10.99 cents per pound. The patrons received 9.65 cents per pound for their cheese, and 9.17 cents for ten pounds of milk. The following were elected as a committee of management:—Wm. York, E. Smith, J. P. Dunn, H. Finch, J. M. O'Neil, W. H. Bowen, and H. Barrons; F. Kunz was elected secretary, R. Facey, salesman, and Wm. Barr, auditor.

"The annual meeting of the Harris Street Cheese Company was held at the Harris Street Hall, on Tuesday, Feb. 17th. The amount of business done at the Company's factory the past season was—amount of milk received, 1,606,424 lbs.; amount of cheese made, 152,016 lbs.; received from sale of cheese, 16,661 dols. 85 cents; average price per lb., 10.96 cents; average number lbs. milk to lb. cheese, 10.56 lbs. The following gentlemen were elected directors for 1885:—Messrs N. Smith, W. H. Cook, H. Gregg, E. G. Poole, R. Mayberry, T. L. Newton, W. Wilkinson, E. Wiseman, and J. Stevenson. T. R. Mayberry was elected salesman."

CHAPTER VI.

CO-OPERATIVE CHEESE-MAKING.

An address read by the author before the Dairymen's Association of Western Ontario, held at the City of London, Ontario, on the 14th day of February, 1884.

IN all human efforts, grand results have been attained chiefly by *concert of action*. The men who reared the magnificent temples of Palmyra, the Pantheon of Agrippa, or the Temple of Mount Zion, understood this fact; and, standing alone, grand and solitary, amid the sands of the desert, the Pyramids of the Ptolemys will remain while time lasts, an evidence of what may be accomplished by human co-operation.

In our own time, everything is done by co-operation. Railways across continents, canals uniting oceans and seas, bridges almost of fabulous proportions, enterprises in engineering and commerce, never before known, evince the extent to which modern genius is availing itself of concert of effort in testing human capacity.

On more than one occasion in my life have I listened to the tones of a well-drilled orchestra, of perhaps twenty pieces. At such times, while listening with delight to the swelling grandeur of the strain, I am always in doubt from which source comes the greatest satisfaction—the harmony of sound to the ear, or the evident *harmony of action, unity of understanding, and singleness of purpose* on the part of the players, manifesting themselves to the eye, as well as to the ear, in the time and movement of the pieces. The hands and hearts of twenty men beating in unison, at the beck and nod of the skilful director, are made to move the sympathies and arouse to quicker action the life-current in the veins of the listening thousands. There is a visible tendency in all branches of business towards co-operation and centralisation.

In looking down upon a large city, the unity visible even in the diversity of human affairs manifests itself in a manner truly wonderful. The air is literally filled with a vast network of wire, crossing and re-crossing in every conceivable direction, and over these, backward and forward, the thoughts of men are made to vibrate with the speed of lightning, in the elaboration and consummation of thousands of business schemes, and the air, as well as the buildings and streets, is full of human activity and enterprise. The lawyer, sitting comfortably at his desk in his office, talks with his banker, physician, grocer, a hundred clients, and his family, all seated, like himself, at home, or at their various places of business. Thus is the telephone made the instrument of human co-operation and concert of action.

It is now less than thirty years since dairymen stumbled into the practice of co-operation in the business of making cheese. Previous to that time, cheese-making in this country was, to say the least, a crude affair. Every farmer ran his own factory, according to his own peculiar notion, and disposed of his products as he could "light on" chaps. In that day cheese-making was guesswork and haphazard. To-day it is a science. Then there were as many rules and methods as there were men. To-day the laws which nature has enacted to govern the process of converting milk into cheese are codified, and cheese-making has become a profession. In that day the accumulated results of the cheese industry of a neighbourhood or township was a sight to behold—all manner of circular blocks, of concentrated error, large and small, thick and thin, when heaped together, presented a spectacle that would now bring a smile upon the countenance of the most sober and dignified cheese-maker in the State.

The condition of the market at that time was quite as crude and irregular as the system, or rather the want of system, in manufacturing. There was no cable, no regular reports from the great business centres of the land, no regularly organised boards of trade, railroads not as numerous, less daily papers were in circulation, and many other circumstances which left the seller comparatively at the mercy of the buyer, and the purchase and sale of a

dairy was conducted upon principles similar to those usually practised in a horse trade.

The great changes which since that day have taken place in the dairying world are due chiefly to a division of labour, the introduction of system, and co-operation. Our machinery, we are sorry to say, is not yet quite perfect in all its parts, and does not move with the precision and harmony of the orchestra to which we have already alluded. Yet, although still in its infancy, it has already produced, and does annually produce, results grand indeed.

If we take a glance at the various industries at which men are to-day engaged, intellectual, commercial, and mechanical, the painstaking exactitude everywhere practised will be found to be a growing subject of wonder and admiration. The secret of this lies in the fact that perfection in any department of business not only enlarges that business but also enriches those engaged in it. For example: there are perhaps ten times as many watches manufactured in the world to-day as at any other period in its history. It is a profitable business, or men would not engage in it, and the superhuman effort that is being continually put forth to increase the value, by making as perfect an article as human power can produce, establishes conclusively the assertion that there is always a profit in doing well. I am glad to observe that in the cheese industry of the United States and Canada the light of this truth has to some extent aroused the slumbering dairymen. I quote from the *Utica Herald* of December 11, 1883:—"It is estimated that about 700,000 men are employed in this business, in one capacity or another, and that about 15,000,000 cows are used to furnish the one product of milk. The return from this product is over 800,000,000 dols. The total amount of capital invested in dairying in the United States is estimated to reach the enormous sum of 2,000,000,000 dols." In considering these figures we hope there is no person so dense of understanding as to entertain for a moment the idea, that had the old system of every man his own cheese-maker prevailed, anything approaching this grand result would ever have been attained. Never. The concert of effort attained in the factory system is the key-note to this grand soul-inspiring chorus.

But an experience of twenty-five years in the dairy industry leads me to the conclusion that in the music of our business there is yet much discord. The dairymen and factorymen fail to understand the spirit of the piece we are attempting to perform, and fail to catch the idea that individual profit and prosperity depends upon the success of the business as a whole. No chain is stronger than its weakest link, and so long as there remains a slovenly dairyman in the business, just so long our system will be incomplete and the working of co-operation remain imperfect. Perfect concert of effort, unbroken unity of hand with hand, in all the various details of the business, reaching down to the most unimportant items in the production of milk and the making of cheese, will produce in the long run the most profitable and permanent results to the individual as well as to the community.

"But," say some, "there is too much of the millennium, too much of theory, too much of the unattainable in all this." To such I answer that there is much of the millennium, much of theory, and much of the unattainable in the Sermon on the Mount, and yet our Divine Master preached it, nevertheless.

It may be considered chimerical and theorising to talk of a time when there will be no such person among dairymen as what is known to the cheese-maker as a skimmer or stripper, but we hope such a time will come, nevertheless.

To what purpose do A, B, and C, and a score of other industrious, honest, painstaking fellows, exert themselves to collect a model dairy—sparing neither time nor expense in providing themselves with perfect sets of improved appurtenances for those dairies, from rich, well-watered pastures down to good, substantial three-legged milking stools, and labour incessantly from sunrise until sundown, that their barns may be in perfect order, and everything connected with the business neat and clean, in order that their material may come into the hands of the manufacturer in a perfect condition—if heedless, lazy, shiftless, dishonest, ignorant, good-for-nothing D keeps about him a herd of sick, disconsolate racks-of-bones, to wander over his arid and desolate fields in search of food and drink in summer; or, with backs humped up, hover together for shelter under the lee of a wheat-straw stack, their only

food in winter; and using a kit of dairying tools, the very best article of which is an old, water-soaked, dirty wooden pail; drawing his whey from the factory in old, rusty, time-embattled milk-cans, in which it is allowed to stand until the next morning, and which, after an imperfect washing, are re-filled and returned to the factory, freighted with a compound sufficiently poisoned to nullify and undo the best efforts of a hundred A, B, and C's? It may be theorising and visionary to talk of a time when the spirit of co-operation shall have driven such fellows out of the dairying business, to betake themselves with a pick-axe and spade to the ditch; but that such a time may come ought to be the earnest prayer of every thorough-going friend of co-operation in the land.

It may seem like castle-building and an unprofitable waste of time to indulge in theories and construct plans by which the rivalry among factory men may be kept within a limit sufficiently circumscribed to prevent the fear of loss of patronage from interfering with and lowering the standard of our cheese. It is too often the case, now-a-days, that factory men are deterred from a full and complete discharge of their duty to themselves, their patrons, and the world in general, by a fear, by no means groundless, that a bold and upright course with regard to the material brought to them, will result in a damaging if not entire loss of their occupation.

The unwise extent to which men have gone in the erection of cheese factories has increased competition to an extent decidedly prejudicial to the interest of the cheese-consuming world. A, having invested his entire capital in the construction and equipment of a factory, will be quite likely, when B, C, and D erect factories in his immediate neighbourhood, to hold his peace when sundry varieties of swill milk are offered at his door, instead of speaking out an unequivocal protest against the insult thus offered to his professional pride and sense of decency.

To the dairyman naturally given to slovenly and careless habits, the restraint to which he might otherwise be subjected is practically removed when nearly equidistant from his place of abode there are three or four factories instead of one, and he knows that if rejected at one place

he can without inconvenience go to another, and thus it transpires that at five factories in every ten there will be found a conspicuous absence of that care and inexorable discrimination which ought always to prevail in the receipt of milk for factory purposes.

For this abuse there is, in our estimation, a remedy, however theoretical and visionary it may appear, and that is concert of action and co-operation among factory men. Men in all branches of business now-a-days associate with each other, and form themselves into bodies, for the purpose of closer union and mutual protection, and when this is done for the general good, as well as individual advancement, the purpose is laudable and universally successful.

We know of no business in which the necessity of combination is so great as that of cheese-making; and what, let me ask, could be more desirable and praiseworthy than an association of cheese-makers, for the purpose of sending the swill milk of the country to the hogs, where it belongs, instead of making it up, as at present, for human consumption?

We have an idea that an association might be successfully formed, and that, when once in effectual operation, it might ask the legislative body of its country to enact a law, entitled "An Act for the Suppression of Swill Milk, and for the General Good of Mankind," in which it should be provided, among other things, that in every case where a dairyman has left a factory, on account of having his milk rejected for cause traceable to his negligence, that in all such cases the factory, or factory company, knowingly receiving the milk of such rejected party shall be liable to some appropriate penalty.

The extreme sensitiveness of milk in the absorption of taint from the atmosphere, or any substance with which it comes in contact, ought to be thoroughly understood by all persons engaged in handling it, but we believe that but few, comparatively, are alive to the true facts of the case. I herewith present several paragraphs clipped from journals of recent date:—

"There are seventy-five cases of typhoid fever in the town of Port Jarvis. Dr. McDonald attributes the spread of the disease to the use of milk from the farm of Mrs. Thomas Cuddebach, in whose family there have been

several typhoid cases, holding that the milk conveyed the disease germs. Nearly all the parties now sick had used milk from the farm."

"A dairyman from Dundee has been apprehended and fined for allowing his wife and daughter to milk cows and assist in the sale of milk after they had been engaged in nursing a child suffering from scarlet fever. No less than nineteen cases of fever, four of which resulted fatally, were traced to this act of carelessness."

With these facts in view, how can it be expected that any amount of diligence on the part of a cheese-maker can atone for the unpardonable sin committed day after day, by the heedless and unobserving patrons, of leaving a can of freshly-drawn milk standing all night in an unwholesome barn or yard, until it has absorbed a whole family of pestilential odours, and then to carry it to the factory, to corrupt and poison everything with which it comes in contact?

Some may suppose it a mere theory to speak of a condition of things in which abuses of this character cannot be found, but during an experience of four years as cheese instructor in the province of Ontario, during which I superintended the making of cheese in about 400 different factories, and during the last year inspected the milk from about 65,000 cows, the property of about 7000 dairymen, I occasionally made up vats in which there was no discoverable taint, and which I was pretty certain came from the farms of well-drilled, well-posted dairymen; and, from a circumstance of this character, I am led to the conclusion that what has once been done can be done again, and I make such facts a text upon which I found my plea for more thorough co-operation and diligent painstaking in the work of producing milk for factory purposes.

There may be times when peculiar atmospheric conditions will exert unfavourable influences, and seasons when drought and wet weather will produce changes over which human effort can have no control, and for these sufficient allowance must be made. We quarrel with the stupidity, shiftlessness, and ignorance of men, and not with the providence of God.

In this day and age of the world, there is no excuse for ignorance upon the points to which we have alluded.

Wisdom uttereth her voice in the streets, and he who will not hear her ought to be drummed out of the camp of dairymen. As a rule a common carpenter puts more thought into his business in a month than many dairymen do in a year. Indeed, it would be difficult to point out a single branch of human industry, of one-half the magnitude which the manufacture and sale of cheese has reached, carried on in a manner so slipshod and slovenly as dairying.

The banker, the columns of whose ledger fails by one cent in balancing, spares neither time nor money in searching out and correcting the error; the merchant brings to bear upon his business a care and insight so unceasing and laborious that his locks are soon sprinkled with premature silver; the machinist works to plans from which the variation of a thousandth part of an inch cannot be allowed to pass uncorrected; but the dairyman too often stumbles along through his work without thought, or employs the little intellect he has in putting in and harvesting his crops, leaving the dairy in the meantime to take care of itself. There are too many men engaged in dairying who can see nothing in the business beyond the factory dividend; men to whom filling the milk pail and can are the alpha and omega of life. To such men such a thing as an ambition that their county, town or neighbourhood, shall attain and hold a reputation for being the banner cheese district of the State or nation, is as thoroughly unknown as the configuration of the bottom of the Dead Sea.

In saying what we have about the patrons of cheese factories, and the closer and more thorough co-operation among them, we have been actuated by no feelings of unkindness or illwill, nor have we arraigned them upon trivial or imaginary charges. The indictments we have found against them are all true bills, against which too many of them will be unable to sustain the plea of not guilty. We have been constrained to our present course by an over-mastering sense of the importance of greater care, deeper thought, and closer union in pushing forward one of the greatest industries of the day. I am confident that before another step can be taken in advance it must be preluded by a correction of the errors which we have feebly attempted to portray, all of which lie outside of and prior to the factory. As a body, cheese-makers can

do little better than they are now doing, until there is some improvement in the material upon which they are called upon to exercise their skill, and the practice of crimination and recrimination, the factorymen tossing the blame upon the dairymen and the dairymen upon the factorymen, which is made use of to conceal the real source of our mistakes, will continue to shield him from the eyes of a discriminating public until the care and diligence of dairymen strip him of this shelter and drive him forward on the march to improvement.

CHAPTER VII.

CHEESE-MAKING.

WE propose to give in this chapter as clear a statement as we are capable of doing of our method of making cheese. And in doing so we shall imagine ourselves as using the apparatus already described in this volume.

Considering the subject as a single day's work, our duty begins the night before, because we shall suppose ourselves, for the purposes of this chapter, at work in the private make room. Having at the time when the milk is being brought in ascertained the temperature of the atmosphere, we regulate the setting with a view to a particular condition in the morning. At this point some experience is necessary. If the atmosphere be clear and dry, and the thermometer standing at 75° , we set at a depth which experience has taught us will bring the temperature down to that point at which the milk of that particular dairy is known to work the best. Of course, there are atmospheric conditions which will materially vary our depth with the thermometer at one point. A muggy, moist atmosphere hastens maturity, and when such is the case the milk should be set shallower than when it is clear and dry. Our object in all this is to secure in the morning, at the time when we wish to begin work, that condition of ripeness essential to the success of the whole operation. We cannot express in figures any rules to guide the maker in setting, as the whole thing is a matter which addresses itself to the judgment and good sense of the operator. If he finds that the milk of his dairy works best when brought to a temperature of 68° in the morning, his efforts the night before should tend toward such a result, and he will soon learn how to regulate his depth in the accomplishment of his purpose.

On entering the make room in the morning our first business is with the thermometer. What is the tempera-

ture of the atmosphere, and what that of the milk? Was our estimate of the weather the night before good? and did we set properly? and what is the present condition of the milk? Having settled these questions satisfactorily, we next proceed to skim. The purpose of skimming is to secure a more equal distribution of the cream than could otherwise be done, for experience has shown that when without it the morning's milk is added and heat is applied, that portion of the cream which had accumulated on the surface will be continually arising in masses, and that it is quite difficult, if not impossible, to distribute it again equally.

If the milk has been set in coolers, we now transfer it to the vat, and add the morning's supply. Our next step is to secure, by the application of heat (if the thing has not already been accomplished by the temperature of the atmosphere) what may be called temper, or a proper condition for the application of rennet. Sometimes, when the milk was too sweet, we have found it necessary to go as high as 96° , and then allow the mass to stand from one to two hours, in order that the required natural change might go forward to the desired point; and at others the condition of the milk has been such that the rennet might be added without the application of heat at all. In carrying forward this part of the process, we frequently have recourse to the litmus-paper test. This test consists in applying to the milk a slip of paper, coloured with a substance sensitive to acid, and so operates that, when applied, if acid be present, the colour is at once changed. A frequent application of the paper will show when the development of acid commences and the proper condition of maturity is reached. This test, although easy of application, is, however, not always satisfactory, and in order to proceed with certainty, we sometimes apply a second.

We take a tea-cup, holding a gill, and into this, full of milk, we introduce a tea-spoonful, or a fluid drachm, of rennet of known strength, and note the time employed in coagulation. If coagulation begins in 20 seconds, add your rennet immediately; if in 40, then it is evident that the process of maturing ought to be carried forward yet for some time. Sudden coagulation indicates the presence

of the desired maturity, while that which is tardy proclaims an indefinite condition, requiring further investigation by a subsequent application of the test. Many cheese-makers seem to have a vague and imperfect understanding of the reasons for procuring ripeness in the milk before the addition of rennet, and do not seem to appreciate the fact, or rather seem not to know, that this ripeness is not merely to facilitate the action of rennet, but is something which goes farther, influencing the balance of the process, and entering into the composition of the cheese itself. It is, therefore, highly important that the greatest amount of light be thrown upon this mystery of the business, and that makers exert themselves in the study of its manifestations and effects. Of one thing we are certain, and that is, that by getting the milk into a certain condition before adding the rennet, much time is saved in a subsequent part of the work, because all we fail to do at this time must be done afterwards, and it is a known fact that milk ripens best when its elements are all together and intact. The ignorance of makers on this subject is never so clearly shown as when they resort to the use of sour whey to bring about the desired condition, because to do so is to depart at once and abruptly from the path which nature in the process of digestion has plainly pointed out, and as thereby a whole brood of unnecessary evils are brought forward to be subsequently contended with.

Having now secured a proper condition in the milk, our next duty will be to return the cream previously taken off. To do this properly requires the use of the strainer, in order that whatever lumps or masses it may contain may be thoroughly broken up and liquified; to further facilitate this work a moderate amount of heat ought to be applied, and the cream brought to as limpid a condition and thin consistency as possible, taking care, however, not to over-heat, as by so doing the texture of the cream will be destroyed. The best method I know of is to wash through the strainer with the warm milk from the vat.

If colouring matter is to be used, it should be added now, so that the stirring which must follow the addition of the cream may assist in its diffusion, as it is highly important that both these substances be mingled with the milk with the utmost uniformity and care.

Now add the rennet. If in spring months, your cheese is required to cure in from 15 to 20 days, or even less, use rennet enough to induce coagulation in from 8 to 12 minutes. To produce this result, the condition of the milk must be considered. If, on the other hand, you desire your cheese to keep one year, use rennet sufficient to induce coagulation in from 18 to 20 minutes.

Milk well matured will coagulate with less rennet than when sweet and new, but this should make no difference with the quantity used, as the curing of the cheese is what we must consider. Always time the process of setting, and stir from 3 to 5 minutes, so as to thoroughly incorporate the rennet with the milk.

As to time for cutting the curd, I have found that twice and one-half the time consumed in coagulation is a good rule. For example, if the time consumed in coagulation is 20 minutes, then 50 minutes from the time the rennet is added will be the time to commence cutting.

In cutting, great care should be taken not to bruise the curd. I cut lengthwise, then across, with perpendicular knife, then with horizontal knife cutting the curd carefully into cubes. I regard the horizontal as indispensable, as it avoids bruising by too much "slashing" with the perpendicular knife.

Experience has taught me that in two messes of milk produced on different soils, the conditions of heat and manipulation being the same, the cheese produced by the one when ready for market will be found to be more moist than the other. This I attribute to a constitutional difference in the milk, arising from a difference in soil, food, and water. The maker having learned by experience the character of the milk in this particular, may regulate the matter by variations in cutting, scalding, and stirring. Having ascertained that moisture predominates in the milk of a given dairy, he will cut finer, scald more slowly, and stir longer, the reason being a common sense one, that the smaller the cubes the more thorough will be the operation of heat upon them; the slower the scalding process, the less likely we shall be to encrust the external surface of the blocks; and the more thoroughly we stir, the more certain we shall be to expel the moisture. Stirring should begin immediately after cutting, and should continue from

10 to 15 minutes prior to the application of heat, and should go on from 30 to 40 minutes continuously, and perhaps 10 more after the heat is withdrawn, the purpose of stirring after the removal of the heat being to prevent baking to the hot surface of the bottom. The original surface of the cubes should be carefully healed over by the gentle operation of heat, and remain intact during the whole balance of the process.

Heating should proceed slowly at first, but gradually increase as the whey separates. Ninety-eight degrees is the usual temperature in summer, but as the season advances the milk becomes richer, and in Scotland I found it necessary after a time to go as high as 102°.

To determine the question whether the curd is properly coated or not, compress a portion in the hand; if found to be springy and elastic—this is one evidence; it is not, however, conclusive, for this quality will sometimes have been attained, and yet cooking not be complete. The *real* condition cannot be described in words, but the maker must learn to recognise it by experience.

DRAWING WHEY.

At the first indications of acidity, indeed at the very moment when it is knocking at the door, if I may be allowed the expression, and before it is admitted, the whey should be drawn. Right here lies the great secret of cheese-making: the absolute expulsion of the whey at the nick of time when acidity is known to be near and yet has not appeared.

The curd is now transferred to the sink, a description of which we have already given, wherein it is stirred *faithfully* for some minutes, and until the *most thorough* drainage is secured. We now draw it together into a mass, having uniform depth of about six inches, in which we allow it to remain until it has become solidified—a process which we call matting. We do this in order to eliminate from the substance of the curd any and all gases which may be still lurking there; it being a fact that by the act of solidification these gases are forced out and made to occupy cavities in the body of the mass after which, by milling, these cavities are cut open, and the gas dispersed. An additional advantage is that, while matted, a less amount

of surface is exposed, and therefore a more uniform and higher temperature is preserved, and the process of maturing assisted.

We know of no way whereby that firmness of texture, and at the same time soft flexibility, and that nutty, buttery quality which characterises good cheese can be obtained but by matting.

As soon as we deem it proper, with a knife we cut down through the mass, first across, then lengthwise of the sink, separating it into blocks of convenient size, and turn it over, repeating the process sometimes several times, and this always with a view to perfect drainage; after which, taking up one of the blocks, I cut it through with a knife and examine the surface thus made, to discover whether or not gas cavities are being formed. If I find they are, I proceed to mill immediately; if not, and the maturity does not demand immediate milling, I allow it to stand for awhile, knowing that while in this condition the process of "cheesing" is going on, and the tendency is all the time in the direction of improvement.

With the curd in a normal condition, my rule for commencing milling is to divide the time from the moment when the curd is taken out of the vat to that in which salting should begin equally. Sometimes, however, when we have a gaseous curd, we find it necessary to mill very soon after dipping, devoting all the balance of the time to the work of stirring and aerating. Indeed, we have had under treatment curds which we have permitted to lie five hours after milling and before salting, with a view to the elimination of gas, but since we have learned better how to treat our milk at the commencement of the process, we accomplish all this in another way, saving much time thereby. In the meantime let us not forget to keep our material warm, never permitting it to fall far below 90°, otherwise the curd becomes soggy, maturity ceases, and an injury to the texture and flavour of our product is the result.

We have arrived now at a point where experience must be our chief, if not our sole guide—the Rubicon of the whole business, so to speak. We know of no words in the English language by which to convey to the mind of the operator a definite idea of that peculiar condition characteristic of curd when ready for the salt. Sometimes

resort is had to the hot iron test, which furnishes us with two distinct species of evidence, the first of which is that if when a portion of the curd is applied to a hot iron it attenuates finely, this is regarded as one evidence; the second is, that if when so applied it emits an odour like nice toasted cheese it is ready for the salt. With regard to the test of attenuation, we would say that the degree of attenuation varies so widely in different localities and under different circumstances that it is not reliable; and in regard to the odour, experience is necessary in order to determine the precise shade of smell required; but when once it is learned it may be regarded as a universal and safe criterion. There is still another method of gaining the desired information which we will notice in passing, and that is by the sense of feeling and the condition of the moisture which oozes out between the fingers when the curd is compressed in the hand. The curd, when ready for the salt, assumes a peculiar *velvety* feeling distinguishable to the expert, and will exude a moisture composed in nearly equal parts of whey and butter when compressed in the hand.

There are no rules by which we may be governed in the use of salt other than, perhaps, very general ones. We should bear in mind always that a portion passes off in the whey in pressing, more or less according to the amount of moisture contained in the curd. We should remember that the purpose of salt is not simply to secure flavour, but is used also as a preservative and a check upon the action of rennet. We must, therefore, have in mind four distinct considerations in the application of salt. First, the amount of loss to be sustained in pressing; second, flavour; third, the amount of rennet used; and fourth, the time of curing. By the use of salt we so balance a set of natural forces as to compel them, in a given length of time, to produce for us a given result, it depending altogether on the skill of the operator as to what this result shall be.

From what has been said above it will appear that little if anything can be effected by the use of figures in regard to the quantity of salt to be used. However, we will give two general propositions which may serve in some degree as a guide to the operator in this matter.

When curd contains about 40 per cent. of moisture it is in its normal condition, and when this is the case, and we desire to sell in 30 days, use $1\frac{3}{4}$ lbs. to each 100 lbs. of curd. Again, with the curd normal in moisture, if we desire that our product remain on our shelves indefinitely, use $2\frac{1}{4}$ lbs. These figures are too small for the United States or Canada, but will do approximately for use in the cooler climate of Scotland.

Having added the salt, care should be taken that thorough permeation be secured, and for this purpose much stirring is necessary. And now, for the first time in the whole process, we permit the temperature to decline. Indeed, we take measures to bring the temperature down as low as 70° , as above this figure in pressing a portion of the fat is liable to be lost.

We have now bridged as perfectly as we are capable in words all the deep and dangerous chasms in cheese-making, the balance of the process requiring only the exercise of a due amount of care. Not much need be said about pressing, further than to remark that the pressure ought to be applied gradually for the first two hours, after which we may apply all the power we have. The cheese merchant is generally gifted with a pretty good eye for form and proportion, and will be very likely to discriminate against ill-fashioned and mis-shaped cheese, and it is therefore important that in pressing the operator bring into requisition some mechanical skill, and produce his cheese upon the shelves uniform in size and perfect in form.

In our paper on cheese for the English market, in another chapter of this volume, we have described somewhat at length the curing-room method of heating, and care of the cheese in curing, to which reference may be had for information on that subject.

CHAPTER VIII.

QUESTIONS AND ANSWERS ON CHEESE- MAKING.

ON the 2nd day of October, 1884, the author being then in Scotland, was waited upon by a committee appointed for the purpose by the Wigtonshire branch of the Scottish Dairy Association. In the conference which followed the committee stated that they had come for the purpose of obtaining from me a statement of my system of cheese-making for the purpose of circulation among the members of the Association. In compliance with their request, I gave them a summary of what is contained in the previous chapter, after which the following questions were propounded to me, to which I gave the following answers, and I subjoin the interview in this connection, with a view to make plain to the reader those points in the foregoing description which I deem of most importance :—

Q. 1.—Why is it necessary to vary the depth of milk in setting over night according to the weather? *A.*—To secure as nearly as may be a given temperature in the morning.

Q. 2.—What would you consider the best morning temperature for the milk of the previous evening? *A.*—68° Fahr.

Q. 3.—What is your reason for separating the cream from the evening's milk? *A.*—Because, if you do not separate, you cannot get the cream to dissolve in the milk.

Q. 4.—Why do you not make up your milk when it is sweetest? *A.*—It is in its best condition when near the neutral state.

Q. 5.—What means ought operators to use to bring about this state? *A.*—Heat, and heat alone; the same being used to effect what we have failed to effect in setting the milk over night.

Q. 6.—What reason have you for adding the colouring before the rennet? A.—So to have it thoroughly mixed with the milk.

Q. 7.—What effect would it have to set at a much higher or lower temperature than 88°? A.—If you steep at a higher temperature you will not have your whey so pure; if at a lower, the curd will be too soft.

Q. 8.—When your milk is not sufficiently advanced, is it a good plan to delay setting? A.—It is; taking care, however, lest the change go on too far.

Q. 9.—Does the same tint, which is produced by acidity on the litmus paper, hold good during the whole season? A.—No; the richer the milk, the deeper the tint required.

Q. 10.—Why steep so long as 50 to 60 minutes? A.—Because experience has shown it the best for a moderately long keeping cheese.

Q. 11.—Would the same quantity of rennet act on all farms alike? A.—No; the cheese-maker must exercise his judgment.

Q. 12.—Need we apprehend danger of loss of cream when milk is in proper condition? A.—If the cream be skimmed off and returned at a proper temperature just prior to adding the rennet there will be no loss.

Q. 13.—To what size should the curd be reduced? A.—If the curd is inclined to be moist, cut fine; if dry, make it coarser.

Q. 14.—Whether would it get more quickly firm with larger or smaller particles? A.—Quicker, if made small.

Q. 15.—What are the sources of loss after proper coagulation? A.—Rough usage in cutting and stirring.

Q. 16.—Why do you stir fifteen minutes before applying the steam? A.—For the purpose of hardening the curd, as also allowing the whey to escape.

Q. 17.—Has a higher or lower temperature the same effect in ripening as in scalding? A.—Yes. (See question 2.) If the milk is richer, scald high; if poor, low.

Q. 18.—Why do you stir fifteen minutes longer? A.—So that the curd may absorb the heat, and that the bottom of the tub may cool.

Q. 19.—Will it get firm as quickly by settling down as by stirring longer in the scald? A.—If the same tem-

perature is kept up when settling as when scalding it will be equally quick.

Q. 20.—You caution us especially against scorching; why do you do so? A.—Because scorching liberates fat which, when so liberated, evades the action of salt, becomes varied, and destroys flavour.

Q. 21.—What is your reason for running off part of the whey? A.—So that the balance may run off more quickly should acidity be coming on.

Q. 22.—What is your reason for taking off the whey sweet, and not allowing it to become acid? A.—If you allow the whey to get acid the cheese will be mealy and dry and more indigestible. In no case allow the acid to be developed in the whey before drawing it off.

Q. 23.—What is your test for knowing when the curd is firm enough for running off the whey? A.—When you press the curd in your hand it springs out to the former shape.

Q. 24.—What difference, if any, should be made in the temperature when using whey instead of steam? A.—In using whey instead of steam the temperatures are the same for ripening and scalding, beginning at 110° and not exceeding 125°.

Q. 25.—Do you consider that at this stage a dry curd assists in producing a finer cheese? A.—Yes.

Q. 26.—What effect has the stirring on the curd after being milled? A.—It assists in getting rid of the gases and bad odours which may be in the curd.

Q. 27.—What tests do you use before milling? A.—The test is to have the curd packed pretty close, and if it become gaseous or full of holes mill sooner; so that you may have longer time for stirring, and thus get clear of the gas.

Q. 28.—What are the tests before salting? A.—They are—(1.) The velvety soft feeling; (2.) The squeezing a quantity of curd in your hand, so that equal quantities of butter and whey exude; (3.) The applying of the hot iron to the curd so as to bring out the flavour of nice toasted cheese; (4.) The perception of acid by smell.

Q. 29.—How would not coming up to these tests or going beyond affect the cheese? A.—If the former, the cheese will be soft; if the latter, tallowy.

Q. 30. Whether is more salt required for poor or rich curd? A.—A rich curd requires more salt than a poor one.

Q. 31.—What effect would putting the curd into the vat at a higher temperature than 70° have upon the cheese? A.—At a much higher temperature the butter would come off with the whey.

Q. 32. What quantities of salt are required for cheese for early or late marketing respectively. A.—For a cheese to keep a long time $2\frac{1}{4}$ lbs. of salt to 100 lbs. of curd when steeping in 50 to 60 minutes, but altering somewhat according to the moisture of the curd. For a cheese to be early marketed steep in about 25 minutes, and use $1\frac{3}{4}$ lbs. of salt to the 100.

Q. 33.—What length of a process is required to make the finest cheese? A.—From 5 to 6 hours after putting in the rennet.

Q. 34.—What is the best temperature for ripening the cheese? A.— 65° .

CHAPTER IX

THE MANUFACTURE OF CHEESE FOR THE ENGLISH MARKET.

*An Address by J. B. Harris, of Antwerp, N.Y., read before the
Dairymen's Association of Western Ontario, at Ingersoll,
February 8th, 1883.*

IN considering the subject of cheese-making, we are sometimes led to question that wisdom which has placed the limit which we call perfection so far beyond our reach. It seems a pity that all human efforts should be doomed to begin and end in imperfection. That cheese-making begins in imperfection is a fact to which every cheese-maker will subscribe a ready assent.

Cheese-making commences with a natural product called milk, a perfect article of which, in such quantities as are accumulated at factories, is rarely seen.

It seems, therefore, to be the design of those engaged in the manufacture of cheese to commence their efforts under conditions which make perfection impossible.

It can hardly be expected that under such circumstances he will ever be able to arrive at the goal of his hopes. If a perfect article of this substance is ever to be produced, the process must begin at a point remote from the cheese factory, with the stock raisers and at the farm.

Cheese-making consists in utilising the laws which nature has enacted to govern the process. These laws, if strictly observed, will inevitably lead to the desired end, and any departure from their provision will be certain to end in defeat.

In treating this subject we shall take matters as we find them, and deal with it, encumbered as it nearly is, with a host of imperfections.

We cannot hope, in the present condition of the industry, to describe a perfect cheese factory, but we can map out a

plan which comes the nearest to perfection we think of any in operation.

In choosing a location a sight should be selected upon high and dry ground, so that *all* refuse matter may be conducted speedily and to a safe distance from the factory.

We will construct our building of the capacity of a thousand cows. We will build substantially, knowing that the industry in which we are to engage is a permanent one. Brick walls are none too good, but if wood is used let them be so constructed that they will be a protection against all unfavourable conditions of the weather. The cold, damp atmosphere of spring and fall, and the excessive heat of summer, both operate to the disadvantage of the cheese-maker. The manufacturing and curing rooms ought to be in separate buildings, and the curing room always on the ground floor. In this, a very prevalent fault in the construction of cheese factories would be avoided.

Cheese cured over the making room and immediately under the roof is always exposed to at least two unfavourable conditions, namely, the heat of the sun on the roof, and the heat, steam, and odour from the making room below.

If the making, boiler, and press room (and we include all three in one apartment) be 96 feet by 36, it will be large enough for our purpose. The boiler and engine shall occupy a position in one corner, so that in the cold portions of the season the heat of the former may be diffused about the apartment, but which in hot weather may be enclosed with a moveable partition.

The capacity of the boiler should not be less than ten horse power, and the power of the engine not less than five.

Five 5000 lb. vats sitting parallel with each other, one end facing the weigh can, will perform the business of the factory.

Upon the platform, 4 feet from the floor, are the scales and weigh can. To a maker a little rusty in his arithmetic, 5 or 7 beam scales are of much service, as the record of several messes can be readily kept without any particular mental effort, and without emptying the can.

Three sinks, each 12 feet by 3 and 9 inches deep, upon frames of convenient height, and supplied with castors and with *slats* in the bottom, will be necessary in which to drain, mature, and salt the curd.

Forty screws or four gang presses will be required in this factory, their position being selected with a view to convenience in the removal of the cheese to the curing room.

With a view to cleanliness, the floor of this apartment has been laid with good, sound, well-planed lumber, with a slight incline from two ways towards a gutter at right angles with the lower end of the vats.

At the lower end of each vat there is a pipe communicating with the whey vat, one end of which protrudes about one inch above the floor.

A large moveable tin funnel, the end of which may be inserted into either of these pipes, and which may be shifted from vat to vat as occasion requires, together with a two-inch syphon, or what is better, a faucet to the end of each vat, are all the appliances necessary for drawing off the whey. At some convenient point in this room a cask of perhaps forty gallons, within which there is a pipe communicating with the boiler, is all the arrangement necessary for the purpose of heating water.

Near this we will have a box eight or ten feet long by sixteen inches wide, and eight inches deep, as a sort of sink in which the tools and utensils can be washed.

Between the two rows of presses, and connecting the make with the curing room, there is a railroad, upon which perambulates a car, thus affording an easy means of conveying the cheese from one apartment to the other.

CURING ROOMS.

This building should be about 80 feet by 30 feet, thus giving ample room in case of emergency, and divided into three apartments.

That the atmosphere of these rooms may be kept at all times in as perfect a condition as possible, their walls should be of three thicknesses, with a space between, in order that dampness, heat, and cold may be effectually excluded. If, as is frequently the case, the building is erected upon posts at some distance from the ground, the

floor should be double and well laid, and the rooms should be supplied with a most thorough and effectual system of ventilation.

The railroad we have already mentioned extends along an entire side of this apartment. At right angles with the railroad, and parallel with the end walls of the building and with each other, not less than two feet apart, are tiers of shelving, each tier containing four shelves.

This room should be supplied with a heating apparatus of sufficient power at all times to control its temperature. This apparatus should be so constructed as to diffuse its heat equally to all parts of the room. For this purpose, we would recommend a coal stove, located in a position as nearly central as possible.

The stove we would surround with a sheet-iron jacket, about five feet high, and large enough to enclose a space of at least two feet above the stove. This jacket should be supplied with a means of hoisting and lowering, and should be so adjusted as to stand about six inches from the floor. The purpose of this arrangement is to cause the heat to pass upward, the space beneath being ample for a draught.

We have now given a brief description of a factory, which, generally speaking, is as perfect as any in operation. We have omitted a host of minor details, leaving them to be supplied by the taste and ingenuity of the cheese-maker.

We have said nothing with reference to many improvements now in use, by which the power of machinery has been made to assist in the process of manufacturing cheese; but we wish to state that, as our industry is a progressive one, and our efforts are to be constantly in the direction of improvement, we shall not hesitate, whenever a real good idea in this direction is offered, to take advantage of it, whether that idea relates to the chemical or the mechanical portion of the work.

We have now built and equipped our factory, but unless we can find patrons it will be of no use.

Ordinarily it will take one hundred of these to supply us with the amount of material for which we have built our factory.

There are as many different minds and as many methods

of running a dairy as there are dairymen. Out of this fact we shall find, in the course of our employment, arise a large portion of the difficulties destined to beset us. If each individual of our one hundred patrons perfectly understood the natural laws which govern the production of milk, and obeyed them, the cheese-maker would be relieved from many sore vexations; but the fact is, a large portion of them do not, and so the cheese vat overflows with the unhappy fruit of ignorance.

In the number we have named there will always be found a few who do not and cannot be made to understand the importance of cleanliness, and the trouble which a want of it occasions at the factory.

There will be others who could not be induced, for love or money, to provide their cows with sweet, wholesome food. It requires but a small outlay of money and labour to produce a field of peas and oats with which to bridge over the dry portions of the season, and *this* they will not make.

In every crowd of a hundred men there will always be found a few downright lazy ones. There are some among our patrons who, having a pump, will not use it, and so their cows are compelled to quench their thirst at the poisonous and pestiferous frog ponds and stagnant pools which here and there dot the surface of their pastures. If a majority of the men engaged in the cheese industry were of this character, the whole business would speedily end in a disastrous overthrow, as the baleful consequences of bad water for the dairy are too far-reaching for description.

The dishonest men are not all dead yet, and it would not be strange if one or two should be found on our list; and even among those who object to be placed in this class, there are some who have a weakness for cream in their tea, coffee, &c., or who, at least, have wives with such a weakness. And it sometimes occurs that their milk is found wanting in this important element. And if this weakness prevails to any considerable extent among our one hundred patrons, a few figures will show how a number of *petit* larcenies may become one great grand larceny. If fifty patrons each abstract a quart of cream, the result is a loss equal to fifty pounds of cheese, and should this be repeated one hundred times during the season, we reach a total of

five thousand pounds; the value of this is five hundred dollars, to steal which, by the laws of our civilised country, is grand larceny. The damage to the cheese is not covered by these figures.

We have heard of a man somewhere at a great distance from here, in a place, the name of which we have forgotten, of whom *it was said that he watered his milk*, but we never could bring ourselves to believe the story.

In the company of our patrons, there is another class of whom we must not forget to speak, namely: the clear-headed, painstaking, industrious, and honest fellows, who *always* bring large yields of pure wholesome milk, the result of whose labour and foresight is too often neutralised in the vat by the product of vice, shiftlessness, and ignorance with which it is mingled. Upon the shoulders of these, the motley company we have above described ride into market and gain the attention of the purchaser.

But the things we do not like to say about the patron would fill a large volume; and as our space is limited, we will bid adieu to this branch of our subject, trusting to time and the future to correct the abuses to which we have thus briefly alluded.

The experienced cheese-maker, who has grown grey in learning the facts we have above enumerated with reference to the patron, and to whom the knowledge thus acquired has given the requisite amount of "cheek," will not fail, on the arrival of the first load of milk, and every subsequent load, to mount the waggon and give the cover of each can a surge up and down, thus forcing the air through the vent up to the nostrils. In this way he will be able to detect any objectionable odours.

If the maker has a proper sense of his responsibility, and that commendable independence of character which the loss of a few paltry dollars cannot daunt, he will promptly reject all material, which, if used, will operate to the disadvantage of those of his patrons who have furnished a good article, and throughout the whole season he will not cease to make use of such tests as science and experience have provided for the discovery of *crime*, and the detection of abuses. In this way he will protect the honesty and industry of some against the vice and indolence of others.

If the maker be a sharp man (and we have known such even among cheese-makers) he will give himself good weight, as in this way he will avoid difficulties, achieve for himself a good reputation, and if he treat all alike, the transaction will be found to be merely a harmless *ruse*.

The milk is now in the vat, and if the maker understands his business, he will by this time have thoroughly familiarised himself with the character of the compound with which he has to deal; he well knows how far it has advanced on the road to maturity, and will regulate his conduct accordingly.

If the milk be far advanced he will heat to not more than 82° , if otherwise, he may go as high as 90° , and here, as elsewhere, throughout the whole system of cheese-making, let me say that there is no absolute rule, and that the figures we have given are only the approximate extremes.

Rennet seems to be the only true agent by which the cheesy matter of milk can be separated from the whey. Nature seems to have provided it for the cheese-maker's especial use. Its office is not simply that of producing coagulation, but it goes farther, and exercises an important part not only in the curing of the cheese, but also in bringing about that condition in its substance which we call digestibility. No other substance of which we have any knowledge is capable of bringing about the same result. In view of these facts more than one idea should govern in the use of this important element.

If it is intended that the cheese shall go into market in from 10 to 20 days, which is always the case in the early part of the season, enough should be used so that the process of coagulation will begin in from 8 to 12 minutes. Rennet sufficient to accomplish this result will, in the time limited for sale, have performed all that is desired in preparing the product for the table.

It will be seen by this, if we have been clear in explaining the idea, that the time of curing rather than the quality of milk should govern the quantity used.

In the preparation of rennet too much pains cannot be taken. In the extract we have an article of uniform strength and always sweet. For this reason it is the safest for cheese-makers to use, especially those who per-

sist in using the whey-soaked article. Some claim they cannot keep rennet sweet when extracted with water. We never fail.

In the years 1880-81, I acted as cheese instructor under the auspices of the Dairymen's Association of Eastern Ontario. During the first season I visited and made cheese in 84 factories, and in 1881, 107. During the first season I found not more than three out of ten in which the rennet jar was in proper condition; seven out of the number using whey for the purpose of extracting. In 1881 the preparation was reversed, and not more than three in ten used whey.

The whey method seems to consist in decomposing the sack as well as extracting the gastric juice in sour whey—a compound, it is needless to say, fit for no purpose but to be thrown away.

Every buyer who has had experience in shipping cheese to England, knows that it will be quite as well for him should his cargo sink to the bottom of the Atlantic as to land upon her docks with a flavour objectionable to English tastes. The rotten compound we have described above will develop such a flavour every time it is used.

The true method of extracting rennet is as follows:—Always use a stone jar. Take a number of rennets sufficient for a week's consumption (if Bavarian are used), cut off the black ends, open and shake them out, and put them into the jar. Use about two quarts of pure water to each rennet, and one half-pound of salt to each gallon of water; rub the skins four or five times each day for two days, then wring them out and strain the liquor thus obtained into another jar, and add all the salt, and a little more than will dissolve. Again, put the skins to soak in another weak brine, and rub as before for two days. The skins should again be wrung out, and as they are of no further use, throw them away. Strain this second liquor into the first and add more salt. If there is a cool place about the factory put the jar into it.

Prof. Arnold recommends making rennet in the winter sufficient for the whole season.

If in closing this branch of our subject we can say a word which will impress the cheese-makers of the country with the importance of untiring painstaking in the pre-

paration and use of rennet, we shall have accomplished a great work.

Let them write these words in letters of gold upon the pages of memory—"A really good cheese can never be made with bad rennet."

I know of no means for the application of heat to milk but what in the use of which it will be found that some portions will be warmer than others.

For this reason I recommend that after heating for a period of about five minutes the vat be occasionally stirred, so that the heat be equally distributed throughout the whole mass, after which it will be proper to add the rennet.

Upon the application of the rennet, a period of at least three minutes should be devoted to thorough agitation, after which it may be allowed to stand for perhaps three or four minutes. Now with the bottom of a dipper occasionally stir carefully the entire surface of the vat, to the depth of about two or three inches, until coagulation begins. The purpose of this is that no portion of the cream in rising to the surface may escape the influence of the rennet.

Coagulation perfect, and the work of cutting begins. Now, let this be done as carefully as possible. I cut first with the perpendicular knife lengthwise, then across, and, finally, horizontally, not waiting, as many do, for the curd to settle and whey to become matted.

This is all the cutting that is necessary, except such pieces of curd as may have escaped the knives; these I cut with the perpendicular knife as they appear when raised to the top.

Unlike some cheese-makers, I am now in no haste to apply the heat, knowing that the chemical process is still going on, and so for perhaps fifteen minutes I address myself to the work of careful hand stirring.

This rule is of more importance than will at first thought appear. By its observation one advantage is gained, the separation of the whey from the curd being more thoroughly effected than by the application of heat immediately after cutting, as the heat has a tendency to harden the exterior of the cubes before the whey has all escaped.

Experience has shown that in the process of making cheese a maximum of from 96° to 98° must somewhere be

attained. If 82° be used in setting, a balance of 16° must be used upon the curd. If 90° , then 8° . Thus, it will be seen that more time is necessary in heating the curd when the milk is set at 82° than at 90° ; and it will be borne in mind that the operation of stirring is to be kept up until the required heat is reached, and from five to ten minutes after. The purpose of stirring is to prevent matting. Care should be taken that no particle of curd be allowed to lie on the bottom exposed to excessive heat until it is burned, as a very small piece of scorched curd will spoil the whole vat.

As careful stirring is necessary in order that the white whey be not started, do not heat too fast, as rapid heating requires rapid agitation.

After the steam is shut off, stir for five or ten minutes to secure a uniform heat throughout the whole mass. A good test by which to discover when the curd is cooked is to compress a quantity in the hand. If sufficiently cooked, it will be found to have attained a certain degree of elasticity, and whenever the pressure is removed the particles will resume their former shape and size. When this condition is reached, it will be time to draw the whey, and for this reason alone attention ought to be given to the work at this time; the test being frequently applied in order that the whey be not allowed to remain with the curd longer than is necessary, as it often contains some disturbing element. This is an important point in cheese-making, as when the whey is allowed to remain too long with the curd, acid is developed, and a dry, mealy cheese is the result. If the whey is drawn too soon, a soft, mushy article will be produced.

At the proper time draw the whey as quickly as possible. The time has now arrived when the sinks we have described in a former part of this article are brought into use. Over one of these a strainer cloth is thrown, and the curd immediately transferred to it. Here it is strained until the whey is all drained off. Sinks such as we have described, with a strainer cloth, and slats in the bottom, will be found to be much more convenient for the purpose of draining than the vat or sinks with a perforated tin bottom, as the process is not obstructed by the matting of the curd.

A good arrangement for effecting this purpose in cold weather are two sections of slats, each of the size of about one-half the length of the bottom of the vat, and so constructed that when placed in position they will stand about six inches high. These covered with a cloth will perform the same office in the vat as that performed by the sink; the advantage of this arrangement being that the curd may be kept warmer in the vat than in the sink. If the curd is allowed to become cold it contracts, and thus the whey is prevented from running off, a condition of things fatal in its consequences.

Too much care cannot be exercised in draining and stirring the curd. When it is borne in mind that one-third of the substance of a perfect cheese is water, and that an addition of not more than five per cent. will spoil the product, the necessity of diligence and care in this branch of cheese-making will be readily seen; and if we have succeeded in making ourselves clearly understood, it will be seen that in all our efforts so far, not only in cutting, heating, and at times withholding the heat, but also in stirring, our aim has been that the separation of the whey might be the most perfect possible.

We will take it for granted that draining is complete; other events must now take place before we are ready for the salt. Let us stand back and let nature do something.

In describing his method of making cider vinegar, Hon. Harris Lewis says that the Lord makes the vinegar and he does the chores. So with us, nature makes the cheese, and we do the chores. Friend Lewis has excellent vinegar, and if we only attend to our business nature will attend to hers, and we shall have first-class cheese.

Mysterious forces are at work, and the curd is gradually becoming softer, and a velvety feeling is being developed; its coarse, harsh texture is rapidly giving place to one of a more cheesy character.

Experience now will tell us when the curd mill should be put in operation. To avoid white whey, this should be at a point and time midway between that in which draining was completed and that when salt should be added. It is a part of the character of curd while going through the process of maturing to adhere and form a solid mass; the purpose of the mill is to again separate it into small

cubes, the better to secure a thorough permeation of the salt. Some cheese-makers contend that matting is of no importance in the process, but experience has shown that such ideas are erroneous.

We know of no way whereby that firmness of texture, and at the same time soft flexibility can be obtained, but by matting.

Without matting, as above described, unless acetic acid be developed, cheese will be soft and porous; acid developed, and they will be mealy, hard, and indigestible, and lack that nutty, buttery quality which characterises the sweet whey-matted process.

Besides, it involves too much labour to keep it fine enough while the work of maturing is progressing, and if this process be not already well advanced when the whey is drawn, and it lies in the sink for three or four hours, as it sometimes does, it will be impossible to prevent solidification, and the stirring to prevent it will be apt to cool the curd too much.

It is desirable that the curd be cut into small pieces of equal size without bruising, and without starting the white whey, and to effect this we know of no machine by which it can be accomplished with so little labour as with the Dominion Curd Cutter. Curd cut with this mill does not patch together, as in the case of the peg or knife mill, and perfect uniformity having been reached in the form and size of the pieces, the permeation of the salt cannot be otherwise than uniform.

So far as we have done right we have kept our curd warm, and in order that it still be kept so our sink should be supplied with a canvas cover. This cover should consist of a piece of canvas or duck, about twelve inches longer and wider than the top of the sink or vat. Along this cloth transversely at intervals of about eight inches are wooden bars of the size of lath, fastened with tacks, or by means of strings tied at convenient distances.

These bars serve the double purpose of holding the cloth in position when spread over the vat or sink, and to facilitate rolling it together when we have done with it.

I cannot find words strong enough to impress upon the minds of cheese-makers the importance of keeping their curd warm while maturing. I have seen so many cheese

spoiled by drafts of cold air through open doors and windows that I have exclaimed with Mark Twain—

“Where ignorance is bliss,
’Twere the height of folly to be otherwise.”

Close attention to the curd at this stage of the process of maturing is important.

So long as there is an odour, as of burnt milk, to the curd when applied to a hot iron, there is no danger, but the moment this odour changes to nice toasted cheese, then apply the salt. On no account allow it to remain a moment longer, or you will have a tallowy cheese. You will have allowed the work of maturing to proceed too far.

The work of grinding done, and our material is wholly at our command; we have only to wait until the condition we have described is reached, when we may apply the salt.

If the curd be a greasy one, the time to doctor it is after grinding and before salting, and the remedy to be used is one which nature has provided, namely, pure air. Exposure to the atmosphere by long and patient stirring will accomplish *wonders* in removing the seeds of decomposition which *bad water*, disease in the cows, or uncleanness in dairymen has implanted in the milk.

SALTING.

There is no rule by which we may be governed in the use of salt, other than perhaps a very general one. If we design our product to cure in twenty days, and have used rennet sufficient to secure that end, more than $1\frac{3}{4}$ lbs. should not be allowed to remain in the cheese, as more than that amount will defeat our purpose.

But here we should consider the condition of the curd when it is applied, making allowance according to the amount of moisture still remaining, in which some portion will be carried off in draining and pressing.

From this it will be seen that in the use of salt we must take into consideration, not only the condition of the curd as to moisture, but also the time to be consumed in curing, thus avoiding the error of using a quantity of salt which will counteract or limit the action of the rennet, as it is known that salt and rennet work in opposite directions.

EXAMPLES.

Given—Time of curing, twenty days; rennet sufficient to secure that, and moisture perfect; use $1\frac{3}{4}$ lbs. salt.

Given—Time of curing, forty days; rennet sufficient for this purpose, moisture perfect; use $2\frac{1}{2}$ lbs. salt.

Given—Time of curing, twenty days; rennet sufficient for that purpose, allow for moisture $1\frac{1}{3}$; use 2 6-16 lbs. salt.

Given—Time of curing, forty days; rennet sufficient for that purpose, allow for moisture 20 per cent.; use 3 lbs. salt.

In the manufacture of cheese, salt performs a hardly less important function than rennet, a fact which we think must have been lost sight of by a number of cheese-makers during the past season, in various parts of the country, from the fact that in buying we found thousands of cheese badly injured from no other cause than the want of salt.

To secure a perfectly equal and thorough distribution and permeation of the salt after a vigorous stirring, allow the whole to stand for ten minutes. It can then go to press.

PRESSING.

Not much need be said upon this branch of the subject more than to say, hoop rapidly. Never allow a full hoop to stand a long time exposed to the atmosphere, as by this means the curd becomes seared over, and a defective rind is the result. Put on the cloth and follower, and allow the mass to settle while engaged in filling the balance of the curd in the sink. By observing this rule cavities are avoided, sometimes occasioned by putting on the power before the particles of curd have been allowed to settle together. Press gradually until the whey is well-nigh expelled, and then put on all the power you have.

To secure a good rind, if the curd is cool when put to press—when bandaging, rinse the whey out of the cap cloths, dip them in scalding water, and place them again upon the cheese, as warm as possible.

To avoid cracks, I think it is a good plan to press a cloth upon the top and bottom. In this way the necessity of greasing, when first put in the curing room, and rubbing every day, is avoided.

Again, do not overlook the importance of turning your cheese the next morning after they are put to press. Examine them in order that you may correct any defect in form produced by the imperfect working of the press. Never put a cheese in the curing room objectionable to the eye in point of form. Let this be observed as an *iron* rule.

CURING.

Curing is a process of nature. We have only to observe certain rules in the care of our product, and in due season nature will have accomplished the work. In another portion of this article we have given a description of the room set apart for this purpose. It only remains for us to give the rules and conditions governing the process. A steady heat of from 65° to 70° ought to be maintained without cessation from the time the cheese are put on the shelves until the work is done.

When artificial heat is applied it will be found that those occupying the higher shelves cure more rapidly than those below, on account of the tendency of heat to ascend. For this reason they ought frequently to be changed, and their positions reversed. Too much heat has a tendency to beget a tallowy condition, while too little retards the process, and a saggy, clammy cheese is the result. In extreme hot weather, to prevent excessive drying, I would recommend occasional sprinkling of the floor.

It is doubtless a fact that many cheese are spoiled after reaching the curing room through neglect.

Many cheese-makers seem to suppose that as soon as the cheese are upon the shelves they are out of harm's way, and need no further care or attention from them, and the work of turning, rubbing, and the general business of this department is given over to the boys.

WEIGHING.

As it is now the custom for each factory to do its own weighing and boxing, it will perhaps not be out of place to say a few words upon this subject. In weighing, care should be taken to give good weights, thus avoiding the mortification of being docked, perhaps a pound upon each box, upon delivering at the station.

BOXING.

In shipping, especially to England, it often occurs that ten, fifteen, or perhaps twenty cheese are piled one upon another. In this way a single cheese is made to sustain a great weight. To provide against this they should be so boxed in substantial boxes, that the surface of the cheese and the upper edge of the box rim be upon the same level. In this way the burden will be divided, and the cheese and the box each be made to sustain its share.

BRANDING.

As branding is a part of the cheese-maker's duty we wish to remind him in this, as in all other parts of his work, pains should be taken, and he should see to it that, in writing weights and stenciling shipping marks the work be done in a neat, workmanlike manner.

In order to protect the figures and letters from obliteration from rolling the boxes about, it is a good plan to place them at the lap in a column, so that when properly piled they all may be seen.

Throughout the whole course of this article we have supposed ourselves engaged in the manufacture of cheese for the English market, and have kept constantly in view a texture, flavour, and general appearance required by that market.

In the business of making cheese no one is more deeply interested than the patron, and with him much depends upon his own efforts. He should be thoroughly alive to the necessity of producing his material at the factory in as perfect a condition as possible, never for a moment allowing cupidity and greed to warp his understanding, or his ignorance and slothfulness to stand in the way of progress and general good.

It is now time to draw our remarks to a close.

If the cheese-maker is actuated by those motives essential to success in any branch of the world's industry, he will form a resolution at the commencement of the season, and renew that resolution on the morning of every day, to neglect no single point in the whole routine of his duties.

It should be his aim to write the name of the factory over which he presides—*First Among Cheese Factories*

In order to do this he should study cheese-making as a science.

He should know the nature of the material upon which he is to operate, the laws governing the process over which he presides, and the characteristics of the result he desires to effect; and knowing this he will be prepared to perform the operations we have described intelligently, and with success.

A mere superficial knowledge, which extends no farther than what the eye sees, and the hand executes, will never succeed on the march

TO SUCCESS.

CHAPTER X.

HINTS ON CHEESE-MAKING.

*Address delivered before the Ontario Dairymen's Association by
J. B. Harris, of Antwerp, N.Y., Jan. 16, 1885.*

It is now thirty years since the late Joseph Harding, of Somerset, was employed to teach the dairymen of Scotland the principles of the Cheddar system of making cheese; and the method taught by him is still in vogue in that country, only the people have retrograded in its practice, and of late years their products have not been as good as formerly.

There can be little doubt that this system, which took the place of the good, old-fashioned Dunlop our grandmothers made, had been of great service to the country; but a feeling prevails that it is not meeting the requirements of the market. That this failure is owing to the faults of the system is not true, but it is attributable chiefly to the manner of its practice in most of the dairies. A want of a knowledge of the character of milk beyond what is visible to the casual observer on the part of the maker, leads to many an error, his position being much like that of one who has lost his way in a forest; he wanders on without knowing whither. Fine cheese have been made by the old system, but nineteen persons in every twenty fail. At any rate, the people now realise the fact that the business has reached a point where it needs stirring up, and this the Scotch Dairy Association proposes to do.

Cheese-making has become a common topic of conversation; everywhere you go it is being discussed, and theories and suggestions too numerous to mention have been written on the subject. But I doubt if there can ever be a code of rules laid down that will provide against all conditions of weather, &c. The maker must use his

own judgment, and vary his practice to suit the conditions of the atmosphere, and a hundred other external and internal circumstances.

In cheese-making, as in everything else, it is the little things which need looking after. "Take care of the little things, and the great ones will take care of themselves," is as true here, and I had almost said truer, than elsewhere; and I venture to say that a large part of the failures we meet with are due to what may be termed slight mistakes.

When we know how, it requires no more labour to make good cheese than it does to make poor, and it is far more profitable. Good cheese well ripened is a valuable article of food, containing as it does a large per cent. of nourishment in an easily digested form. In fact, good cheese, when taken into the stomach, promotes digestion, the action of the rennet being of itself a digestive process. Imperfectly cured cheese, on the other hand, is difficult of digestion, the rennet used in its composition never having broken down by digestive action the fibre of the curd. Such food can be disposed of only by the strongest stomachs, and is dear at any price.

CAUSES OF POOR CHEESE.

The causes which produce poor cheese are many, but I shall content myself by mentioning a few of the leading troubles with which makers have to contend.

First.—Some of the cows may have been out of health, or eaten something prejudicial to the quality of the milk. Perhaps the milk may have been used too soon after coming in, or the herd may have had access to bad water, or the cows may have been worried or over-driven, causing the milk to spoil in the udder.

Second.—Filth breeds a numerous progeny of refractory and vicious consequences, all more or less far-reaching in their power to do harm. The most scrupulous cleanliness is requisite in all the operations of cheese-making.

Third.—The cheese may be injured by setting the milk at night too deep or too shallow, because, when set too deep, the work of maturing goes forward too rapidly, and it is of the utmost importance that the milk reach and be not carried beyond a certain condition before the rennet is added. If, when this condition is reached, the rennet be

applied at the nick of time, so to speak, the cheese is half made. This point the maker must learn to determine for himself, as it varies widely according to the character of the soil upon which the animals feed, and a variety of other circumstances.

Again, evil consequences may result from heating too high, or not heating high enough; from the use of too much or too little rennet; from not cutting at the proper time; from scalding too rapidly; from drawing the whey too soon, or not soon enough; from insufficient draining and over acidity; or from a lack of maturity, from miscalculation as to the quantity of salt used, and from mistakes in the time for going to press. The curing room may be over heated, too cold, too damp, or too dry. In short, the name of the pitfalls that beset the cheesemaker is legion, in any one of which, if he be caught, it will matter little that he has avoided all the rest.

From what has now been said, it will be seen that the making of good cheese is not the result of chance or a process likely to be hit upon by accident, but that experience based upon shrewd and systematic observation is alone to be relied upon.

Heat, rennet, salt, moisture, lactic acid, and the atmosphere, are the principal natural agents which must work together in the fabrication of good cheese, and the successful maker is he who knows how to preserve a healthful balance of power between them from first to last.

The office of rennet cannot be explained more definitely than to say that it is a law of nature that when mingled with milk it solidifies the caseine or albuminous portion of that fluid, as the air solidifies the fibrin of the blood. This solidification is called coagulation. In the coagulation of milk the cream is held in suspension, and the whey expelled like the serum in the blood when that fluid solidifies. The function of rennet in curing is much the same as that of the gastric juice of the stomach, breaking down as it does the fibre of the curd, and carrying it forward toward a condition like that of chyle in the digestive process of animals.

The purpose served by salt is to prevent putrefactive fermentation, give flavour, harden and regulate the ripening influence of the rennet. Moisture gives consistency.

It has two forms, free and assimilated, the free separating from the curd and passing off either by pressing or gravitation, and the assimilated being taken up by the rennet and made a factor in the texture of the cheese. Lactic acid seems to act as an auxiliary to or at least in harmony with rennet, and helps to carry forward the various processes of change which occur in the lactic fluid, from the time when it leaves the udder until the final setting in of decay. At 98° heat seems to facilitate the action of all the other agents, but above that and up to 140° , it distresses and in fact arrests them, its influence being of a killing character. The following may serve as useful hints for the use of active chemical agents, with a view to produce the largest yield and the best quality:—

For summer and fall cheese, use rennet sufficient to produce coagulation in 50 minutes with the milk at a temperature of from 86 to 88° . In the spring, while making fodder cheese, use one-third more rennet and less salt. The purpose of this is to facilitate the ripening process in order that the product may be ready for the market at the earliest day possible. To accomplish this result four ounces of Hanson's rennet for summer, and six for spring, with salt in proportion, will be sufficient. I speak of Hanson's rennet simply because I am accustomed to its use, and not for the purpose of advertising that commodity.

Experience has taught me that in two messes of milk produced on different soils, the conditions of heat and manipulation being the same, the cheese produced by the one when ready for market will be found to be more moist than the other. This I attribute to a constitutional difference in the milk, arising from a difference in soil, food, and water. The maker having learned by experience the character of the milk in this particular, may regulate the matter by variations in cutting, scalding, and stirring. Having ascertained that moisture predominates in the milk of a given dairy, he will cut finer, scald more slowly, and stir longer, the reason being a common sense one, that the smaller the cubes the more thorough will be the operation of heat upon them; the slower the scalding process the less likely we shall be to encrust the external surface of the blocks; and the more thoroughly we stir the more certain we shall be to expel the moisture. Stirring should

begin immediately after cutting, and should continue from 10 to 15 minutes prior to the application of heat, and should go on from 30 to 40 minutes continuously, and perhaps 10 more after the heat is withdrawn, the purpose of stirring after the removal of the heat being to prevent baking to the hot surface of the bottom. The original surfaces of the cubes should be carefully healed over by the gentle operation of heat, and remain intact during the whole balance of the process.

Heating should proceed slowly at first, but gradually increase as the whey separates. Ninety-eight degrees is the usual temperature in summer; but as the season advances the milk becomes richer, and in Scotland I found it necessary after a time to go as high as 102°. The heat must be kept up until the curd is matured, and then cooled and aired well before salting.

DRAWING WHEY.

At the first indications of acidity—indeed at the very moment when it is knocking at the door, if I may be allowed the expression, and before it is admitted—the whey should be drawn. Right here lies the great secret of cheese-making—the absolute expulsion of the whey at the nick of time when acidity is known to be near and yet has not appeared.

After the whey is removed, and while the subsequent stirring proceeds, a new acid makes its appearance in the body of the curd, which seems to depend for its development upon the action of the air, and the presence of which experience has shown to be an essential element in the make-up of cheese. This acid should be allowed to develop properly before the addition of salt, as the presence of that substance will preclude its appearance.

Curd should contain about 75 per cent. moisture when pressed, and dry out down to 33 per cent. when cured. To determine and retain this proper proportion of moisture in cheese is one point which requires good judgment in the operator, and cannot be determined readily by any means now known of a practical nature. Observation and practice are the only guides at present known, and a cheese-maker must rely on his own experience and good common sense.

I might go on with a long list of practical hints embracing the whole subject of cheese-making, with strictures on a countless multitude of sins and shortcomings on the part of makers and patrons, but having on previous occasions expressed my opinion pretty frankly to this audience on these topics I forbear, not because of a failure on my part to recognise the value to be derived from the reiteration of valuable truths, but through fear lest my remarks should partake too much of the sterility and barrenness common to all hackneyed and overworn themes. The temperance lecturer may find new words in which to express his thoughts, and may employ new figures of rhetoric with which to embellish them; but the old evils, and the same staggering and abandoned bad examples, will ever constitute the subject of his discourse. I will, therefore, conclude this paper with a description of what I call my tea-cup test and the litmus paper test.

Everybody knows that a part of the process of cheese-making exactly coincides with a part of that process performed by the stomach in the digestion of milk; and it will be found that so far as this coincidence continues, the closer we imitate the action of that organ the more perfect will be our work. When new milk is introduced into the stomach it is at once submitted to a heat of 98 degrees. At the same time nature begins to mingle it with gastric juice. This goes on until a chemical change takes place in the character of the milk, when coagulation begins and the mass becomes curd. Nature here, as everywhere, proceeds with unerring certainty in the performance of her work.

"For Art may err, but Nature cannot miss."

But man, as the poet intimates, with all his boasted astuteness, is nevertheless at best a bungler, and must feel his way as one wandering in the dark; and in order to properly execute the laws of the Creator, must ever resort to experiments to learn the way, as the navigator resorts to his reckoning as a guide on the pathless deep.

In the course of my business as a cheese-maker, I have not infrequently found myself at sea in determining the condition of the milk upon which I was to begin operations; and so, to settle the question about which I was undecided,

namely, the ripeness or maturity of the fluid, I had recourse to two tests, one of which was the use of litmus paper. This, as you know, is ordinary paper coloured with a substance sensitive to the action of acid, so that when introduced into any liquid containing acid an immediate change is produced in its colour. This test, however, is liable to mislead, because of the fact that when sometimes used upon freshly drawn milk it will discover the presence of acid, when at the same time the milk will be found not susceptible to the action of rennet. Of course this phenomenon is due to the presence of carbonic acid gas, which evaporates after a time, and then the paper may be used with certainty; the difficult point being to know of a surety that the carbon has entirely disappeared.

The second test to which I had recourse was that I have been pleased to call the "tea-cup test."

When your milk is of that uncertain and deceptive character that puts you at a loss, take an ordinary-sized tea-cup, holding one gill, and into this full of milk introduce a drachm or a teaspoonful of rennet of which you know the strength, and then note the time employed to perfect coagulation. This will furnish you with unerring certainty with a knowledge of that of which you are in search. By the use of this test I was able to determine to a minute the time which would be consumed before cutting should begin. Moreover, I was able to produce some indications of astonishment among my Scotch pupils by informing them, after consulting my tea-cup, of the amount of time I should use in producing my curd ready for the salt.

A word more with reference to the means I used to hasten the ripening process, and I have done.

When the milk was refractory and manifested a reluctance to come forward, the means I used to hasten its movement was heat. If in the morning I found the night's milk had descended to a temperature of say 66° , I ran up to 94° ; if at 68° , then to 92° , my rule being to go as far above 90° as it had descended below 70° . Thus you see by a natural and salutary process I was able to dispose of my material at a seasonable hour, and was not compelled to resort to the baleful practice of introducing sour whey.

CHAPTER XI.

PRACTICAL BUTTER-MAKING.

HAVING now described at some length the process of cheese-making, we will turn our attention for a time to the fabrication of butter, the product-in-chief of the dairy world. From the Ural River westward to the shores of the Pacific, and from the Tropic of Capricorn to the Equator, butter everywhere holds a high place in the dietary of mankind. Indeed, beyond these limits, among the principalities of South America, the islands of the South Sea, and to the shores of Eastern Asia, this much-prized article of food holds a high place as an article of commerce. To the countries where it is manufactured, butter is doubtless a prolific source of wealth, and will continue so to be so long as there exists a civilisation to demand its manufacture. The manufacture of butter, however, is a profitable business only to those who produce a good article. It therefore behoves those engaged in its manufacture to avail themselves of every light, whether from their own experience or the experience of others.

Having in the first chapter of this volume treated of milk, our first topic under this head will be

CREAM.

Butter is the aggregated fat of milk, which is first known as cream. Pure cream consists of the globules in milk which rise to the surface on standing. These globules, as has already been observed, are composed principally of three varieties of fatty matter—stearine, palmitine, and oleine, enclosed in a membranous pellicle. Butter is formed from them by removing the pellicle and collecting the fat into a mass. Occasionally particles of fat are mingled with them which have no pellicle. This is especially true with respect to the lighter fats which are

derived from the essential oils in the food of the cow. The naked fat appears in very minute particles. Water also enters more or less into the composition of the milk globules, apparently taking the place of a part of the fat. I have recently, as before observed, found globules in which the fat was entirely displaced with water. As the composition of cream is variable, there is a corresponding variation in the specific gravity of different samples. It varies, according to different authorities, from 1024.4 by Berzelius, down to 983 by Sturtevant. The actual difference in the gravity of different samples of cream, I apprehend, is less than is generally estimated, the samples being varied by the amount of milk taken with the cream. Taken from grass-fed milk in June, the cream being very carefully separated from the milk, the pure cream had a gravity of 985, water being 1000; this is the lowest determination I have made. I have never met with a sample of sweet cream which I can recall as being heavier than water. Sour cream will often sink in water because of the coagulated caseine which adheres to it; but when sweet cream is placed in distilled water the caseine sinks and the cream rises. Hence I infer that though the great majority of authorities agree in putting the specific gravity of cream greater than that of water, the higher gravity is due to an imperfect separating of cream from the milk. That this was so in the extraordinary gravity ascribed to it by Berzelius is evident from the fact that the cream so estimated produced only $4\frac{1}{2}$ per cent. of butter, while the residue gave $3\frac{1}{2}$ per cent. of caseine and 92 per cent. of whey. Such a result could not be obtained without having mixed with the cream a large amount of milk. Pure cream ought to yield 20 per cent. of butter. I have obtained from it 25 per cent., and it sometimes yields more.

It must not be understood from this remark that cream is all supposed to be alike in respect to gravity or value, for neither is true. The cream from the milk of different cows varies both in gravity and value, and even in the milk of the same they are varied considerably by the effect of feed. A cow in April, while in the barn, and fed on hay and wheat bran, gave milk in which the cream differed so little from the rest of the milk that no distinct line between milk and cream could be observed after standing twenty-

four hours in a graduated glass ten inches deep. The cream appeared to diminish from the top to the bottom of the glass by a gradation nearly uniform. About one-fourth of the way from the top down was a confused change in the shading, showing the cream to be thicker above than below, but the diminution of opacity downward showed considerable cream below. A milk so very rich as to show 25 per cent. of cream, and still cream to spare below that, seemed a remarkable instance of richness and to be worthy of analysis, but I was much disappointed to find in a total of dry solids of thirteen per cent. less than four per cent. fat. The milk of this cow was watched, and the diminution of the per cent. of cream with a change of feed noted. In June, when fully established on a diet of grass, the cream had dwindled to twelve per cent., and its line of separation became distinct. An analysis showed a slight falling off in solids, and a trifling increase in fat. The changes noted in the milk of this cow are interesting as indicating the possible change upon the gravity of cream by the influence of feed, and the unreliability of the volume of cream as an absolute guide to value, and may help to throw some light upon the variable specific gravities ascribed to cream. The April cream was evidently largely composed of milk, because its gravity being so near that of the milk itself it did not crowd itself to the surface to displace the milk that was mingled with it. In June, the globules were better filled, and the fat in them was lighter, and they pushed themselves (so to speak) with more force to the surface, displacing the milk and forming a compact coat of cream with a deep colour. The former must have weighed heavily; the latter light.

Cream from the milk of different cows and from different breeds of cows is liable to similar variations. The bulk of cream, however, affords a strong probable evidence of the butter product in the milk, but not an absolute one. The opacity of the cream is often as good an index of value as bulk.

RAISING CREAM.

From time immemorial, cream has been separated from the other parts of milk for the purpose of making butter, yet the best method of effecting the separation is far from being settled.

Opposite practices, in many particulars, are advocated and adopted. A beginner in butter-making is always confused with the contradictory notions of old practitioners; and these differences of opinion and practice are likely to continue till the operators assemble and compare practices and products, and settle differences by discussion.

In the present unsettled state of opinion and modes of operating, an appeal to general principles becomes necessary. The statement of a few leading facts will help us very much in deciding what is, and what is not, proper.

The first prominent fact in the separation of cream from milk is, that it rises by reason of its having a less specific gravity than the milk with which it is mingled.

The average specific gravity of milk is about 1030. The difference between this and 985 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 toward the surface at all. Neither do the larger ones always rise; some of them settle instead of rising. In placing in a glass tube sixteen 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 ($\frac{1}{8000}$ 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 in milk 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 three 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 flavoured article is desired, it is not advisable to continue the process of creaming too long. What will rise in forty-eight hours, at sixty degrees, on milk four inches deep, is all that it 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 with heat and cold than water, and more than the other elements of milk. The difference in 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 can 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 as fast at 60 as at 160 degrees. In butter-making, the waste of butyraceous matter 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 degrees, 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 degrees, 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 degrees, 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 a low one. Water rising from 40 to 50 degrees swells only one-tenth as much as when rising from 80 to 90 degrees; 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. When 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, although always open for recognition in every butter-making establishment, whether corporate or private, it has failed of being recognised both by dairy-men and dairy writers—perhaps because they have had

their minds intently bent on some ideal temperature or depth as the *sine qua non*.

A fourth consideration is depth; other circumstances being equal it must be evident that it will take cream less time to rise through a thin structure of milk than a thick one—less time to rise through three inches than twelve. But depth involves temperature, and 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 temperature; and of temperature it may be also 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 80°, and of the same depth and quality, are set in a room which has an even temperature of 50°—one being cooled to 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 50° until the cream ceases to rise, it is warmed and then set again in a room at 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 feebler degree, if the milk which was not cooled before setting were treated in the same way, provided it was set shallow, say two inches deep, in the first place. Milk set shallow in a cold room will not throw up its cream so perfectly as when set in a warm room, because when shallow it drops to the temperature of the room before the cream is all up, and having ceased to derive any benefit from a decreasing temperature, it will not now throw up its cream with

sufficient force to bring the heavier particles to the surface. Bearing in mind that the warmer milk is kept, up to a certain point, the sooner it spoils, 65° is a high temperature to set milk in; yet milk set two inches deep at 65° will throw up its cream quickly and perfectly when it would not do so if set at 50° , because the milk will very soon fall to the standard of the room, and cease to derive any advantage from a falling temperature. As cream rises more rapidly in a high temperature than in a low one, it will, at two inches depth, in a temperature of 65° , come up fast enough to rise perfectly before souring begins. If we should set warm milk in vessels six inches deep, in a room at 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 vessel be placed in a cold room, say 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 two inches deep at 65° , and accomplished the same result, takes position on the other side and becomes an advocate of shallow setting under all circumstances. Each having weighed but half the facts, his arguments cover but half the ground. Had both investigated more thoroughly, they might have been 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 its depth, and the cooler it is, the greater may be the depth. By having the foregoing general 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 the 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 80° down to 40° in the same time. Facts like these have often been noticed, and a wrong inference drawn from them. It is supposed because cooling to 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 half cooled only to 60 degrees. 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 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 is so efficient, and has been so long and so entirely overlooked, that it deserves a more extended notice than can here be given, but what has been said may be sufficient to direct attention to it. The practices in Sweden, and the experiments of Tisserand and others, in cooling to low temperatures, which are just now going the rounds of the agricultural press in this country as evidence that cold favours the rising of cream, are obviously the result of a *falling* temperature rather than a *low* one, *per se*.

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.

There are thousands of germs, in all milk exposed to the air, 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 cells are the principal obstructions in the way of the rising of cream; they begin to form long before the milk begins to appear thick. The growth of other germs do injury by altering the flavour.

Organic germs are prevented from interfering with the rising of cream, either by retarding their growth by cooling the milk, or killing them by heating.

SKIMMING.

The time at which skimming should be done, and the best mode of doing it, are also subject to modification by circumstances. The most general rule is to skim when the milk first begins to be sensibly sour. When milk is to

be used only for butter making, and is set in broad vessels with little depth, the rule of fitness for skimming is a certain consistency of the cream. When the cream becomes so thick that it will not flow back behind the finger as it is passed through it, it is time to skim. If the vessels are very deep and the temperature very low, this rule will not be applicable, for the cream will remain soft and flowing for a long time after it is all up. Milk which is cooled down much below 50° while the cream is rising, remains sweet almost indefinitely. On such milk the cream continues to rise as long as it is sweet, but after sixty or seventy hours the quantity is almost imperceptible, and the quality so poor as to detract from the value of the butter more than will be added by increased quantity. The judgment of the operator must be the final appeal in all such cases. The sooner it is taken off after it is all up the better. There is no advantage in keeping cream standing exposed to the air longer than is necessary for it to rise.

In my early dairy experience a skimmer was the only implement made use of for removing cream from milk, but with me it has long since been laid by as neither convenient nor appropriate for the purpose. The impression once generally prevailed, and does to some extent still, that the cream should be separated as completely as possible from the milk before churning. But this is not best—the butter is better and more of it is obtained by churning a portion of the milk with the cream. The cream and the milk taken with it should constitute one-quarter of the milk. To churn less than this tends to injure the grain of the butter by having too much butter in proportion to the liquid in the churn. The butter suffers by friction with a small amount of liquid in churning, which is obviated with more liquid. On this account some of the best modern butter-makers churn the whole milk; but I do not regard this as necessary. Since it is desirable to have some milk go with the cream, a skimmer is not the best instrument to remove it with. In its place I use a broad and shallow tin scoop, resembling a dust pan or a curd scoop, which I pass under the cream so as to take in the top of the milk with it. The top of the milk often contains considerable butter which this mode of skimming saves, but which is lost in using a skimmer, and

not unfrequently some of the thinner cream also. In deep setting cream should always be dipped off.

PREPARING CREAM FOR CHURNING.

From the time it begins to rise, cream is all the time changing till it is at last consumed by the products of the fermentation which goes on in the milk, if left standing long enough. *Ripeness* is the term used to indicate the degree of advancement in this changing. The principal circumstance which affects the ripening of cream is temperature; the cooler it is the slower it ripens, and *vice versa*. To produce the best result for general use and the largest yield, the cream to be operated on should have a certain degree of ripeness, which is indicated by a moderate sourness, and it should all be equally advanced. If some of it is sweet and some of it sour, or parts of it are of unequal sourness, the unlike parts will not churn in the same time, and a part of the butter will be left back in the buttermilk. If a churning is to be composed of cream skimmed at different times, the different messes should be well mixed and stand together twelve hours at sixty degrees. If it is colder, it should stand longer, as the changes are slower and it will take a longer time for it all to assume the same condition. If it is warmer than sixty degrees, less than twelve hours will make it all alike. Unless there is some special reason for churning immediately, it is better to let cream stand twelve hours before churning than to churn as soon as it is skimmed, for it is generally not all ripe alike when skimmed, though all taken off of one vessel. The upper part which is exposed to the air and light generally ripens faster than the under side, if the air has humidity enough to keep the top soft, and it will require time after skimming and mixing to make it all assume the same condition. If the air is so dry as to dry the top of the cream, it will require time for it to soak up soft again. When the circumstances are such that neither of these conditions occur, there is no objection to churning as soon as skimmed, if enough for a churning is skimmed at a time. It is not well to keep cream very long after removing it from the milk. Butter-makers often lose by keeping it too long. Cream changes faster than milk. It both sours and decays sooner than milk under the same

circumstances. This makes it necessary to keep the cream jar cooler than the milk, if it must be kept, but it is better and safer to churn often. If there is not enough for a churning of the cream alone, it is better to add milk and let the churning go on, rather than keep the cream beyond the proper time.

If the temperature of the cream is to be changed before churning it should be done gradually. The best way to do it is to place it in a tin vessel and surround it with water, either cold or warm, according as the temperature is to be lowered or raised.

FLECKS IN CREAM.

White specks in butter come from different causes. There are at least two causes which seem to produce this result: one is dried cream, but it is very seldom that dried cream produces the specks, for, if cream is dry when churned, unless the butter comes very quickly, churning long enough to bring the butter will dash the dried lumps to pieces. They will become soft, and mingle with the buttermilk, and, of course, no longer remain in lumps. But sometimes that may not occur; they may not be so broken up but that particles of cream stuck together will appear. The usual cause of flecks in butter is the coagulation of drops of milk by the action of germs in them. In the fall, when the cows are being dried off, and the milk remains some time in the cow's bag, specks are very likely to appear. If a glass vessel that can be looked through is used, flecks may often be seen developing in the bottom. The growing germs will curdle a little milk, and by the fermentation which centres around that spot, gas will be formed in the fleck, and it will become lighter than the milk and work its way up to the top, where it will be found in the cream. At another time, it will develop in the cream. The germ will coagulate a little bit of milk and remain there; and when churned, the lump of curd will not be broken to pieces. If such milk is scalded, the white specks will not appear.

These specks are sometimes developed by the action of air and light. I have taken two pans of milk from the same mess and set them side by side; one pan would have the specks in it, and the other would not. I was at first a

little puzzled to account for this; but after a while, I found that the light, which shone into a window, struck one pan and developed the germs, thus making the specks. The development was not so rapid in the other pan, because it was in the shade, so the specks did not appear. I have had them appear in one cow's milk and not in another's, when the milk of both cows was placed just alike, and subjected to the same influences in every particular. Specks of dried cream may not injure the quality of the butter materially, but when the conditions of milk or cream are such as to develop flecks by coagulating specks of milk, I do not think as good butter can be made. The specks in butter may be dried cream, but they are oftener floating curd, made by the development of germs in the milk. A current of air will in a very short time produce flecks; it will ripen the germs that lie on the top of the cream, so that little specks will very soon form and be seen floating on the surface. It will bring other germs into the same condition, just as one apple rotting in a barrel will make half a dozen others rot around it. Those which form down in the milk are composed almost entirely of curd, the atoms of which are bound firmly together, probably by the mycelium of the fungus which has occasioned their formation. Those which form in the cream are partly curd, but largely cream which do not break to pieces by the action of the churn. Some butter-makers, after the cream is ready for the churn, strain it to pulverise whatever there may be of flecks from dried cream or any other cause in it. The instrument used for this purpose is a cone-shaped strainer, the pointed end of the cone being made of wire gauze, with a band of tin at the broad end as a support. An interior cone of wood is made to rotate over the gauze and crowd the cream through, pulverising any lumps and grinding flecks or fat to atoms if any there be in the cream; but this is a labour of doubtful utility. If the flecks come from dried cream, the difficulty would be sufficiently removed by mixing and stirring the cream and letting it stand awhile before churning. It takes but a very short time for dried cream to soak so soft as not to be distinguished from the rest. If it would not do so, crowding it through the meshes of a wire sieve would not help the matter much. In case there are flecks,

it would be much better to leave them whole, as they would be much less likely to get mingled with the butter than in their pulverised state. They never churn in either case, and their presence in the butter detracts from its good quality and keeping. Flecks usually come from a faulty condition of the milk, and the butter made from such milk should not be mixed with other butter, as it will not keep like butter from sound milk. They may be prevented by scalding the milk in which they occur to 130° , to kill the germs which occasion them. When the milk is very much affected, a higher heat will be necessary.

COLOURING.

When butter is very pale its market value is enhanced by colouring it. This should always be done in the cream just before churning, and it is best done with annattoine or some preparation of annatto. No colouring should be added directly to the butter; it would be impossible to incorporate any colouring material evenly with the butter after it has been churned without injury to the grain of the butter, and I know of no material which could be used that would not injure the butter by direct contact. Some colour butter with carrot juice, and a few do so whether it is to be sold or used at home, because they like the modified flavour given to the butter by the addition of carrot juice. But the great majority of consumers, especially those with cultivated taste, prefer the taste of good butter to that of carrots, and to all such the carrots do a double injury, for they injure the keeping as well as the flavour. The vegetable matter soon decays, and works the destruction of the butter by its own decomposition.

Butter-makers can prepare their own colouring by dissolving annattoine in potash, using equal weights of potash and annattoine, with water enough to give it the strength desired. It is most convenient to make it concentrated. Some add as much sal soda as potash, and think the colour is improved by the addition. When annatto is used it should be dissolved in strong ley and boiled, then strained, and, when it has settled, the pure liquid turned off from the sediment.

Artificial colouring for butter should always be sparingly used. The added hue is seldom, if ever, quite equal to the

natural one, and if it is a little too strong it disfigures by giving an unnatural appearance.

It requires some skill to prepare the colouring, which is only acquired by experience. To be sure of having a good article, and to avoid the muss which its preparation generally makes, it is better for all small dairies, at least, to buy the small amount they use ready made.

CHURNING.

Before discussing the process of churning and working butter, a brief explanation of what is understood by the *grain of butter* seems appropriate.

It has already been stated that butter is made up of the fat globules in milk which adhere after having been divested of their delicate membranous envelopes by churning, and that these little atoms of fat are themselves made up of several varieties of fatty elements, such as stearine, palmitine, and oleine. These fatty elements have in each globule not only a definite composition, but also a definite organisation, as much so as that assumed by the several parts composing an egg.

When butter can be churned and worked so as to leave the disrobed granules of fat whole, or nearly so, if a piece of it at 60° or below is broken in two, it will show a clear and distinct fracture like broken cast iron, and when the fracture is viewed with a magnifier it will show a granular structure. This unbroken and undisturbed condition of the granules of fat is what constitutes the *grain of butter*.

In this condition butter has its best flavour and best keeping quality. If the churning, working, or handling, has been such as to mash and break the granules, the fatty elements composing them become mixed, and the oily parts spread and give to the whole a greasy appearance, and the fracture, instead of being distinct like that of cast iron, will be more like a fracture of lard, green putty, or salve. The more the atoms of fat are mashed and broken, the more the flavour is depressed and the sooner the butter spoils, just as an egg might be expected to spoil the sooner for having its contents disturbed and mixed up. The difference in the keeping of butter, whether the grain is broken or not, is very great. When the grain is all right, butter may be kept under great disadvantages, and almost anywhere. If

the grain is spoiled, it will hardly keep long under any circumstances, and the flavour is about as much affected as the keeping.

In all the processes, therefore, of making and handling butter, the preservation of the grain should be kept constantly in view, and those methods adopted which will do it the least violence and have the least tendency to make it appear greasy. The right temperature, too, must be observed, for, if too cold when manipulated, the granules will grind against each other and injure by the friction, and, if too warm, the grain is spoiled by the too easy mixing of the softened fats.

The object of churning is to divest the milk globules of their delicate membranous covering without breaking or disturbing the granules of fat within them. This is best done by a force in which *motion* and *pressure* are combined. Such a power is much better than *motion* and *friction*. Repeated impulses of motion and pressure act upon the entire mass at once and alike. Motion and friction act only upon such particles as the instrument used comes in contact with. Friction *wears* off the pellicles and does its work unevenly. The larger globules meet with the most friction, and hence their pellicles are worn off first. These gather into lumps before the smaller ones become churned. If the churning continues till the smaller ones "come," the larger ones become over-churned and greasy by the excessive friction. Pressure operates upon large and small nearly alike, and the globules of different sizes come nearer together and more perfectly, producing more and better butter.

WORKING BUTTER.

The object of working butter is to free it from buttermilk, to mix salt through it evenly, and to make the mass as solid as possible.

The less labour with which these ends can be accomplished the better for the butter. If well washed in the churn or in a butter bowl, very little working will free it from the water left in by washing; if unwashed, considerable working may be saved by pressing the butter with a damp linen or cotton cloth, alternating with the use of the ladle or lever.

There are a great many devices in use for working

butter—quite too many to be separately described. Some of them are very excellent and convenient, while others are only supposed improvements. For small dairies the common wooden bowl and ladle are in general use, and, all things considered, are perhaps the best. For larger dairies, factory, and creamery use, the slab and lever make a cheap and excellent worker, and one that is durable and easy to clean. The slab and lever do the work as perfectly as any of the more complicated workers I have examined, and cost the least and last the longest, and hence are in extensive use where large quantities of butter are manufactured. They are made of two-inch white oak, maple, or birch plank, three to six feet long and two to four feet wide at one end, and half as wide at the other. A thicker plank is often used. It stands on three legs, and inclines toward the narrow end, so as to drain off the liquid worked out of the butter, which is conducted down the slope by means of a shallow groove on either side of the plank. A loosely-fitting standard sets in a hole at the middle of the lower end of the plank, resting upon a shoulder, and fastened in place by a pin through the end, which reaches down below the plank. Through a hole in this standard one end of the lever is inserted and the other is handled by the operator.

The working is best done by pressing upon the butter with the lever, which should be four inches through, and which may be square, octagonal, three-cornered, round, or flat on one side and round on the other, to suit the fancy of the workman. The structure of this simple butter worker, if not already familiar, will be understood by the illustration on page 116.

With whatever machine the butter is worked, the working should be done by *pressing* on the butter, and all rubbing, sliding, or grinding motion most carefully avoided, as it breaks the grain and makes the butter greasy.

The temperature of the butter should be 58°, to work with the best effect and greatest facility. If more than a few degrees either above or below 58°, the work will not be so perfectly or so rapidly done, and the grain will be affected, in one case by being too soft and the other too hard. It is a common fault with butter-makers to work their butter too much. A watchful attention is necessary to guard against this. Not a stroke of the ladle or lever

should be used beyond what is actually needed. Every unnecessary stroke tells on the quality. As soon as ready, the salt should be evenly incorporated, always doing it with the least possible labour, and then the butter set away for six to twelve hours for the salt to dissolve, and then worked again with a light working. Some dairymen are in the habit of working but once, and packing as soon as salted. This treatment will not spoil good butter, but when the finest quality is desired, and the butter is to be long kept, the practice is not advisable. When the salt is added to the butter, it absorbs the water of composition, and leaves the butter a little porous. A short second working makes it more solid. A firkin which will hold 100 pounds of butter worked once, will hold 102 pounds of butter worked twice. The second working should be barely enough to press the mass firmly together and get out a part of the brine. To remove all the brine makes it too dry, but not to work out any leaves too much in and the texture a little spongy.

CHAPTER XII.

OUR SYSTEM OF BUTTER-MAKING PRACTICALLY STATED.

EXACTLY at what period of the world's history, or among what people butter was discovered, is not known; but we are certain of the fact that so early as the time of Abraham it was in use, and appreciated as an article of food. We read that "Abraham took butter and milk" and set them before the three strangers who came to visit him, "and they did eat," Gen. xviii. 8. Again, in Deut. xxxii. 14, Moses sings of the "butter of kine." Still again, in Judges v. 25, Deborah and Barak say, "He asked water, and she gave him milk. She brought forth butter in a lordly dish;" and finally, in Proverbs xxx. 33, Solomon says, "The churning of milk bringeth forth butter," &c., facts which prove conclusively the early origin of butter. The manner of its discovery is stated to have been as follows:—The people of the East used as vessels for holding and transporting liquids the skins of animals sewn together like sacks, which strange sort of receptacle is even now in use among the people of Syria. In these sacks, which in Holy Writ were called bottles, milk was transported from place to place on the backs of asses and camels, where, by the jolting motion, butter was churned from milk. But whether butter was discovered in this or some other way is not material in this connection; we know, however, that even now in Oriental countries, butter is produced by jolting milk in leathern vessels like those described above.

However great the antiquity of butter may be, it was not until recently that it became worthy of consideration as an article of commerce; indeed, so late as the year 1685, in England, whose markets now govern the price of that commodity, butter, as an agricultural product, had not reached

sufficient importance to entitle it to notice by the historian who condescends to discuss beans and rye in treating of agriculture. Coming down still later, it is not more than thirty years since in the United States and Canada butter began to assume respectable proportions as an article of commerce; but within that period it has grown from year to year with a rapidity quite bewildering, until to-day, as we have said in another place, it has reached a magnitude that is simply magnificent.

In treating on this subject, we will begin with

MILKING.

In performing this operation, there is no consideration of more importance than *cleanliness*. Beginning with the person by whom the milk is to be drawn, everything connected with the operation should be scrupulously clean and neat. A naturally slovenly person will never make a good milker, any more than an obtuse and unobserving one will ever succeed as an artist. The place where the milking is done should be properly ventilated, the floor should be clean and dry, and spread with straw or other clean material to prevent spattering. The pail or other receptacle used in drawing should always after use be thoroughly *washed* and *then* scalded, the purpose being to remove any particle of milk, so that nothing remains to disease future messes.

"Now, the cow is ready to welcome the milker, who presents himself with clean hands, and by a kindly word and a gentle patting gains her confidence. Before bringing the milking-pail to the cow, the milker gives the udder a good brushing with a cloth, or the hands. It is taken for granted here that the cow has all along been properly bedded and carded, and that previous milkings have always left the udder clean and in healthy condition. Failure in this respect may make it necessary to wash the udder and teats. If so, let it be done with clean water—never with milk—and the udder be wiped dry before milking. To milk clean, dry teats with clean dry hands is not only cleanly but easier and more pleasant."

Let the milker provide himself with a stool—not the one-legged affair usually so effective in the hands of the merciless hired help, but a good three or four-legged stool—

which will require no special knack at balancing. The pail should be large enough to hold an entire milking, so that the operator will not be compelled to rise during the performance.

The left arm should be so used as to protect the pail against the intrusion of a wayward or lawless foot, and the operation should be so managed as to relieve the udder equally, the hands alternating frequently among the teats. The hand should grasp the teat close to the udder, closing gradually downward with a firm, gentle pressure, forcing the milk outward as steadily and rapidly as possible. In stripping, let the milker see to it that he leaves nothing behind, as it is a fact that in the strippings lie the greater percentage of cream, and that by leaving milk in the udder the cow gradually dries up.

There is always more or less taint in the atmosphere about the place where milking is done, and milk ought not to remain long in any vessel before being transferred to the setting receptacles. The wise dairyman, therefore, will remove his yield at the earliest possible moment to the setting vessels.

Before proceeding to other topics in the process, we would say that there is nothing like regularity in milking. Nature loves regularity; the organism of the brute, as well as that of man, appreciates it, and responds to it; while irregularity serves only to confuse and embarrass. Milking should, therefore, be performed with the utmost regularity, so that the organism of the animal may know when to expect it, and be prepared for it. The milker should have a definite number of cows for each milking, and should milk them at the same hours each day, and always in the same order.

A great variety of vessels have been devised in which to set milk, the merits and demerits of which we shall not pause in this connection to consider, any further than to say that the leading idea in the most of them is a reduction of temperature. Prior to the introduction of the centrifuge, the leading thought was the placing of milk in a state of rest at a greater or less depth, with devices for the application of ice or cold water.

Not long ago M. F. Jord, of Copenhagen, Denmark, commenced a series of experiments extending over two

years, for the purpose of determining the relative merits of three different methods of obtaining cream and butter from equal quantities of milk of the same quality, taken from one common sample, and the Danish Government, with considerable liberality, appropriated several thousand dollars to the object. Then experiments were continued through the entire year, a number of trials being made each month. The methods employed were the German centrifuge of Lefelt and an improved Danish centrifuge, on the one hand; and the ice method of Swartz, and the common shallow pan system of setting milk, on the other hand. The milk was taken from the dairy of 200 cows, and after being thoroughly mixed, 600 pounds were weighed for each experiment. This quantity was divided into three parts, of 200 pounds each, one part being treated with the centrifuge, one part set on the Swartz plan in ice water, and the third part of 200 pounds being set shallow in common flat pans.

The milk which was set in ice water was placed in pails having a capacity of fifty pounds each, the milk having an average depth of sixteen inches, and it remained in the water for the space of thirty-four hours before skimming. The regular skimming time for the shallow pans was fixed for thirty-four hours after the milk had been set, though this was regulated somewhat by the condition of the milk from the end of May to the middle of September, when the milk was allowed to stand only from twenty-two to thirty hours before skimming.

Without going into all the details of M. F. Jord's experiments, showing the careful manner in which they were conducted, it will be sufficient to say that they exhibited the peculiarities of the milk in the yielding of butter by the three systems. They also demonstrated the quantity of butter obtained from 100 pounds of milk by each of the three systems, during the different months of the year; and the remarkable variations at certain seasons by the different methods show some curious things in the behaviour of milk, which the science of M. F. Jord was unable to explain.

The following table gives the relative value of the three systems in figures for the different months of the year:—

POUNDS OF MILK FOR ONE POUND OF BUTTER.

1879.	Centrifuge.	Ice, 34 Hrs.	Shallow Pans.
May,	27 6	30 0	30 4
June,	26 4	28 3	28 8
July,	26 8	28 0	30 5
August,	28 5	27 7	31 7
September,	26 6	27 6	30 9
October,	24 3	28 7	27 9
November,	24 6	31 5	28 4
December,	24 2	28 5	27 4
1880.			
January,	25 8	27 8	28 0
February,	26 4	27 4	27 8
March,	27 8	28 8	29 5
April,	28 3	29 4	30 1

Referring to the above table, it will be seen that the superiority of the centrifuge over both the ice and pan systems is especially noticeable during October, November, and December, while during August it falls below the ice method.

It will be thus seen that, aside from the very primitive method of churning butter from milk, the butter-maker, up to this date, has discovered but two practical methods of separating cream from milk—setting and the centrifuge. The latter, it would seem from the figures above given and the recent experience of creamery men, is greatly superior to the former, and will no doubt in the course of time, so far as practicable, supersede it.

Our book, however, is not written in the interest of any particular method of raising cream. Men are generally disposed in what they do to adopt the most profitable methods, yet, notwithstanding this fact, we find a great variety of cream-raising utensils still in use throughout the dairy world, and we must take them as we find them. There are a great many dairymen who still use the old-fashioned shallow pan, between which and the ordinary clay cooler there is little if any difference in principle, both failing in convenience and effectiveness in the matter of cooling. Much superior to this is what is called the Fairlaw system. It consists of a tin can about 18 inches deep by 12 in diameter, and holds in the neighbourhood of four gallons.

In the centre of this can stands a tube about two inches in diameter, closed at the top and open at the bottom. One or more of these cans, full of milk, is placed in a tank of a depth nearly equal to that of the can. The tank is now filled with cold water, which surrounds the can to a height equal to that of the milk, and arises in the tube through the aperture in the bottom to about the same height, thus exposing a great amount of surface to the action of cold, and also invading, by means of the tube, the central stronghold of heat.

There are many other devices similar to the above, all more or less meritorious, and differing one from another only in some minor particulars, which we do not care to point out, but will leave the matter to the good sense of the dairyman, and will close the topic by saying that when milk set thick or thin in a cool sweet atmosphere is reduced to a proper degree of temperature, it will yield pretty nearly all its butter-producing elements.

SKIMMING.

For ordinary farms, we advocate but once skimming, which should be done in from twenty-four to thirty-six hours after setting, according to the weather, and always before there is any separation of whey. It requires no great outlay of intellectual ability to skim milk properly. A common ladle-shaped perforated tin skimmer is as good as any with which to perform the work. It will do no harm should a portion of the milk be removed with the cream, as that lying near the surface is usually quite rich in fat.

RIPENING.

In average-sized dairies it will not be practicable to churn each milking by itself, but several skimmings must be kept until a sufficient quantity has accumulated. In such cases never attempt to keep the different skimmings separate, as such a course would result in loss of quantity, but select a vessel large enough for the purpose, and add the several messes as they are taken off, stirring the whole well together. If considerable time elapse before enough is accumulated for a churning, stirring at other times than when cream is added ought to be resorted to, in order that the process of ripening proceed with uniformity. When, at

length, enough is secured for a churning, the whole should be allowed to stand for about twelve hours after the last addition at an average temperature of 60 degrees (a higher temperature requires less time). The object of this rule is to have the cream equally ripened, otherwise the cream will not churn evenly, the more ripened coming to butter first. This is the great point in butter-making—the ripening of the cream and the securing of that exact degree of acidity which is known to produce the best results. It can only be known to the experienced, and is determined by taste alone. A deficiency in acid, and we have a loss in yield; a surplus, and there is a failure in quality. Sweet cream butter is nice in quality, but requires immediate consumption, but for all purposes that produced by a proper development of acidity is the best.

We have observed a practice, particularly in Scotland, among the large cheese dairies, of allowing cream to stand a week before churning, and we never saw an ounce of good butter produced from such cream. Cream should never, under ordinary circumstances, be allowed to stand more than three days, and only then under a low temperature.

The butter-maker who attempts to wander through the mysteries of his business without a thermometer is quite as foolish as the mariner who trusts himself afar on the deep without a compass, and will quite as certainly come to grief.

Sixty degrees may be stated as an average temperature at which churning ought to be performed, varying according to circumstances from fifty-eight to sixty-two. If the weather be cold, the operator should begin at sixty-two, from which there ought to be a fall to fifty-eight when the work is done. If, on the other hand, the weather be warm, the cream ought to be reduced to a point anticipating a rise in the churn to fifty-eight. In heating cream always use a bath, for the reason that, if it be warmed by adding water, a large bulk must be used, or the water must be heated so high as to destroy the texture of that portion of the cream with which it first comes in contact. In the use of the bath, care should be taken lest the cream standing near the outside of the vessel become too hot; to avoid this, constant stirring ought to be kept up.

CHURNING.

The leading idea of churning is agitation. Whether it be for the purpose of breaking the covering of the cream pellicles, or the collecting of fats of milk held in solution, we shall leave the reader to decide for himself from what we have already said on the subject, and from what he may be able to glean from other sources, our present business being with the act more particularly.

By a persistent agitation of freshly drawn milk, or milk in any form, or cream, it is found that the fats accumulate in a gradual way, the infinitesimal particles having a tendency, when kept in motion, to unite one with another. This work of accumulation probably begins very soon after agitation is begun, and goes forward, imperceptible to the eye at first, until each little nucleus has gathered to itself a sufficient number of particles to bring it within the range of human vision, and still goes on increasing in size until each molecule has reached the size of a grain of wheat, at which time it ought to be separated from the milk.

A great variety of contrivances have been employed with which to perform this work of agitation, particular description of which will not be necessary in this place. We incline, however, to favour those machines which have for their principle concussion rather than friction.

The barrel churn, which is nothing more than an empty barrel revolving on gudgeons, adjusted either to the ends or sides with a lid large enough to admit of free access to the interior, is as good as any. Akin to this, and perhaps just as good, is the rectangular churn, which revolves upon gudgeons like the barrel; but with this as with the barrel I would have nothing of the character of breakers on the inside, the simple pouring about and flowing produced by the revolutions of the churn being all that is necessary to effect the purpose, and all violence and friction is avoided.

Churning should begin slowly at first, and go on increasing until a speed of about forty-five revolutions per minute is attained, and from this figure there should be no departure until the work is done; a steady, uniform motion being decidedly the best for all purposes.

There are some lazy makers who think they have achieved a success when they have accomplished a churning

in five or ten minutes, and we have heard of *churns* which were recommended to perform the operation in one minute, but such churns and such makers, we believe, were never in any great demand. Cream ought to be so tempered as to produce butter by moderate churning in about thirty minutes, and, as we have said, the proper time to cease is when the butter is in a granular form of the size of wheat grains. It is a good rule to stop churning and *strain* off the buttermilk as soon as this can be done without loss.

WASHING.

Washing ought to be done with cool *pure* water in the churn. For the first washing only enough water should be used to carry off the buttermilk which remains after draining; the purpose of this being to have the smallest amount of water possible in the buttermilk thus washed out, as it is usually saved. The second washing will be done by adding an amount of water about equal to the whole amount of cream at the commencement of churning, and may contain, if thought desirable, a light solution of salt, the purpose being to cool and harden the molecules. In the third an amount of water sufficient to float the butter should be used, so that the granules may be easily removed with a hair sieve. Each successive washing should be accompanied by two or three gentle revolutions of the churn, taking care, however, in so doing not to beat the granules together into lumps, thereby spoiling the grain of your product.

WORKING.

Our method of working is briefly described as follows:—We take the granules of butter from the water of the last washing in the churn with a hair sieve dipper, putting it into some receptacle in which it may be weighed, after which we transfer it to the working board, where it is allowed to drain. We salt according to the taste of the market for which we design our product; the general rule being one ounce of salt to each pound of butter. Having weighed our salt, we apply it in its dry state to the granules which we have just emptied upon the working board, and with a long-handled paddle proceed to mix thoroughly. In this way the evils resulting from the old-fashioned way

of first working the butter into a mass, and then by a persistent use of brute force crowding the particles through the fibre, thereby quite destroying its texture, is avoided. By our method the work of permeation is effected naturally, the saline influence coming home to each item of butter gently and in a natural way, as the summer rain moistens the soil. The work of salt penetration should be allowed to go forward for some time unmolested; an hour is none too long, and it will do no harm should an entire day be devoted to the purpose.

We have now but one purpose, and that is to solidify the mass and exclude the water, and the quicker and more

directly this is done the better, a persistent kneading being decidedly detrimental. A direct pressure is what is needed, a drawing or spreading motion with the ladle having a tendency to produce a salvey effect. Never on any account use the hands, the warmth as well as the yielding flexible surface of those members tending directly to destroy the grain.

Above will be found an engraving of a good apparatus for working butter. Its principle is that which we have just attempted to describe. It is simply an

inclined surface, contracting towards its lower end, with raised sides, so that the moisture is brought together and runs off in a jet. At the point of discharge a pivot is arranged, into which one end of the roller is adjusted, the other being free, with a handle to fit the hand. By this arrangement the butter, being placed upon the incline, is pressed by the roller passing over it from side to side, thereby excluding the moisture by a very convenient and non-injurious pressure.

PACKING.

If the directions we have now given are accurately followed, we shall have a first-class product, which will deserve a neat and attractive package. It will not be denied that a man, no matter how superior in intellect, graceful in form, or cultured in deportment, appears all the more attractive when arrayed in clean, well-fitting apparel; and the same may be said of butter. It is more attractive, will sell better, and will, moreover, enhance the reputation of him who sends it forth for the inspection of mankind.

We will close this chapter by saying that, in describing our system of butter-making, we have spoken to the million, not presuming to go into creamery methods and practices, conceiving that instructions are more needed at the farm and among small producers than at the factories, where it is to be expected that thoroughly competent talent is employed.

We have tried to write plainly, avoiding, as far as possible, everything in the way of theorising, knowing well enough, from what we have seen and heard among the class of makers we are attempting to instruct, that what is needed is not a dry recital of chemical explorations and scientific researches, but directions, plain and practical, how to make butter.

CHAPTER XIII.

ESSAY ON BUTTER-MAKING.

THE following essay by W. D. Curtis, on butter making, took the first prize of 15 dols. at a late meeting of the Wisconsin Dairymen's Association at Lake Mills. The essays were not to exceed in extent 250 words.

Truth is not always the most effective or the most agreeable when arrayed in a multiplicity of words; indeed, the philosophy of that rule in rhetoric which says that a sentence loses strength when a numerous family of modifiers are attached, will become singularly apparent when we read the following essay on butter-making. There is a volume in the two hundred and fifty words which are made to embrace the whole system of butter-making.

The author of this volume was one of a committee of three appointed by the convention above referred to, to pass judgment upon the merits of a number of essays on the subject of butter-making, read at the said convention. There were a number of essays examined, each of which had its merits and demerits; but this, although in the opinion of the committee not quite perfect, was nevertheless the best presented. Mr. Curtis's method of salting has the objection pointed out in the preceding chapter:—

BUTTER MAKING.

Select cows rich in butter-making qualities.

FEED.

Pasture should be dry, free from slough-holes, well seeded with different kinds of tame grasses, so that good feed is assured. If timothy or clover, cut early and cure properly. Feed corn stalks, pumpkins, ensilage, and plenty of vegetables in winter.

GRAIN.

Corn and oats, corn and bran; oil-meal in small quantities.

WATER.

Let cows drink only such water as you would yourself.

CARE OF COWS.

Gentleness and cleanliness.

CARE OF MILK.

Strain while warm; submerge in water 48 degrees.
Open setting 60 degrees.

SKIMMING.

Skim at twelve hours; at twenty-four hours.

CARE OF CREAM.

Care must be exercised to ripen cream by frequent stirrings, keeping at 60 degrees until slightly sour.

UTENSILS.

Better have one cow less than be without a thermometer. Churns without inside fixtures. Lever butter worker. Keep sweet and clean.

CHURNING.

Stir the cream thoroughly; temper to 60 degrees; warm or cool with water. Churn immediately when properly soured, slowly at first with regular motion in 40 to 60 minutes. When butter is formed in granules the size of wheat kernels, draw off the buttermilk, washing with cold water and brine until no trace of buttermilk is left.

WORKING AND SALTING.

Let the water drain out; salt, one ounce to the pound; sift salt on the butter, and work with lever worker. Set away two to four hours; lightly re-work and pack.

CHAPTER XIV.

DESCRIPTION OF AN ILLINOIS CREAMERY.

A paper by J. B. Harris, Esq., of Antwerp, N. Y., read before the Dairymen's Association of Western Ontario, at Ingersoll, February 7th, 1883.

ON visiting the Butter and Cheese Board of Trade at Elgin, Illinois, December 11th, 1882, I was not a little astonished at the prices at which butter was there bought and sold. There was about 350 tubs put on the board and struck off to the highest bidder, the greater portion of which reached 42c. and some 42½c. As these figures are considerably above the market price for ordinary butter, I was filled with a curiosity to see the place where an article which could command such a price was manufactured. Accordingly I took the North Western train for St. Charles, where the creamery is located which is able to accomplish such a result.

The factory of the St. Charles Co-operative Creamery Company is a plain brick structure, two storeys high, 116 feet in length by 54 feet in width, and is located on the bank of the Fox river, ten miles from Elgin, and within a quarter of a mile of railroad communications. The building is a new one, and occupies the place upon which stood a similar factory, owned by this company, which was destroyed by fire in September, 1882. The building at the time of my visit was not completed, workmen being still engaged upon some portions of the interior.

In giving a description of this factory I will begin with the ground floor. Across one entire end of the building, and occupying about one-ninth of the length from the ground to its roof, is the ice house, the dimensions of which I am unable to give, but which I judge were ample for all purposes of the establishment. Next adjoining the ice house, and occupying about one-tenth the length of the building on the first floor, is the refrigerator, of a capacity of about five car loads. Adjoining this, a third section of

the ground floor is devoted to the reception and cooling of milk, raising and separating the cream, and the churning, working, and salting the butter. In this section also was located the boiler of 35 horse-power and the engine 15 horse-power; the boiler being separated from the butter and cheese room by a partition. Another portion of this section contained the apparatus and machinery for the manufacture of cheese. On the second floor was the office, the curing room, and a large room in which boxes were to be made up. The weigh-can occupies a platform of 9 feet from the ground floor. From this can the milk is drawn into 5 vats standing 4 feet lower than the scales. These vats are each divided into two longitudinal compartments. The 5 vats are each about 16 feet long, by 5 feet in width, the compartments being of the same length, by 2 feet in width, and 20 inches in depth. These compartments contain the milk, while the space around them is occupied by ice and water. A few feet from these vats, in the corner of the ice house, a large tank supplies them with water. These are the vats in which the cream is raised and from which the milk is drawn into two large circular vats, 5 feet lower, where it is manufactured into cheese. The cream is not skimmed, but the milk is drawn from under it and left in the bottom, from whence it is conducted into a tempering vat, also 5 feet lower. Immediately below the vats I have described are four pools, each 2 feet deep, about 16 feet long, and 5 feet wide, built in the floor like tanner's vats. Each of these pools will contain about 100 cans. In warm weather these pools are used for raising cream, the milk being drawn into cans made for the purpose, each holding about 30 lbs. The cans are placed in the pools and surrounded by water. The tempering vat is about the size of an ordinary cheese vat, and is supplied with both heating and cooling appliances. If the temperature of the cream is too high it is reduced, and if too low it is raised; from 58 to 64 being the proper points, according to the season. From this vat the cream is removed to the churn. The churn consists of an oblong box, about 15 feet long and 3 feet square, with bearing at each end, and is turned at the rate of 45 revolutions per minute. I remarked to the butter-maker that I thought this motion too rapid, its tendency being to create heat. He, however, informed me that this was the motion

required, but gave no reasons, and I still hold to the opinion I expressed on that occasion. From 30 to 50 minutes, I was informed, was the time occupied at the churning. When churned the butter was in a granular form, of the size of wheat. The buttermilk was then drawn and its place supplied with water, in which the butter was washed. It was then removed from the churn to the power worker, which consists of a table with an incline surface, over which two fluted conical rollers revolved, the one following the other. The butter was placed upon this worker, where it was drained, salted, and worked, and then removed to trays, upon which it was allowed to remain until the following morning. It was then re-worked, packed in Welsh tubs, and sent to the refrigerator.

CHEESE DEPARTMENT.

Having given a brief and very imperfect description of the butter department of the establishment, I ask the

reader's patience while I attempt to follow the milk, from which, as we have seen, the cream has already been

removed, through the various operations by which it is converted into cheese. If the reader will picture in his mind two immense wash tubs, about 12 feet in diameter by 20 inches in depth, constructed of staves and hoops, and resting upon blocks of sufficient thickness to raise them to a convenient height, he will have formed a pretty good idea of the appearance of the vats used at this factory. If he

will then go a step further and conceive these tubs as lined with tin, a space being left between the tub and its lining of about $2\frac{1}{2}$ inches for circulating steam or water, he will have a still better idea of them. In the centre of each of these vats arises a conical-shaped hollow turret, about 12 inches in diameter, and as high as the top of the vat, in the centre of which there is a perpendicular shaft connected by

gearing with a horizontal shaft under the vat. This shaft supplies the motion to a roller, one end of which rests in a wheel which rolls around upon the edge of the vat. This roller is supplied with 180 spokes, or paddles, of sufficient length to reach nearly to the bottom of the vat. These paddles are arranged in rows winding about the roller like the thread of a screw. The roller has two motions, one in which its outer end traverses the whole circumference of the vat, and another in which it revolves. The purpose of this roller is that of agitating the milk in the vat while heating, distributing the rennet and stirring the curd after it is cut, operations which it performs very perfectly. After the rennet is sufficiently mixed, and before coagulation begins, this roller is removed and another put in its place, upon which curd knives are adjusted. These knives are so arranged on the roller that with each revolution around the vat a space of about 15 inches is cut perpendicular until the whole surface is completed. It is then cut by hand in a direction radiating from the centre all round. The third cutting is performed by the roller horizontally by means of knives properly adjusted for that purpose. The process of cutting completed, the second roller is removed and the first restored to its place, which proceeds with the business of stirring. From the moment the process of cutting ends and that of the stirring begins, this agitator performs the whole operation, including the salting of the curd and preparing the same for the press, in a neat and very satisfactory manner. The vats are so arranged that one side may be lowered, thus allowing the whey to pass off through a faucet in the bottom, the incline position of the vat not disturbing in the least the working of the agitator. The capacity of these vats is each 14,000 lbs., 12,000 or 13,000 lbs. being the amount usually worked in them. They are the invention of Mr T. B. Wire, of Geneva, Ohio, and in my estimation are superior to any self-agitating vat in use, the superiority consisting in the very effectual manner in which they stir the curd during the process of heating, airing, and salting.

From the description I have given, any intelligent cheesemaker will be able to see that the very large quantity of milk I have named is worked with a comparative small outlay of manual labour, no other vat of which I have any

knowledge doing the business of stirring the curd unassisted. It will be seen that all the cheese manufactured at this establishment are skims, the milk being allowed to set about 20 hours, and each 100 lbs. furnishing to the butter department cream for about $3\frac{1}{2}$ lbs. of butter. In some particulars the method used in the manufacture of milk of this character into cheese differs from that employed upon whole milk. First, more rennet should be used; the reason for this being that it is desirable to have cheese of this character go into consumption as soon as possible, and the process of curing is promoted by a liberal use of rennet. Second, that the cheese may be soft in texture, less heat is required than with the whole milk, 82 being the point at which they added the rennet at this factory, scalding being accomplished at from 92 to 94. Third, unlike the whole milk method, no delay is necessary after scalding for the purpose of maturing, the whey being drawn immediately. Fourth, less salt is required. At this factory 3 lbs. to the 1000 lbs. of milk was used, but the salt was added when the curd was in very moist condition, so I calculated that not more than 2 lbs. remained in the curd.

PRESSES USED.

The ordinary screw press was used, of which they had between 40 and 50. On the day of my visit about 12,000 lbs. of milk were made up, 32 cheese being produced, weighing about 34 lbs. each. These cheese were 15 inches in diameter by about 5 inches in thickness, and resembled Ohio flats. An examination of the cheese in the curing room convinced me that they were skimmed, but very good, being soft and not too dry, and at the same time firm.

In concluding this article I would say that the impressions I formed, as the result of my visit to this creamery, were, upon the whole, very favourable to its methods and appliances in the manufacture of butter and cheese, its arrangements, from the point when the milk was taken into the places from whence its products were discharged for market, all being admirably calculated for facility and ease in the performance of every branch of labour therein performed. Its machinery and apparatus, it seems to me, are unusually well calculated to work in harmony with the laws which nature has enacted to govern the process by which

these two very important articles are brought into being. Its butter sells with the very best in the Elgin market, while its cheese is not inferior to any of that variety manufactured anywhere. As a proof that this method of working up milk is profitable to those who engage in it, the superintendent informed me that dividends have been declared by this company as high as 1 dol. 80 cents. per 100 lbs. of milk. Mr S. S. Pembleton, the superintendent, is a gentleman of whose ability to manage the affairs of the company there can be no doubt. He treated me politely, and spared no pains in giving me a thorough insight into the whole business of the creamery.

CHAPTER XV.

CHEESE CONSIDERED CHEMICALLY AND AS FOOD COMPARED WITH BUTCHER MEAT.

CHEESE constitutes but a small part of the dairy products of the United States. Fifty per cent. of the milk produced in the country is employed in making butter, and forty-five per cent. is used in human and animal food, and the remaining five per cent. is converted into cheese. Ten times as much milk is used for making butter as there is for making cheese, but inasmuch as the milk required for making a pound of butter will make two pounds of cheese, the butter produced is but five times that of cheese. In commerce, cheese has relatively a larger importance. Being made chiefly in factories, a large share of it finds its way into the channels of commerce, and becomes conspicuous for the magnitude of its transactions. Butter being made chiefly in families, much of it never leaves the premises of the producer, and still more never goes beyond the village store or grocery, and hence is not recognised in the quoted transactions. On this account, cheese assumes a commercial importance, so far as bulk is concerned, equal to about two-fifths that of butter.

Cheese in the States is, to a considerable extent, used as a luxury. It brings a price, on account of the agreeable relish it affords, above what it would bring as a means of sustaining life. In some other countries it is largely used by the labouring classes as an article of necessity, and is purchased at a lower price. When sold for this purpose it always goes at a low figure, and yet its food value is generally estimated very high—higher than facts will warrant.

The estimates, too often, are theoretical. Caseine is flesh-forming food, and the theorist counts all this as so much actual food, and bases the life-sustaining power of cheese on the caseine or albuminous matter an analysis shows

it to contain. This is not safe reckoning. To make such an assumption would be to make skim cheese more valuable as food than whole milk cheese. A good full milk cheese contains about equal parts of caseine, fat, and water, say thirty-two per cent. of each, with four per cent. of ash, including salt. But these proportions vary considerably, the caseine running up to thirty-six and down to twenty-eight, with corresponding variations in the fat. To assume that a skim cheese of the white oak variety, which by analysis shows fifty-eight per cent. caseine and two per cent. fat, as I have sometimes found them, is twice as valuable for food as a well cured whole milk cheese which happens to contain but twenty-nine per cent. caseine, is to do harsh violence to both fact and logic. It is unsafe to estimate the value of cheese, or any other food for human use, by the amount of caseine or other nitrogenous matter it shows by analysis, so much of its value depends upon its conditions and connections with associated matter. Analyses show corn cobs to contain from one to three per cent. of nitrogenous or flesh-forming matter, and fruit to contain but one per cent. or less. It would be ridiculous in the extreme to claim that a given weight of cobs would sustain human life better than an equal weight of fruit because they are estimated to contain more flesh-forming matter. Fruit alone will sustain human life very well, but no argument is necessary to show that the more cobs one should eat the sooner he would die. Potatoes will illustrate the importance of a difference in the condition of food. When raw they are indigestible and useless as human food. When they are cooked they are easily and perfectly available. Yet an analysis of the two would be the same. Caseine is subject to similar variations in its availability. As it exists in milk it is liquid, and if it remained so when taken into the stomach it would at once, and without alteration, be taken into the circulation and assimilated. Whether unfortunately or otherwise, as soon as it comes into contact with gastric juice it coagulates and forms a curd, insoluble in water and other neutral liquids, but is readily soluble in alkaline liquids, and is slowly soluble in gastric juice. Its conversion into curd greatly retards its digestion. Its congener and associate, albumen, which it closely resembles, but which is not coagulated by stomach juices, retains its liquid form in the stomach and is

at once taken into the circulation, and is out of the way and in process of assimilation long before the stubborn coagulum of caseine begins to yield to the slow action of gastric influence.

The first thing we do in making cheese is to convert the liquid caseine into an insoluble and almost indigestible curd. The next step is to deprive it of twenty-nine thirtieths of its water, making it still harder and more indigestible, and finally we solidify it still further by adding salt, and thus, by the time it is out of the press, we have put it into an indigestible condition and rendered it unfit for human food until modified by further change. This we effect by waiting for the slow action of rennet and the free oxygen of the air to break down the tough, elastic, and insoluble compound into tender, plastic, soluble cheese—a cured cheese—ripe and rich, with a new flavour, and digestible and wholesome and untritious.

This is cheese in its best state. In this condition it is wholly utilised. There is nothing of it lost, and it counts as food; for all theorists estimate that a properly made and thoroughly cured cheese is twice as valuable as an equal weight of butcher meat for sustaining life, and is quite as palatable, as easily digested, and as wholesome. If all the cheese of the country was properly made and cured, the consumption would become enormous, because of its low cost as compared with its usefulness. It costs less—certainly no more—to produce a pound of cheese than it does a pound of beef, and, being more valuable and equally as appetising and healthful, it would be preferred.

All cheese is not equal to its highest possibilities. There are many reasons why it cannot be. In the first place, good cheese can only be made out of good milk, and this is not always at the control of the cheese-maker. Then milk which was good when it came from the cow may not be so when it reaches the cheese vat—it may be sour, stale, or uncleanly. And further, milk itself is a very complex and variable substance, always changing in the quality and proportion of its constituents, and thereby modifying the products derived from it. To show its complexity Dr. Sturtevant divides it up as follows :

MILK.							
Cream.				Skim Milk.			
Butter.		Buttermilk.		Coagulable Matter.		Whey or Serum.	
Solid Fat.	Liquid Fat.	Caseine.	Whey or Serum.	By Rennet.	By Acetic Acid.	Salts.	Nitrog. Matter or
Stearine.	Oleine.			Caseine.	Ziege.	Potash.	Osmazome.
Palmatine.	Butyrine.					Soda.	Sach. Matter
	Caproine.					Lime.	or
	Capryline.					Magnesia.	Milk Sugar.
	Caprine.					Iron.	
	Arachine.					Phos. Acid.	
	Myristine.					Sulph. Acid.	
						Carbonic Acid.	
						Silicic Acid.	
						Chlorine.	

With such a number of constituents, all the time varying in their proportions by reason of soil, climate, water, feed, breed, age, health, and treatment of cows, it ought not to be very surprising if the cheese made from it was not very uniform and sometimes not just right. But there is another element in milk which the doctor has not mentioned that often modifies it materially, and interferes with the work of the cheese-maker. I allude to pepsin as a constant element in milk, with variable degrees of strength, which it is difficult for the manufacturers to estimate. If there is more than usual in the milk, his customary application of rennet makes an excess to the injury of the cheese. If there is less than usual, his work will go too slow, and his cheese be liable to injury therefrom. I have never made an absolute test of this agent in milk, but I know it is always present, and sometimes in such quantities as to produce spontaneous coagulation without souring, and sufficient to serve the full purpose of rennet in pushing forward the conversion of curd into cheese. Frequent comparative tests have shown it to average equal to twenty to twenty-five per cent. of the rennet commonly used by cheese-makers. Then there are often foreign bodies in milk which have no legitimate place there, but are accidentally present, such as poisonous and medicinal agents taken in with food or drink. All such modify milk for cheese-making in a very marked degree, and generally unfavourably. There are also essential oils

of plants, strong-flavoured and strong-scented, and organic ferments from impure water and decaying food consumed by the cows.

Besides these irregularities in milk, there are others peculiar to manufacture, which tend quite effectively to demoralise the matured cheese. These are also numerous. Some of the more active of this class are quantity and quality of rennet, variations in temperature, modes of handling the curd, quantity of salt used, and last, but not least, the conditions under which the curing is done.

When we thus glance over the exceedingly complex nature of milk, and the ease and extent of modification in its composition, the frequency with which it is moulded by substances foreign to its necessary constituents, the changes in its conditions by time and temperature, and the ever-varying influences exerted by the treatment in manufacturing and curing cheese, it must be apparent that the task of the cheese-maker is a pretty difficult one, and involves an amount of ready knowledge, judgment, and skill not easily attained, and is intricate enough to class the business of cheese-making as a fine art.

Whoever will take the trouble to give but a hasty consideration to the wide and numerous modifications which are liable to occur in milk and its manufacture into cheese, can hardly be surprised at the statement that the number of successful cheese-makers is very small, and that the great bulk of the product goes into the markets in an imperfect condition and with impaired food value.

I have had occasion, during my long connection with the dairy interest, to examine a great many cheese, and, though I have not kept an exact list of the number examined nor any precise statement of the quality noted, I know from recollection that of the whole number examined there has not been one per cent. which has come up to the highest possibilities cheese is capable of reaching, and less than ten per cent. which would be reckoned as first-class, or which would grade above ninety-five per cent. of perfection.

The public judgment rates cheese at half its possible value. The average price of cheese is not above that of butcher meat, if it will run as high. Perfect cheese having twice the life-sustaining powers of an equal weight

of meat, it ought, if it was all perfect, to sell for twice as much. The fact that when used as an article of necessity it brings no more than meat, is evidence that the public, from its practical use, judge it to have no greater value than meat, which is placing it at half its possible value. It has often been observed by those who have kept a close run of the cheese-market, that it competes with meat, and the price runs up and down with certain classes of animal food.

I have made a considerable number of tests of the digestibility of cheese. These tests have embraced many different kinds of cheese and states of maturity. The average of the results has shown over half of the solid matter to be digestible. Of fifty samples tested at one time, ten per cent., or five of them, were perfectly digested, the digestion of both fat and caseine being complete by the action of stomach juices. But these were selected samples, and showed a higher percentage of perfect cheese than would obtain in cheese for general consumption. It may be interesting to state that one of these perfect cheeses was an American cheddar, fine flavoured, flaky, ripe, and rich. Another was a French cheese of the Roquefort make, also old and fine with very strong and full flavour of cheese. The third was an American dairy cheese, old, dry, and crumbly, but with cheesy flavour very full. The fourth was an imitation English dairy, made from new milk right from the cows, with all the animal heat in that could be retained. The cheese was fancy in quality, and retailed in New York for thirty-five cents a pound. The fifth was an imitation of Muenster—a small German cheese, a sweet curd cheese, and full of fine holes. All of them had the characteristic quality when moistened in the mouth of melting on the tongue like butter, or a ripe pear. The remaining samples showed a grading of digestibility all the way down to fifteen per cent., and in all cases of inferior digestion pepsin had no influence on the fat.

The state of curing has very much to do with the food value of cheese. I have referred before to the indigestibility of curd and green cheese. Digestibility increases as the green or curdy state diminishes and the cured state advances. Much of the cheese of commerce, when it goes into the markets and into consumption, is too little removed

from its curdy state to be fully available for human food, if everything else about it was right. It often acquires an agreeable flavour before it does perfect digestibility, and this is believed to be one cause for its going into consumption too soon. A thorough curing and breaking down of the tough and elastic condition of the curd, by which it is changed from curd to cheese, must take place before the human stomach can cope with it. A desire to save labour in curing for it, and to realise on it as soon as possible, also tends to push it off while in an inferior condition for food.

Another reason for shipping before ripe enough for use, arises from poor-keeping qualities. As the owners of western hogs sometimes kill them to save their lives when attacked with cholera, so salesmen of cheese made in hot weather are sometimes obliged to sell them when immature to keep them from spoiling on their hands, and, besides this, a great deal of traffic goes on in green cheese without the parties concerned having any idea of its inferiority for food. The short-lived character of midsummer cheese is not a necessity of the hot weather, or of the imperfect condition of the milk at that time. Just as good cheese, and just as long-keeping cheese, can be made in July and August as at any other season. The whole difficulty with hot weather cheese, and what is known as tainted and gasey milk, arises from a lack of knowledge of the actual condition of such milk, and of skill in manufacturing and curing the cheese. One of the leading items in defective skill lies in the faulty care and preparation of rennet. In three-fourths of the factories I have visited for the purpose of giving advice during the last five years, rennet was found in an actual state of putrefaction, or otherwise fatally defective in preparation. Putrefying rennet does not make good cheese at any time, but in the heated term of the season it is certain destruction. When milk is curdled with rennet in a state of putrefaction, it is just as sure to work its legitimate effects in due time as it would if put into the brine in which meat was placed for preservation. The only difference would be the speedier destruction of the meat.

Another cause of depreciation, resulting from defects in manufacture, comes from the manner of employing acidity while manipulating the curds. The defect alluded to is the

practice of leaving curd in the whey after the whey becomes sour. This practice, which has been so generally followed for the purpose of hardening the curd and making solid and firm cheese, has not been without some compensating effect, but the injury it has done far outweighs the good. There are three classes of elements in the food of animals, each of which is equally essential to the maintenance of life and health. They are the carbohydrates, which develop fat and animal heat, such as starch, gum, sugar, and animal and vegetable fats; albuminoids, which build up flesh and tissue, such as the solid matter in cheese or caseine, animal flesh and tissue, the white of eggs; and the gluten in wheat; and, third, the mineral elements, which go to build up the bony structure and teeth, and serve other purposes in the animal economy, such as potash, soda, lime, iron, and other mineral matters, including phosphorus, which exists in the form of phosphates. Each of these three kinds of matter is equally important and indispensable. These all exist in milk in just the right proportions to sustain life and health, and this is what makes milk the perfect food it is. Take out either one of these kinds of matter, and the young animal for whose nourishment milk was designed would soon sicken and die, and the adult living upon it would soon tire of its use and fail in health. The practice of soaking curd in whey till the latter becomes sour injures the food value of cheese by dissolving out of the curd the mineral matter the milk contained, thereby changing, in a very marked degree, the character of the resulting cheese, and rendering it an imperfect and unhealthy food. A little explanation will make this point clear. The mineral elements of milk constitute its ash. They consist mostly of phosphates, as the phosphate of lime, of soda, potash, iron, and magnesia. About one-half of milk ash is phosphate of lime, which consists of phosphoric acid and lime. This compound is easily dissolved, for lime has only a feeble affinity for phosphoric acid. When in contact with a liquid acid, for which it has a stronger affinity than for phosphoric acid, the lime lets go of the phosphoric and combines with the stronger acid, forming a new compound, and leaving the weaker acid free.

Lime has a stronger attraction for lactic or milk acid than it has for phosphoric acid, and, when the curd containing phosphate of lime is immersed in sour whey, the lime

lets go of the phosphoric acid and combines with the lactic acid, forming lactate of lime, which is insoluble and useless, leaving the phosphoric acid in solution to be carried off in the whey.

Leaving curd in sour whey the length of time customary in the so-called acid process of cheese-making, I have found by testing, carries off in the whey one-third of the mineral matter of the milk, which so far destroys the balance of elements in the cheese as to make it unwholesome food; and this is one of the pre-eminent reasons why people so easily tire of cheese as we have been in the habit of making it, and so many people object to it on the score of health.

This practice of steeping curd in sour whey further depreciates the food value of cheese in another way. The loss of mineral matter impairs the salubrity and digestibility both of the curd and cheese, causing a large loss of the solid matter of cheese from imperfect digestion. The loss from this cause in the food value of cheese is simply immense. Like the cuts of a two-edged sword, it works injury in two directions. First, the loss of a large part of the mineral elements in milk so impairs the digestibility of cheese that the average human stomach is unable to cope with it, and much of what might otherwise have been valuable nutriment is passed indigested, and lost to the consumer. Second, by tendency to unhealthfulness from its imperfect character as a nutrient, by reason of the loss of the necessary mineral element. This loss so impairs the composition of cheese as to compel a very limited use of it by most people. It is rare indeed that any one can partake at all freely of such cheese without soon suffering from its notorious tendency to constipation and a general disturbance of the whole system. These effects are so uniform and frequent that people very naturally suspect they are the legitimate consequence of eating any cheese. This, however, is not so. It is only the effect of imperfect manufacture and curing. When properly made and cured, cheese is as healthful as other human food, and can be freely used by the average citizen, and even by invalids, with impunity; and so far from having any constipating tendency, is rather a laxative.

I suppose, now, my readers are all ready to say—If the

defects in cheese, which are notoriously common, and which work loss and bad health, are due to faulty manufacture and curing, will you tell us how to make it so as to avoid the bad effects? The question is a fair one, and I will answer it. In a few points only does the manufacture need to differ from the customary mode. The first point I make is, that rennet not only coagulates the milk but it cures the cheese, and it should be used with this end in view. Enough clean and sweet rennet, prepared only by steeping in brine, or rennet extract, should be used to cure the milk and cure the cheese in the time desired, which should not be too soon. Cheese which cures too soon, perishes early, and soon develops bad flavour.

Assuming that the milk is of good average quality and in fair condition, the customary temperature of the milk for applying rennet, and the modes of cutting, heating, and stirring curd, need not necessarily be changed. They are usually done well enough by most workmen. No essential point is made in respect to any of these operations, but the time for taking the curd out of the whey is made an important point. It must be taken out before the whey becomes perceptibly sour. This, as already explained, is done, first, to prevent the mineral matter of the curd from being dissolved out of it and carried off in the whey; second, to prevent the acid in the whey from cutting and carrying off the oily fats of the milk from which nutty flavour in the cured cheese is derived. These are important items in securing easy digestibility, fine flavour, and wholesome quality. They are also essential to the best keeping quality and to richness. The injury done to cheese by permitting curd to be retained in the whey after it becomes sour, is in proportion to the intensity of the acid and the time it is so retained. If taken from the whey at the first appearance of sensible acidity, but little harm will be done and a very good cheese may result. Cheese-makers often adopt this method with very good effect, but a fancier cheese can be made by drawing the whey a little sooner. The whey, however, should not be drawn too soon. If drawn when the curd is too soft, it will pack together in a soggy mass, from which the whey cannot properly escape. The whey so retained will do severe injury to the curd, and also cause a loss from an abundance of white whey.

The best time for drawing the whey is just before acidity is likely to appear, or it may be drawn at any time when the curd has become firm enough so that it can, by brisk stirring, be kept fine so as to give the whey a chance to drain away quickly and thoroughly. A thorough disposal of the whey as it separates is essential. It requires lively stirring for a while, but in a short time the curd will begin to grow harder, and soon it will only require stirring at intervals, which may be longer as time advances. The stirring should be enough to keep the curd fine, and should be continued for three hours or more, and kept warm, or in the vicinity of 90°, till the curd begins to grow tender and to smell and taste like cheese when scorched on a hot iron. The cheese-maker may apply the hot iron test if he likes. This thorough and protracted airing in a fine and warm state is the third essential point I insist on in cheese-making. It is important to keep the curd warm to give activity to the rennet and the proper expulsion of whey, and it is important to keep the curd fine that the free oxygen of the air may advance the changes necessary to the development of the best cheese flavour, and for removing foreign odours from the curd. Thoroughly airing the curd while fine and warm will remove all the animal odours of milk, and the strong odours and flavours occasioned by cows eating strong-scented and strong-flavoured weeds. The airing will not remove everything, but it will nearly everything in the line of bad odours, except such as originate from putrefying rennet or other positive nastiness. It is proper here to caution the cheese-maker that airing will make but a very partial removal of bad odours if the curd is permitted to remain in the whey till it becomes distinctly sour. It must be drawn sweet to make the work effectual. Neither will they be effectually removed from curd when it is too cold.

When the curd has been properly matured and freed from odours, it may be cooled and salted and put to press in the usual way, and a fine, solid, rich, wholesome, and durable cheese will result whenever the work is well done. This is one method of treating curds after drawing sweet.

There is another way of handling curds, after they are out of the whey, when it has been drawn sweet, which will produce the same results, and by following which the

average cheese-maker is more uniformly successful than by continuous stirring, because there is less left to his judgment. As soon as the whey is off and the vat is tipped, the curd is dipped into a sink and briskly stirred for ten or fifteen minutes till the whey is well drained out of it. It is then allowed to pack till it is well formed into a solid mass, when it is cut into pieces convenient to handling, and turned occasionally to give the whey a better chance to escape, and to keep all parts of it warm alike. This treatment is continued for about an hour and a-half, or until pin-holes from the development of gas begin to appear, which should be the limit of packing. The curd is then put through a curd mill. After the grinding is done, the curd is kept warm and stirred enough to prevent the pieces from adhering, and in this way the airing is continued for two hours or more, till the curd begins to grow tender and cheesy flavour to develop, and foreign odours, if any, have disappeared—or until, when applied to a hot iron, it will spin out in long, fine threads. This process is an easy and safe one to follow. A man of ordinary intelligence, if he desires to do well, and his head is not set by prejudice, seldom goes far out of the way in attempting to follow it. It is this process which I have had the satisfaction of introducing into Canada, and which has been making a very happy change in the quality of Canadian cheese. Improvement during the last three seasons has been very marked. Three experts (pupils of the author) were employed as instructors in Eastern Ontario—two by the Government and one by a combination of factories—all teaching essentially the same process. They have been eminently successful, and have given the cheese of Canada an impetus which has brought it up to a position fully abreast of the cheese in the States, and I think a little above. This is a great change, and the continuance of the same or similar instructors another year will make a still further advance.

It is a gratifying feature in the cheese-making of the States that it is gradually tending towards the same process. Though a great many cheese-makers in the States have adopted the plan of drawing the whey when entirely sweet and giving the curd a long airing, as above described, the great majority of them still follow the acid process and keep their curds in the whey till they sour, and then, when

the whey is drawn, salt as soon as well drained, and put them at once to press, and think they must do so to make a cheese sufficiently compact and firm; but the discussion upon the ill effect of acid process has led most of them to suspect that they were developing a deeper acid than was necessary, and they have been gradually letting up on it, and to the extent they have done so there has been an improvement in their cheese.

CHAPTER XVI.

CONDITION OF FOOD FOR BOVINE DIGESTION.

THE condition in which food is offered to dairy stock is sometimes a matter of no little importance. This remark will indeed apply to all stock, but from the peculiar construction of their digestive apparatus, it often has a special significance with respect to ruminants. The digestive apparatus of ruminants is peculiar, and food is handled by it in a different way from what it is in the stomachs of non-ruminants, and for that reason ruminants may be affected by the condition of food where non-ruminants would not be. A brief statement of the bovine stomach will help the reader to understand how it acts upon the food received, and how food affects it.

The cow and other ruminants have a compound stomach containing four apartments. When coarse food, like grass, is eaten, it is only partially masticated at first, and, upon being swallowed, it is passed into the first stomach or paunch. This is the largest division, and is about equal to the other three. It serves as a receptacle to hold the coarse half-ground food till the animal has leisure to re-masticate. From the first stomach, it is gradually worked into the second, which is only an appendage of the first, lying close to the œsophagus, and separated from the main part of the paunch by a partial diaphragm in the inside of the paunch that reaches in only a little way, and makes only a

partial separation between the two divisions. From the outside appearance one would hardly suspect the second stomach to be a distinct division of the first. In the second division the food is rolled into pellets, and by a spasmodic motion thrown back to the mouth. When re-masticated, instead of going into the first stomach, as it did at first, it now goes into the third, or manifold, as it is sometimes called. This is a nearly round body attached to the branching termination of the œsophagus. It passes directly from the third into the fourth stomach, and the work of digestion is so far advanced that the labour of this division is quickly and perfectly performed. The fourth stomach is designed to receive food only in the plastic condition it assumes in passing through the other three divisions, with the added influence of re-mastication. It is not calculated to take in, like the first stomach, food in a coarse, fibrous state, unfermented, unsoftened, and unprepared by the partial digestion of the other divisions. The food of the entire bovine race, when taken in its natural condition as grown in the forest or the field, always takes the course here described. The lower end of the meat-pipe branches out at its connection with the stomach, so that it can communicate with any of the first three divisions; and to aid and ensure the passage of the partially masticated food into the proper receptacle, the termination of the meat-pipe at its connection with the first stomach is lined with papillæ, bent like card teeth, the action of which helps to work the coarse food along to the place it should go. In their domesticated state, cattle do not always take their food in the coarse condition in which their digestive apparatus indicates it was designed to be received. It is desirable to feed them on grain and other feed that is pulverised even finer than their re-mastication would make it. In this condition the papillæ cannot grasp it to haul it along into the rumen, and through a passage way between the ends of the folds in the third stomach it passes directly into the fourth. Perhaps the will of the animal may have something to do with the direction the food takes. But certain it is that very fine food, like corn-meal, when fed alone, goes directly into the fourth stomach, missing the other three, and the preparation for digestion they were calculated to give it. This I have repeatedly demonstrated, as any one else may

do, by feeding meal to animals that were to be slaughtered immediately, and searching for it as soon as the stomach could be reached.

There may be some exceptions to this rule, as seems to have been recently demonstrated. First, when the stomach is entirely empty, meal, when fed alone, may either voluntarily or involuntarily go into the first stomach. L. W. Miller, of Stockton, N.Y., after feeding on an exclusive meal diet for a week, found the meal, apparently a mixture of each feeding, in the first and fourth stomachs, but the great bulk of it in the first. Second, A. W. Cheever, of the *New England Farmer*, fed a beef cow with meal just before slaughtering, and found the meal all snugly stowed in the first stomach or paunch, where only coarse food usually goes. Others report finding meal divided when taken alone, a part of it going into the first and a part disappearing in the third division. In 1858-59, the author made a dozen or more experiments in feeding meal and other food with various degrees of fineness, just before slaughtering, and in every instance found the fine food in the fourth stomach and the coarse food in the first. In some instances where food having different degrees of fineness was swallowed together, a separation was made, the coarse going into the first and the fine passing on to the fourth. For instance, when corn in the ear was fed to yearlings, the pieces of cob and corn, down to a certain degree of fineness, dropped into the paunch, while the finer masticated part went on into the fourth. When an ear of corn was wrapped with a wisp of green hay, so that the hay and corn were ground together, the meal finely masticated adhered to the hay, and all went into the paunch together. Feeding corn in the ear worked differently with cattle of different ages. When fed to cows ten or twelve years old nearly all the corn passed directly to the fourth stomach, only the whole kernels and large fragments stopping in the first, and often whole grains passed by the first and lodged in the fourth. In yearlings and two-year-olds, a much finer grade of mastication was caught in the rumen, so that the corn was most of it lodged there.

About 1862, Prof. E. W. Stewart, of Lake View, without any knowledge of the experiments just related, for they had not then been published, made some eight experiments in a similar way, using various kinds of fine food, with

similar results, the fine food in every case going to the fourth stomach, and showing that, as a general rule, fine food is not deposited in the rumen when fed alone. How numerous the exceptions are must be determined by further observations, and also what causes the exceptions; whether they are controlled by the will of the cow, or whether in individual cases the structure of the digestive apparatus, by reason of domestication, varies so that, without any special effort of the animal, fine food in one case passes by the rumen and in another drops into it. And equally undetermined is the way in which fine food passes the third stomach, whether the manifolds fail to take up food comminuted to a certain degree, or whether by an effort of the will it passes through between the folds, while their action is suspended. The structure of the third division of the ruminants is so constructed that it would not, from inspection, seem probable that anything would be carried directly through it, but certain it is that food does, in certain cases, go direct from the mouth to the true or fourth stomach.

The ruminant stomach is a complex organ, and its action is so complicated as to be difficult to trace with exactness, so that its ways are not well known, and hence it is sometimes found doing what we would little suspect.

From the peculiar structure of their stomachs the ruminants' mode of feeding is generally different from that of other animals. The non-ruminant herbivora take their food slowly and grind it well, because they can do nothing further to aid digestion after it is swallowed. The horse, for instance, requires an hour to masticate properly five pounds of hay. A cow will eat the same in less than half the time, and with fewer strokes of the jaw. This is characteristic of ruminants generally.

They partially grind or crush their food and swallow it into a receptacle suited to such food, but which could be dispensed with if the food was all fine when swallowed, and hence the inference that it is neither absolutely necessary nor natural for food already fine to go there. The coarse food to which this receptacle points as the kind on which the cow was intended to live, is more difficult of digestion than food more concentrated and minutely divided, hence special provision is made for reducing such food. From

the membranes forming the receptacle into which it is first received, is poured a fluid slightly acid, and charged with a yeast which produces a gentle fermentation, which is the beginning of digestion. By an unequal but regular contraction and relaxation of fibres in the muscular walls of the reservoir, the whole mass is stirred up, kept in motion, mixed, warmed, softened, and prepared in the best possible manner for easy, rapid, and perfect mastication. In this condition, with digestion begun, it goes back through the second stomach to the mouth to finish the comminution begun when first swallowed. This done, it goes back into the stomach, but this time it goes into another division (third stomach) filled with pendant folds, between which it is rubbed and triturated and pressed till much of the aliment is separated, and the whole so changed that when it passes hence to the fourth or true stomach, the work of stomach digestion is much more easily and perfectly completed than it would be had not this preparation been made by the other parts of the digestive apparatus.

While this compound arrangement of stomachs enhances the power of digestion as a whole, it is probable, from certain physiological reasons, that the fourth stomach is not, when acting alone, as powerful as the single stomach of the non-ruminants, of which it is a proper representation. Though the appendages to the fourth or true stomach were evidently designed for coarse and not for fine food like meal, yet they can be made available for facilitating and perfecting the digestion of finely ground food. It has been already remarked that when meal alone is fed to cows it goes, as a rule, directly to the fourth stomach. To prevent this and ensure its passage into the rumen, wet the coarse food, whether cut or long, and mix the meal with it. It is better to cut the fodder, but it may be used long. By adhering to the wet fodder it is carried along with it into the rumen. The feed for this purpose should be ground as fine as possible.

When it is desired to feed largely with ground feed there is quite an advantage in feeding in this way. The meal digests the easier for the preparation it has received in the rumen, and consequently more can be digested in a given time. In feeding cows for milk it is desirable to induce the largest digestion possible, as the more food used the more

milk. There is a limit to profitable meal feeding, and this limit is readily determined by the effect upon the health. When more is fed than can be digested, the indigested meal will produce scouring, but so long as it is perfectly digested no such result will occur. A short trial will show that more ground feed can be given without producing scouring, by mixing the feed with some coarse fodder, than when it is fed alone. If the quantity of fine food to be fed is small, the difference will not be very marked. A good way to feed meal is to mix it with sliced or pulped roots. Such has been the author's experience in meal feeding.

The same reasons which have just been used apply to cooking food to hasten digestion. All food which digests slowly or imperfectly is benefited by being cooked or steamed. More food will be consumed in a given time and more nutriment obtained, and hence the more milk, or the more flesh and fat, will come from it.

Rapid and perfect digestion are all-important in feeding cows in milk. No animal can fatten rapidly or give much milk on food which the stomach has to labour with long and hard. To illustrate: straw and roots are quite similar in the proportions of their nutriment, but a pound of straw contains more than twice as much as a pound of roots. A cow can barely digest straw enough to keep the wheels of life going at a slow rate. She could neither fatten if she was dry, nor give milk without growing poor. But because she can digest ten times as many pounds of roots as she can straw, she can consume enough to support herself and have a surplus left for producing fat or milk.

Unless it is cooked it does not pay to feed straw, or other late-cut feed, to cows in milk, because they cannot consume enough of it to allow of any profit, and the slow and imperfect manner in which common hay digests is an objection to using it to the extent many dairymen do as the main food for the dairy. It is often a boast that cows have all the hay they can eat, but it is a boast which does not speak well for the largest returns. Hay will not allow of the best results in milk production. Dried grass will do very well; but common hay would require an amount burthensome for a cow to carry, an amount beyond the capacity of her stomach, to yield the material for a good flow of milk without drawing on her store of flesh to pro-

duce it. The more I study the food of milch cows, the more am I inclined to limit the quantity of hay to the smallest amount which will afford a comfortable distention of the stomach, and make up the rest of the ration with food richer and more rapidly digested. It is the best way to get large and paying returns.

Green and succulent food is best for milch cows, but the succulence of food should not be in excess. Food containing more than about 70 per cent. of water will produce more milk by evaporating the water in excess of that quantity. Green fodder corn, for instance, which contains from 80 to 85 per cent. of water, will produce more milk by evaporating 10 to 15 per cent. of its moisture. Another item to regard in the selection of food for milk production is, that the digestible elements of the food should contain flesh-forming and respiratory matter in the same relative proportions, or as near as may be, as they exist in milk. If there is an excess of either, it will be fed at a loss; if a deficiency of either, the quantity will diminish. When proper proportions do not exist they may be regulated by mixing different feeds. Thus fodder corn has an excess of respiratory matter; clover of flesh-forming: by mixing the two both are fed more profitably. In grasses these elements are pretty well balanced; so they are in wheat and rye, bran and various other foods. So far as milk is concerned, an excess of albuminoids occasions less loss than an excess of starch, sugar, and fat, and a deficiency of albuminoids will also occasion the greater loss. The quantity of milk varies pretty nearly with the supply of flesh-producing food when other circumstances are equal.

Water is an important article in the diet of any kind of stock. If possible, it is more so with dairy stock than with any other kind. It constitutes not only about 70 per cent. of the weight of the entire body, but 87 per cent. of the milk secretions. To supply so large an amount of water to the constantly wasting tissues and for the composition of milk, requires free access to it in abundance, at all times, or at comparatively short intervals. In the pasture it is not enough that there is a sluggish pond or a ditch of brackish water, nor that a supply may be had if the animal travels a long distance to reach it. The quality of the water affects the

health of the cow and the wholesomeness of her milk secretions. Many impurities will at once show their presence, in the diseased condition of the cow and in the deteriorated quality of her flow of milk. There are many organic germs, that enter into the circulation of the blood from bad water and appear in the milk secretions, ready to propagate their kind whenever the conditions are favourable. Whoever partakes of the milk introduces these germs into his or her system, where the conditions may be favourable for their growth, and their multiplication may produce disease of a more or less positive form, often resulting in severe if not fatal fevers. These same germs have a similar effect in the system of the cow. So it is important, not only that the supply of water should be abundant, but that it should be pure—that is, as pure as clean spring or brook water, and fit for the use of man as well as of beast. And the accessibility of water is of no small degree of importance. Cattle will travel long distances to get it before they will die of thirst, but they will often delay the journey and get excessively thirsty before performing it; in consequence, when they reach the water they injure themselves by an excessive draught, drinking until they feel not only uncomfortable but actually suffer for some time from a slow fever. This will always happen where the water is not only at the back end of the pasture, but at the back end of a large piece of woods which contains little for them to eat, and through which and back again they must make a special journey every time they drink. If the water is bad when they do reach it, then the injurious effects are doubly aggravated. In winter cattle do not suffer so much from thirst, but they need to drink scarcely less if they are kept exclusively on dry feed. The purity of the water is also a matter of importance in winter, and it should not only be abundant but easily accessible, for cattle will get very thirsty before they will go a long distance on a cold, stormy, or windy day to get drink. Provision should be made for the weaker animals—that is, the conveniences for getting water should be such that the weaker animals will not be kept long waiting and possibly deprived altogether of drink. On a severe day they will soon give up in despair and return to the stable, even though very thirsty, without drinking. Such an occurrence should be

carefully guarded against. If they are long kept waiting they get badly chilled, and if the water they drink is ice-cold, the shock to the system is severe, and either makes them sick or costs an extra amount of food to supply the consumption of tissue in heating up. Cows giving milk, if thus chilled, will shrink largely in their yield; indeed, even a slight chill, such as caused by leaving the stable and going to a trough in the barnyard to drink, has been observed to make a sensible shrinkage in the mess of milk. It will pay, both in the increased comfort and health of the cow, and in the lessened consumption of food and augmented flow of milk, to make provision for watering milch cows in winter without chilling them, and if the water which they drink can be tempered to 60 or 70 degrees, it will be an advantage. Of course every dairyman must be governed by circumstances in regard to water, as in other matters, but if he cannot provide all the best facilities and conditions for watering his stock, his aim should be to approximate them as nearly as possible by every reasonable care and expense of time and money. Often only a little foresight and energy is all that will be needed to provide every requisite.

CHAPTER XVII.

DAIRYMAN'S TEN COMMANDMENTS.

THE following, whether they were written by some modern Moses, and engraved on tablets of stone on Mount Sinai or not, we do not know, but we do know that they ought to be engraved in letters of gold in the memory and mind of every dairyman in this broad land. I have been repeatedly urged to draw up a set of rules for the observance of the patrons of cheese-factories. I have preferred, like Moses, to give my inspiration in the form of a Decalogue, without the observance of which no patron need hope to make the land flow with milk and money:—

1. Thou shalt not abuse or worry thy cow—thou nor thy man-servant, nor thy maid-servant, nor thy dog, nor the mischievous boy who driveth her up, but thou shalt at all times treat her with gentleness, and allow no one to molest or make her afraid; for in the day that thou vexeth her or suffer her to be vexed there shall come a pestilence upon her, and it shall enter into her milk, and taint thy butter and thy cheese, so that it shall become a stench in the nostrils of the buyer, and he shall turn away from thee with contempt.

2. Thou shalt not starve or stint thy cow for food, nor give her poor, unnutritious, or unwholesome feed of any kind whatsoever, but an abundance of that which is palatable and good for her system, that she may keep in good flesh, have a smooth coat, and a clear eye; for I have given her unto thee as an inheritance and a blessing, and a woe shall come upon him who offendeth against her, for his bank account shall wither away and become as nought, and he shall be a bankrupt in the land.

3. The water that thy cow drinketh shall be pure water—water that bubbleth up in the crystal fountain or runneth in the brook or the swift river, or that which is drawn from the deep well; for if thou by sloth compel her to quench her thirst at mud-holes and stagnant pools, there shall a day overtake thee when thy goods shall be refused at the

hands of the market-man, and he shall set his mark upon thee, and will have no further dealings with thee.

4. Thou shalt give thy cows ample shade in summer and a warm shelter in the winter ; and the latter shall be kept clean and sweet, and be withal well ventilated ; and thy cow shall have room for freedom of motion, a clean bed to lie on, and opportunity for such out-door exercise as she may desire, to the end that her blood shall freely circulate, that her muscles shall not deteriorate and become weak or stiffened, and that her digestion and appetite shall remain good.

5. When thou milketh her thou shalt lead her apart into a cool, quiet place, where there is nought to disturb her or make her afraid ; and while she cheweth her cud thou shalt milk her after a fashion of cleanliness ; thou shalt not sell or offer to sell as food for man her milk if she hath a calf of an age less than four days, or if she be struck with any plague like unto horn distemper, or fever, or gorget, or any other disease, lest the magistrate summon thee to appear and answer before him.

6. Thou shalt be clean, for, lo ! it standeth as an everlasting truth that cleanliness is next to godliness ; and if thou keep thy byres clean and thy milking vessels thoroughly washed and scalded, and everything about thee neat and clean, it shall become a mark of distinction unto thee, and thou shalt be favoured before thy brethren, and shall increase in possessions and honour.

7. Thou shalt cool and air thy milk as soon as drawn from the cow, by using the best appliances at thy command—not by putting cold water or ice into it, for that would be a violation of both the law and the commandments—but by bringing thy milk in contact with a cool surface above the freezing point, and exposing thy milk in thin sheets to a clean atmosphere, that it may become charged with oxygen, which has a wonderful virtue to prevent souring and tainting. It is shrewdly suspected by some of the prophets that airing milk is of more value than cooling it, and experience showeth that stirring with a dipper has a preservative effect. Thou shalt confine thy milk in a covered can as short a time as possible, and protect it from the rays of the sun and the hot atmosphere.

8. Thou shalt not water thy milk by mixing with it the contents of the spring, the well, the cistern, the brook, the

watering trough, or other source of water supply; nor by feeding thy cow villanous slops, whey, or extremely succulent food, whereby the contents of thy milk-can shall be increased in quantity at the expense of quality, with the view of cheating thy neighbour; for thou wilt thereby be cheating thine own soul and stand in constant danger of the penalty of the law.

9. Thou shalt not skim thy milk by taking off the cream that riseth in the can over night, that thou mayest have a little cream for coffee; nor by setting it in pans or other utensils over night; nor by saving strippings, nor by any other process—for if thine own sense of honesty does not restrain thee, thou shouldst constantly have the fear of the law and of the watchful eyes of thy neighbours before thee. It is better to save out a small mess of milk for thine own use.

10. Thou shalt not commit adultery by adulterating thy milk with burnt sugar, chalk, salt, soda, or any ingredient or compound whatsoever; nor by giving vile stuffs to thy cow; nor by any means, trick, device, or process, known or unknown to be naturally depraved. The laws of the country, the health of the community, and the lives of the people, especially of the hosts of little ones who are likened unto the kingdom of heaven, cry out against this unpardonable sin.

Under the new dispensation, I add the eleventh commandment:

11. Thou shalt love thy neighbour as thyself, and keep thy Sunday's milk at home for the purpose of making sweet butter for the use of thy family, and that the cheese-maker and all who labour with him in the factory may rest, and worship according to the dictates of conscience, on every Sunday. Thereby shalt thou meet the requirements of the Scriptures and of the laws of the country, and prolong the lives and improve the morals of a large and constantly increasing class of useful citizens.

By faithfully observing these commandments, the dairyman shall keep a clear conscience, avoid annoying and expensive prosecutions, retain the respect of his neighbours, secure a competency of this world's goods, live a peaceful life, and in his old age "approach the bed of death like one who wraps the drapery of his couch about him and lies down to pleasant dreams."

CHAPTER XVIII.

THE AUTHOR'S THIRD ANNUAL REPORT OF INSTRUCTION FOR CHEESE-FACTORIES IN CANADA.

Read at the Convention, London, Ontario.

To the President and Directors of the Dairymen's Association of
Western Ontario :

GENTLEMEN,—In the month of March, 1883, I was engaged by the President of this Association to act as your Cheese Instructor for the season. With the assistance of Providence I have been able to discharge my duty thus far, and will now proceed to give you an account of my stewardship. I commenced my engagement on the first day of May and closed the third of October. The number of factories I visited, and the time and order in which they were visited, may be seen by an examination of the following schedule :—

OXFORD COUNTY.

May	1.....	Wilkinson's Factory.	
"	2.....	Salford	"
"	3.....	Pransen's	"
"	4.....	Newark	"
"	5.....	Dearham	"
"	7.....	West Oxford, John Wilkin-	
		son's, Verschoyle, Culloden, and Brownsville Factory.	
"	8.....	Bayham	"
"	9.....	Campbelltown	"
"	10.....	Springford	"
"	11.....	Summerville	"
"	12.....	Farrington's	"
"	14.....	Burnside	"
"	16.....	John Wilkinson's	"
"	17.....	Gore	"
"	18.....	Avon	"
"	19.....	Harrietsville	"

MIDDLESEX COUNTY.

May	21.....	Nilestown Factory.	
"	23.....	Gladstone	"

ELGIN COUNTY.

May 24.....	Lyon's	Factory.
" 25.....	Northwood	"
" 26.....	Springfield	"
" 29.....	Galloway	"
" 30.....	Mattheson's	"

BRANT COUNTY.

June 1.....	New Durham	Factory.
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MIDDLESEX COUNTY.

June 4.....	Kerrwood	Factory.
" 5.....	Napier	"
" 6.....	Brook	"
" 7.....	Alvinston	"
" 8.....	Beckett	"

PERTH COUNTY.

June 9.....	James Peckart's	Factory.
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ELGIN COUNTY.

June 11.....	Mapleton	Factory.
" 12.....	Sparta	"

MIDDLESEX COUNTY.

June 14.....	Mount Carmel	Factory.
" 15.....	Karadock	"
" 16.....	Muncey	"
" 18.....	Mud Creek	"
" 19.....	Victory	"
" 20.....	Sifton's	"
" 21.....	Appin	"
" 22.....	Eckford	"
" 23.....	Glencoe	"
" 25.....	Silvercreek	"
" 26.....	Wilson's	"

LAMINGTON COUNTY.

June 27.....	Maple Grove	Factory.
" 28.....	Utoxeter	"
" 29.....	Symington and Wyoming	"

PERTH COUNTY.

July 2.....	Black Creek	Factory.
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SIMCOE COUNTY.

July 5.....	Rockford	Factory.
" 6.....	Villa Nova	"

MIDDLESEX COUNTY.

July 9.....	Dorchester	Factory.
" 10.....	Nilestown	"
" 11.....	Nilestown	"

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July 13.....	Watford	Factory.
" 14.....	Brook	"
" 16.....	Warwick	"

LAMPTON COUNTY.

July 17.....	Cole's	Factory.
" 18.....	Collinsville	"
" 19.....	Vyner	"
" 20.....	McAdam	"

PERTH COUNTY.

July 23.....	Kesterville	Factory.
" 24.....	Downey	"
" 25.....	Melvton	"
" 26.....	Honey Grove	"

WATERLOO COUNTY.

July 27.....	Philipsburg	Factory.
" 28.....	Oak Grove	"

PERTH COUNTY.

July 30.....	Harrington	Factory.
" 31.....	Brooksdale	"

HURON COUNTY.

Aug. 1.....	Rogerville	Factory.
" 2.....	Brucefield	"
" 3.....	Winthrope	"
" 4.....	Walton	"

PERTH COUNTY.

Aug. 6.....	German Union	Factory.
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OXFORD COUNTY.

Aug. 7.....	Bright	Factory.
" 8.....	East and West Oxford	"
" 9.....	Marton	"
" 10.....	East Zora and Blanford	"

PERTH COUNTY.

Aug. 13.....	St. Mary's Union	Factory.
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MIDDLESEX COUNTY.

Aug. 14.....	Devise's	Factory.
" 15.....	Bryanston	"
" 16.....	Geary	"
" 17.....	North Branch	"
" 20.....	Proof Lime	"

KENT COUNTY.

Aug. 21.....	Thamesville	Factory.
" 22.....	Botney	"
" 23.....	Buller's	"

Aug. 24.....	Blenheim Factory.
„ 25.....	Poak's „
„ 28.....	Crinan „

MIDDLESEX COUNTY.

Sept. 4.....	Dorchester Factory.
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GRAY COUNTY.

Sept. 6, 7, and 8.....	Dunkeld Factory.
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PERTH COUNTY.

Sept. 10.....	Elma Factory.
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WELLINGTON COUNTY.

Sept. 11.....	Rothsey Factory.
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PERTH COUNTY.

Sept. 12.....	Carthage	Factory.
„ 13.....	Third Line Wallace	„

WELLINGTON COUNTY.

Sept. 14.....	Wyandott Factory.
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Re-visited the following factories :

- Sept. 21.—Galloway's, Wilkinson's, Salford, Pransen's, Campbelltown, Springford, and Summerville.
 Sept. 22.—Farrington's, Newark, Mt. Elgin, Verschoyle, Culloden, Brownsville, and Beheam and Springfield.
 Sept. 24.—Northwood, Lyons, Harrietsville, Gladstone, and Burnside.
 Sept. 25.—John Wilkinson's, Gore, and Avon.
 Sept. 26.—East and West Oxford.
 Sept. 28.—Philipsburg, Oak Grove, and German Union.
 Oct. 1.—Muncey.
 Oct. 2.—Victory, Warwick, Utoxeter, and Maple Grove.
 Oct. 3.—Wilson's.

The territory over which I travelled embraces thirteen counties of what is probably the best farming country in the Dominion of Canada. I found the factories I visited in a fair condition, so far as buildings are concerned, averaging, I believe, much better than a similar number visited by me in Eastern Ontario, while acting as instructor under the auspices of that Association.

In climate and physical features the country over which I travelled is, as a whole, well calculated for dairying and other agricultural purposes, and I found the people intelligent, industrious, and hospitable. With one or two ex-

ceptions I was pleasantly received, and it gives me pleasure to announce generally able to discharge my duty with success.

Three years' experience as instructor in Eastern Ontario had served to convince me that a system of milk inspection was a thing quite as much needed in the cheese business of that section as general instruction in making, and so, acting upon that knowledge, I assumed the character of general milk inspector for my district, and from the beginning to the close of my labours never failed to arrive in season at a factory to give the milk upon its arrival a thorough examination. For this purpose I procured, before beginning my circuit, a German pioskop, by the aid of which I was able to tell with unerring certainty the quality of the milk brought in. This, of course, was a work of supererogation on my part, and yet I feel that I am well paid for the extra labour it cost me for two reasons—one of them being the fact that when once it became raised abroad that I was inspecting the milk the effect was the subject of general remarks among buyers as well as makers; and second, the confirmation of a previously-formed opinion of the beneficial results arising from such a system. And before I go farther I shall venture to offer as a suggestion to your honourable body, that if it is your purpose to continue in the future your present system of instruction, that you couple with it a system of milk inspection, and that you clothe your instructor with authority and invest him with the dignity of your sanction, in order that he may the more effectually discharge this portion of his duties. It would be a work of too much time, and require too much space, for me to give in detail an account of the numerous instances in which milk inspection, during the past season, manifested its power for good. Let one or two suffice. A certain factory in my circuit had fallen into a condition of things quite deplorable and ruinous, not only to the maker, but to the patrons as well. On visiting that factory in the month of June I found about fifty per cent. of the milk wanting cream, and informed the maker of the fact. It is quite probable that this had been the case for a long time previous, as I judged from the cheese which lay upon his shelves, and yet when I explained to him the condition of his milk he was

evidently astonished, and his manner indicated to me clearly a total ignorance of the difficulty under which he was labouring. Within a few hours the news had gone abroad that the Inspector had been at the factory, and that Tom, Dick, and Harry's milk was short in cream. The report created quite a sensation among the delinquents, as it is the wounded birds that always flutter, and upon visiting the factory in September I found the cheese improved fifty per cent., and the maker in much better spirits than when I first met him. From the beginning of the season until the day of my visit his cheese had been a drug in the market, and could hardly be sold at any price; subsequently he had no difficulty in selling at the highest market price.

One morning while busily engaged in the examination of a load of milk, I came to a mess which the indication showed was wanting cream. "Whose milk is this?" said I to the maker. He gave me the name, which I entered on the factory milk-book with the word "poor" opposite. "This is the man," continued the maker, when I had finished the entry, pointing to the man on the waggon. "What is the difficulty with your milk?" I asked. "Nothing," he replied; "it is just as it came from the cow." "That cannot be," said I; "no cow ever gave such milk. Do you bring all the milk your cows give?" "Indeed," said he, "my wife and girl milk the cows and we send that to the factory, and then they milk them again and we keep that." "Just so," said I; "you keep the strippings, and that is what's the matter with your milk." And thereupon I invited him into the factory and read to him the law of this Province upon the subject of milk stripping and adulteration, assented to March 4th, 1868, and warned him to be careful in the future. I learned afterward that the cheese-maker had no further cause of complaint from him.

In the month of July I visited a large factory at which the milk of 150 or more patrons was received, and upon inspecting the milk I found no great occasion for complaint, except in three instances—these the tester indicated as poor. At the request of the maker I addressed these three patrons each a note, in which I informed them of the condition of their milk, and asked an explanation. The next day one of them came to the factory and informed the maker that

his wife was sick, and that her sister, who was in attendance, had skimmed the can unbeknown to him, and agreed that the circumstance should not happen again.

The force of my remarks will be perhaps more apparent to the majority of my hearers when I state that, throughout the whole course of my circuit, including, as I have previously stated, 100 factories, I found not more than three or four at which all the milk was up in quality, the balance showing anywhere from one to ten poor, and from one to fifty less fat. Such being the case, who will say that something ought not to be done to remedy this widespread evil?

In addition to the labour heretofore performed by me while acting as Cheese Instructor for the Association of Eastern Ontario, I have made it a practice the past season to write up and publish from time to time in some local papers some extracts from my journal containing criticisms upon the milk, buildings, methods, rennet, cleanliness, and products of the several factories I visited. Some of these reports were widely copied by other journals, and read and commented upon with much interest by the dairy public. My impressions are that the effect of this practice was, in the main, of much benefit to the dairying interests of the community. It is not often that we meet with persons so void of pride and ambition as not to desire to appear well when they go into print, and were it generally known by both makers and patrons that at the same time during the season the Government Inspector (as I was by many thought to be) would arrive and would lay bare to the gaze of the public all their vices and shortcomings, the effect would be a general house cleaning throughout the whole district, and only the *confirmed slovens* would be caught napping.

Although, as I have previously intimated, the buildings, so far as I have seen, are better than those of Eastern Ontario, there is, nevertheless, much room for improvement. Indeed, I found some in a condition of absolute dilapidation and ruin, buildings in which to make cheese is a right down insult to the business; standing in the make-room one's gaze was hardly obstructed in any direction, so open and broken were the walls. There are, doubtless, days in the season when cheese can be made up in such

buildings without difficulty, but when the cold, bleak winds of spring or autumn are abroad the work is complicated beyond calculation.

As a contrast to these it gives me much pleasure to state that I visited some factory buildings which, for general substantiality, style, convenience in arrangement, and every quality necessary to a model factory, cannot be surpassed in the continent of America.

THE PATRON.

The co-operative system of cheese-making under which we are now operating has some features which serve to characterise it in a general way from almost any other human occupation. The character of the people who engage in it is, of course, as diversified as that of those of any other of the walks of life, but the realisations of dairy-men and makers are peculiarly intimate and should be characterised by perfect harmony and confidence, while the condition of the cheese market is such as to bind together the entire industry of the continent into one indissoluble community, within which all the interests are in common and all the relations mutual and dependent. To one engaged in the business of cheese instruction this fact is peculiarly apparent, and he naturally falls into the habit of viewing affairs from a general standpoint, and of aggregating all its peculiar features brought to his attention in the course of his business, and in this way he is able to form pretty just conclusions of the business as a whole. To-day he is surrounded by circumstances singularly down at the heel and out of joint. To-morrow everything is in apple-pie order, and the business appears to its very best advantage. In neither case, taken alone, is he able to form a true picture of the whole industry, and it is only by comparing his experience of yesterday with that of to-day that he is able to reach a just conclusion. To a man of despondent temperament the effect of this is, upon the whole, gloomy and in some degree hopeless; but to one naturally inclined to take a cheerful view of life there is much that is cheering and hope-inspiring in my experience of the last season. One circumstance in particular I remember inspired me with new confidence in the ultimate success of our business. I came one day, in the course of

my wanderings, to a factory which, in all its surroundings, came as near my idea of a model as any I have ever seen.

The physical features of the farms around this factory are not better than around many others in this favoured section of Canada, and in natural advantages it has nothing to boast when compared with other factories in its neighbourhood. Moreover, the factory buildings are not as good as many others I visited, but aside from these particulars it is difficult to mention a circumstance connected with it wherein one ordinarily up in cheese matters would be able to suggest improvement. In the first place, the patrons from A to Z are thoroughly educated in every point connected with the production of milk for factory purposes, and in not one instance among 150 patrons, producing in the aggregate in the month of July 27,000 lbs. of milk, did I find a dairy wanting in quality and other characteristics; the supply was universally good. At this factory the *detestable* practice of drawing whey in milk cans is not followed.

In the second place, the cheese-maker was a thorough master of his business. In the course of my season's work I came across several fellows operating in third-class establishments who received me coolly, and manifested a disposition to take the *bit* and do as they pleased, giving me to understand by their manner that they had acquired in their estimation all the information extant on the subject of making cheese.

My friend at the factory under review was not of this class; he had evidently made the subject of cheese-making a study, and, among other things, had learned that "one small head cannot contain it all." His cheese were perfectly uniform in size, texture, colour, and flavour, and as good a lot as I ever saw. The factory has been running for seventeen years, and during that time this man has had but a single predecessor—a fact which proves conclusively to my mind the wisdom of the owner, not only in the matter of selection, but also in the policy of keeping good men as long as you can. One fact struck me with considerable force while inspecting the condition of things in and about this factory, and that was that the majority of its many excellent features were due to the sagacity, energy, and reputation of one man, viz., the owner. His

cheese always sells above the market, and this is the *lever* by which he is able to control the machinery of the business and propel it forward with *harmony* and success.

Of course we do not wish to be understood as placing this factory alone on the list of good factories out of many we visited, but would state that we saw many which rank well among the factories of this province. We have, however, selected this one as a sort of portrait to hold up for your inspection, to enable you the better to appreciate what we have said and propose to say upon this branch of our report. We have said that exhibitions of this character fill us with hope and courage as to the future of cheesemaking, and we say that when all the parts of the great whole of this magnificent industry equal or excel this, we shall have reached an attitude many degrees above our present condition, and yet not higher than we ought reasonably to expect; indeed, it seems but a step. Let us one and all adopt as our motto "*Excelsior*," and prepare to move on.

We have on many occasions publicly expressed our sentiments with reference to certain abuses, the practice of which is too common among the patrons of factories, and the existence of which is but too well known by the public generally. To point out these in detail on this occasion seems unnecessary and futile, and yet we feel that the cry against them ought to be kept up until those who practise them are frightened into a reformation.

We have often tried to settle in our minds the question to which of two causes to ascribe the evils of which we speak—is it ignorance or wilfulness? Is it possible that there can be any considerable number of dairymen in this enlightened land who have never read the utterances of the agricultural papers, pamphlets, association reports, and the disquisitions of scholars, upon the subject of milk, who have not yet learned in one way or another their duty in the matter of keeping and handling it? We cannot bring ourselves to believe that such is the case. Were ignorance, however, to blame for the great bulk of objectionable milk left at factories to be made up, the remedy might be easily found and a cure speedily effected. If, however, sloth and wilfulness lie at the bottom of the difficulty, the case is not so clear, and the remedy, if there is one, must

be sought in the list of expedients which up to this time human ingenuity has left untried.

The night of the 2nd and morning of the 3rd of August last was, for the time of year, quite cool, and that morning, while inspecting the milk at a factory in Huron county, I found three messes in a condition which I regarded as wholly unfit for use. It was not sour, and the weather, as I have said, had been favourable for keeping; and yet, on surging the cover of the can up and down, it emitted an odour which to me was simply sickening, and I promptly rejected them.

The maker, who had called my attention especially to these three messes, informed me at the same time that they had been troubling him for some time. The milk was sent back to the patrons who had sent it, and the result was, as I learned a month later, he had had no further cause of complaint from them. This incident, although it does not furnish an answer to the problem we were trying to solve, yet it furnishes us with a clue to a *remedy* which, like a certain cow doctor's medicine, will cure the disease regardless of the cause, and the question is, will the time ever come when cheese-makers will have the pluck, stamina, and unanimity sufficient to enable them to present a united front against impositions of this character? The incident plainly shadows forth another fact, viz.: It was supposed by many that I was acting under constituted authority in my capacity as milk inspector, and thus it transpired that in the matter of rejecting milk by me no loss of patronage accrued to the factory. Whereas, had the maker done as he ought a long time prior to my visit, he would undoubtedly have been rewarded for his integrity and uprightness by the loss of these patrons. One other fact connected with this incident I cannot omit to relate in passing. The maker at this factory was really one of the best in the province; at his previous place he had attained an excellent reputation; but upon coming to this factory matters turned with him, and a combination of circumstances, among which bad milk and a fear of loss of patronage in case of rejecting any was not among the least, nearly stripped him of the laurels he had won. At the time of my visit he had become quite discouraged, and had even proposed to give up the

factory. The last I heard of him he was getting on finely.

DRAWING WHEY IN CANS.

Against the practice of drawing whey in the milk cans I am resolved to wage an unceasing and relentless warfare. Not because there is any harm in the simple act in itself considered, but for the reason that *in so many cases* where it is practised the parties *will* leave it standing all day in the cans, emptying it out but a short time before they are to be used again, and then, after going through with a performance which, as a washing, is a most ridiculous farce, they are re-filled and allowed to stand until the next morning. In this way dairymen do themselves incalculable harm. In the year 1882 a very extensive buyer in this part of the province purchased a car load or more of cheese at a factory, the name of which I withhold, the fine appearance and texture of which he believed would warrant him in paying the price demanded, which was above the market. The cheese were not taken at the time of purchase, but three weeks later, when the purchaser came for his goods, they had developed what is known in common parlance as a "bucky" flavour, and the purchaser was compelled to sell them at a loss of over 300 dols. It was universally agreed by the experienced cheesemen who examined this lot, that the cause of defect was clearly traceable to the practice of drawing whey in the milk cans. This was not the first loss which the same buyer had sustained from the same factory and the *same cause*, but if I am correctly informed it was the *last*. Incidents of this character might be multiplied to a surprising extent in the history of the cheese business on this *continent* to prove the folly of this pernicious practice, but to what purpose? it is only adding line to line and precept to precept, and since Adam's time there has always been some fools in the family.

CHEESE-MAKERS.

With reference to the makers with whom I have had the pleasure of meeting, allow me to say that, with very few exceptions, our intercourse has been to me of the most satisfactory character. As a rule I have found them sufficiently alive to the importance of the part they are playing on the stage of human activity; the greater part of

them seem to realise the fact that the business in which they are engaged is a progressive one, and that, in order to climb higher, any circumstance, however unimportant it may seem, tending to throw additional light upon their work, is not to be disregarded; and I have been more than once cheered and encouraged in my efforts by warm and evidently heartfelt acknowledgments on their part of (what was perhaps undeserved) benefits received from my instruction.

With such pupils the work of instruction is nothing less than a pleasure. But when we encounter, as we have on one or two occasions, the fellow who has reached the top round of the ladder and stands as it were in mid-air, having nothing farther to reach or hope for in the way of information—an Alexander in the business, as it were—the case becomes different. We have such a fellow at present in our mind's eye. We meet him in the morning and state to him our business, and immediately there appears in the corner of his left eye a twinkle which says plainer than words, "The idea that any common man can teach me anything about cheese-making!" and then he says, "Well, you may take that vat, and I will make up the balance to suit myself." Now and then during the course of our day's work he puts a question, his manner at the same time clearly indicating that he is only doing it to draw me out and see if I really do know anything about the business. At the close of the day it is, however, quite consoling to have my vat turn out pretty good, and the *balance* which he has made to suit himself in what may be mildly termed a bad way.

We have made use of this circumstance, not for the purpose of venting any ill-will toward any one, but to show forth in as strong a light as possible the narrow-minded meanness of those who are incapable of appreciating the noble and praiseworthy motive of this honourable Association in sending forth some one (however incompetent it matters not) to raise if possible our industry to a higher plain of excellence, not for selfish purposes but for the general good of the community.

RENNET.

We have not succeeded in one season in exterminating whey rennet, but we hope that our successor will carry

forward the good work we have begun, until there is not enough of that article left in the Province of Ontario to spoil a quart of sweet milk. It would seem to us that it has now accomplished its mission, and ought to be allowed to take its place in history as one of the evils of the past. Some of the makers know of surety that the business cannot be carried on without it, and so long as they live, we suppose, it will remain a source of vexation to both buyer and consumer. I met with some makers the past season, who, after having made what they claimed to be a thorough trial at making rennet extract, had given up in despair and said it was no use trying, they could not make an article that would keep. This seemed very strange to me, as I never failed; and I have in my possession a vialful made at the Springfield factory in the month of April last, which to-day is in perfect condition. This sample was a part of fifty gallons made by Mr. Joseph Dickinson, four ounces of which was sufficient to coagulate 1000 lbs. of milk. It would seem that what one man has done another may do; there is no necromancy or legerdemain in the art; perfect fidelity to the instructions I gave will invariably produce a first-class article of rennet extract.

CLEANLINESS.

Cleanliness is a virtue practised almost universally throughout the whole animal kingdom, the only exceptions we have in mind are the swine, some dairymen, and a few cheese-makers. If there is one place more than another where absolute cleanliness ought to prevail, that place is the cheese factory. The business is such that a little neglect here and there, now and then, in the matter of washing, scouring, and scalding, becomes in time a very great evil.

Filth accumulates rapidly everywhere, and the make-room very soon becomes an exceedingly filthy place. To prevent this we know of but one good rule, and that is—*keep clean.*

In the course of the season I found many factories worthy of the highest praise for the exactitude and perseverance with which they practised this virtue, and these, were it prudent, it would give me pleasure to designate by name. Indeed, there can be little reason for withholding so

poor a reward from those who are entitled to any amount of praise for the example they are furnishing to the cheese-makers, not only of this province, but of this continent.

I found others, I am sorry to say, in every particular, the exact antipodes of these. Dirt had accumulated everywhere; it glued your feet to the floor; it clouded the vats inside and out; there was the accumulation of months in the bottom of the sinks; the cloths were heavy with slime and rottenness; even the dipper refused to be laid down if once taken into the hand; and the atmosphere was laden with a family of sour, nauseating odours. Moreover, the disease was not confined to the make-room, but communicated itself, as a natural consequence, to the cheese; and when the buyer came with the market tending downward, the epidemic spread abroad and made all the patrons sick.

This picture, let me say, is in nothing exaggerated or overdrawn, and were such a state of things the rule instead of the exception, or in any degree general, we should have withheld comment; but we have said what we have, hoping that the power of the contrast may be seen and appreciated by all *whom it may concern*.

PRODUCTS.

With reference to the products made the past season under my instruction, I ought perhaps to say nothing having the appearance of self-laudation; but as it was a fact that during the months of June and July, cheese at a number of factories I had previously visited were off flavour and seriously defective in keeping qualities, and that to shirk the responsibility for this condition of things the factorymen of the factories have charged the fault upon me, I deem it a duty which I owe myself to say a word upon this subject. Upon visiting these factories in the early part of the season, when they are making cheese for immediate consumption, I had advised the use of a sufficient quantity of rennet to be used with two to two and a-quarter pounds of salt, keeping qualities at that time being only a secondary consideration; at the same time I instructed the makers that as the season advanced to diminish the rennet and increase the quantity of salt, and I supplemented my instruction by explaining to them

the nature of the balance which ought to be secured between rennet and salt when keeping qualities are desirable. As I afterwards learned, these makers, instead of following my instructions and varying the quantities of rennet and salt as the season advanced, did as they pleased, and the result was as I have already stated—their cheese were off flavour and unmarketable early in the month of August.

Farther than this, and concerning the great bulk of my work, I will add that perhaps the persons most competent to give an opinion are the buyers, and to them I submit my case without fear as to the verdict.

CLOSING.

Allow me, gentlemen, in closing this already long report, to thank you for the patience and attention you have given me. In attempting to furnish you with some idea of what I have been doing, I have deemed it prudent to speak of things in a general way, believing that such a method would be preferred by you to a more specific account in which everything of a censorial character would have to be avoided, in order not to sow seeds of discord and contention where all now is peace and harmony. I am aware that my practice of reporting to the local papers, previously alluded to, caused the factory-men and patrons to counsel with reference to me as Burns counselled concerning Captain Grose :

“Hear ! land o’ cakes, and brither Scots,
Frae Maidenkirke to John o’ Groats ;
If there’s a hole in a’ your coats,
I rede ye tent it ;
A chiel’s amang you takin’ notes,
And faith he’ll prent it.”

The practice, however, I believe, created no *serious* disturbance and was, upon the whole, productive of good. I desire, in closing, to thank *all* with whom my business has brought me in contact for their universal kindness and courtesy ; the President and officers of this Association, for the important place I have so imperfectly filled ; and last, but not least, the gentlemen of the instruction committee, Mr. Thomas Ballantyne, Mr. L. R. Richardson, and Mr. E. Caswell, for the patience and politeness with which they have treated me. I have laboured to the best

of my ability to discharge faithfully the duties of my position, and I hope to the entire satisfaction of the Dairymen's Association of Western Ontario.

In the discussion which followed the above report, the president, Thos. Ballantyne, M.P.P., said :—The results of the labours of Mr. Harris, as instructor, are very marked and decided. I know some places, where the goods were of the poorest description, that the maker was desirous he should come; and you could date from that very day the cheese were much better, and continued so till the end of the season. This was in a case where the cheese-maker felt that there was much to learn. If our funds would admit of it, it would be a good thing to employ a number of instructors, so that they could be all the time about with the factories. It would pay well. The result would in every case be of the greatest benefit. I am warm on this subject. I feel, as Chairman of that Committee who engaged Mr. Harris, that we made the arrangements and did as far as we possibly could; we made the arrangements so that those sections that had not been visited by Prof. Arnold should be visited by Mr. Harris first. The result is, some factories have since been making very fine cheese that before Mr. Harris' visit were doing very poorly. One place, the maker had had several years' experience and understood the principles of cheese-making, but was neglecting some detail, and if you succeed in making cheese you must not only know how to make cheese but attend to every detail from first to last. This party wanted Mr. Harris to come to him and I told him we would try and get him there as quickly as possible. Well, the result is that there is no finer goods made in Western Ontario. In some of these places I have paid the highest prices for their cheese, right from almost the very day after Mr. Harris had been with them. He performed his duties as satisfactorily as a person possibly could under the peculiar circumstances in which he was placed. It was no easy matter, travelling about from factory to factory, working all day and getting up early in the morning. It was no light job, but he took hold of it in a determined and energetic manner, and so far as I know, they were willing to learn. They were very much benefited by his instructions.

CHAPTER XIX.

DAIRYING IN SCOTLAND.

Address delivered before the Dairymen's Convention, Stratford, Ontario, Canada, January 16, 1885, by J. B. Harris, Antwerp, New York.

I WAS much pleased to receive from your secretary an invitation to be present on this occasion, more especially because I knew it would give me an opportunity to again meet with many old and highly valued friends in this section of the province, and because I knew that by meeting with you at this time, I should be able to learn something of the prosperity and progress made by you since your last annual meeting, and also preserve my identity with this, one of the most splendid of Canadian industries.

At the very outset I must take occasion to bestow upon you a well-deserved compliment. During the last twelve months I have learned that in cheese-making Canada leads the world, and when I say this, I do not wish the remark to pass as a mere indulgence on my part in a little meaningless hyperbole, but I wish it distinctly understood that in the great cheese markets of the world *Canada stands second to none*. On the 4th day of November last I was standing in a commission house in the city of London England, and saw two extensive dealers in cheese examine his stock with a view to purchase a large quantity.

Sample after sample of State cheese from this dealer's extensive stock were brought forward and promptly rejected. At length the proprietor caused a sample of Canadian cheese to be brought forward; this the two gentlemen carefully examined, and immediately left their order. These gentlemen evidently understood their business, at least such was my opinion, for I examined the samples with them, and the Canadian cheese were at least

two grades better than the best State I saw. Indeed, several of the leading cheesemen of Great Britain told me that, with the exception of four or five English dairies, Canadian cheese was the best in the market.

I understand that in the first nine months of 1882 you shipped to Great Britain 233,509 cwts.; in the same months in 1883, 324,418 cwts.; and in 1884, 385,482 cwts. This shows an enormous increase, which you will find, if you take the trouble to investigate the matter, you have won at the expense of your neighbours south of the lakes.

In the game which the commercial world calls competition, superiority in quality is the winning card, and this it seems you at present hold; be steadfast in your efforts to excel, and the game is yours. Wise and judicious management on the part of the Dairy Association of Eastern and Western Ontario has given the Dominion a strong lift up the steep declivity of success. Another lift, gentlemen, and like Alexander, there will be no more worlds for you to conquer.

In the fall of 1883 the dairymen of Scotland, perceiving that for some cause they were being excelled in the London market by the Canadians, began to cast about them for some means by which to keep pace with their Western competitors. As a first step toward the accomplishment of this result, they called a meeting of the dairymen of Scotland to be held at Kilmarnock, which resulted in the organisation of the Dairy Association of Scotland. This society is not yet completely organised, but the spirit of enterprise is in the hearts of the Scottish dairymen, and the impetuosity and pluck that won the field at Bannockburn is destined to characterise its future operations. They are resolved that whatever intelligence, perseverance, and money can do in the way of improvement in the manufacture of butter and cheese shall be done; and if the observations I made during my last summer's residence in that country are correct, their chances of success are excellent.

In geographical extent the cheese district of Scotland, comprising the counties of Wigtown, Kirkcudbright, Dumfries, Ayr, and a part of Argyll, is perhaps not larger than the area embraced within the limits of your four counties

of Oxford, Middlesex, Perth, and Huron, and in this small section the waste or unoccupied territory is much greater than in the Canadian counties named. Thus it will be seen that by reason of the narrowness of the dairy belt of that country, neither Canada nor the States have much to fear from their Scotch competitors in the markets of the world. And I do not understand that it is expected by the Scotch dairymen that any great accession to their boundaries is ever to be expected, and so it remains as a natural consequence that whatever impression they succeed in making upon the English market must be in the direction of quality. Although I cannot speak authoritatively, my opinion is there is more cheese produced to the square mile of Scotch dairy country than there is to the square mile in the Canadian counties above referred to. This fact, however, does not materially alter the case. Scotland, in winning her laurels, must ever look to the quality of her products, as on the score of quantity she has nothing to expect.

In climate, water, and pasturage, our Scotch brethren, it seems to me, have the advantage. In the first place, their winters are not nearly so severe as ours, and, as a consequence, less of the profits of the season are required to carry the dairy through to grass the following spring. Again, I am inclined to think that upon the whole the Scotch dairy at the commencement of the season is in better condition to perform the requirements of the summer than are ours. Our long winter, our cold and badly ventilated barns, our imperfect methods of feeding and watering, and the insufficiency of our food in quality as well as quantity, starts us off at the beginning of each season with a family of evil effects which our summers are hardly long enough to correct. The foddering period is about as long with them as it is with us, but the mildness of their climate in a great degree dispenses with that necessity for vigilance and painstaking in the care of their herds which *should* characterise every State and Canadian dairy during our long and intensely cold winters.

From the 5th of March last until the 21st of the following November, the period of my sojourn in that country, although I took no notes, it occurred to me that the temperature was less fluctuating than in Canada, and I

had a notion that on account of the close proximity of the sea in either direction there was a moisture in the atmosphere grateful to the grass and vegetation about me that you do not experience here. There occurred, however, in the month of June, quite a serious drought, which continued for three weeks, and made itself felt all over the dairy section. This, however, I was told was an unusual occurrence, and that generally the pastures were good throughout the entire season. Anybody at all familiar with the world's geography, the world's history, or the world's poetry, knows the hilly character of Scotland, for

"Auld Coila's plains an' fells,
Her moors, red brown wi' heather bells,
Her banks an' braes, her dens and dells,
Where glorious Wallace
Aft bare the gree, as story tells,
Frae Southern billies,"

have somehow succeeded in mixing themselves up with the world's affairs to a rather remarkable extent, considering the size of her territory and rather limited number of her children.

One need not peruse very far the writings of Scotland's most gifted poet to learn how her surface is interlaced with a network of silvery streams, whose limpid waters leap her rocks and plough her valleys from the Mull of Galloway to John o' Groats. These streams, fed by the snows of her mountains and the mists of the deep, are of the most lively and pure character, an item not to be overlooked in considering the physical character of a country from a dairyman's standpoint. Indeed, we believe as a general rule dairymen do not appreciate the value of pure, living water as an item in the successful management of their business.

As a rule, the Scotch dairy farm is larger than the Canadian. In the counties of Wigtown and Kirkcudbright I believe they run from two to five hundred acres; and, if my observations were correct, these farms maintain a larger number of cows than the same acreage in Canada. This is due largely to the extent to which root culture is carried on in that country. I visited farms where I saw fields of at least one hundred acres of turnips and mangels, which I was told would yield from twenty-five to forty

tons to the acre. Now, while I do not regard turnips as a very excellent food for cheese or butter purposes, I must say that as a winter food in that mild climate they do keep stock in excellent heart and health. Another reason I gave why the Scotch farmer can keep more cows on a given territory than we do, is the amount he expends annually in manures. I have known farmers to expend as high as £4 per acre for artificial manures; these facts, together with the other fact already mentioned, viz., the mildness of the Scotch winters, enable him to excel us in the size of his dairies.

BUILDINGS.

With reference to dairy buildings I must say, for warmth and general substantialness of structure, they appeared to me almost ludicrously out of proportion to the requirements of the climate, and, while looking them over, I was often constrained to exclaim, What a pity that such buildings are not universal with the dairy farmers of Canada, where the need for them is so much greater! Substantial stone structures with slate roofs, built not to subserve the needs of a few fleeting years but to resist the storms of centuries, universally characterise the dairy farms of that thorough-going country.

With reference to the general plan and use of barn room, however, I would say I am not so sure about the wisdom of their method; one never sees in that country a building corresponding to the American or Canadian barn, but, instead of this, a quadrangular collection of byres enclosing a court corresponding in some respects to our barnyards. These byres are sometimes a hundred feet in length and are generally twelve feet in width. Sometimes they are built for two rows of cows, and then they are at least eighteen feet in width. The walls are always of stone, of a height to the eaves of from eight to twelve feet, with here and there sections of drain tile laid in for the purpose of ventilation. The roofs, generally gabled, are universally slated. On the court side of these structures a number of commodious doors, placed at convenient intervals, afford ample means of egress, regress, and light. The floors are always paved either with stone or brick, with a drop of perhaps six inches immediately in the rear of the

animal. These drops are gutters of perhaps a foot in width, with an incline towards one end to carry off the liquid manure. In those instances where two rows of cows are sheltered in one byre, a raised platform or walk, perhaps four feet wide, paved like the floor, separates the gutters. It will be seen from this description that the byre is built exclusively for housing the dairy, there being no space in them that is ever used for the purpose of storing fodder. The byre is divided into spaces or stalls each wide enough for two cows, the partitions being generally a slab of stone, in size three by four feet, and from two to three inches thick, set up edgewise and supplied with a staple on either side for the purpose of hitching. A chain about the neck just long enough to prevent interference one with the other is the universal method. The stalls are each supplied with two burned clay boxes about six inches deep and two feet long and fourteen inches wide. These boxes, the only food receptacle provided, are most serviceable for root and grain feeding.

In addition to the byres the Scotch dairy farm is always supplied with a sufficient number of horse stables, carriage and implement houses, but no storage is ever provided for unthreshed grain or fodder. To the American the number of stacks to be seen after harvest on a Scotch dairy farm is something wonderful. A hundred neatly-constructed, beautifully-thatched, carefully-rope, symmetrical stacks of unthreshed oats and other grains standing in ranks like well-drilled soldiers, is a sight not common to the American eye, and as he looks upon them he not unfrequently will be led to wonder why the material used in the construction of the long byres and stables was not brought together and great barns erected, as in this country, where stock and produce might be housed under a single roof. On account of the extreme moisture of the climate it is impossible to house their grain. There is another feature in Scotch dairy buildings which in passing I must not overlook, and that is what is called the midden. A rectangular bin, generally in the centre of the court above mentioned, consisting of four stone walls from four to five feet high, enclosing a space sometimes a hundred feet long by fifty wide, and sometimes roofed and used as a manure storage, is a distinctive feature of the Scotch

dairy farm. These institutions, when located at a proper distance from the point where the milk is drawn and handled, I can but regard with much favour, and I hope the time will come when the dairymen of this country will learn to appreciate, as these men do, the value of manure, and will take as much pains to preserve it and apply it to the soil.

As soon as the grass begins to fail, which occurs generally in October, feeding begins. The cows are milked always in the byres, and it is there they are fed. After turning out in the morning, the gutters are cleaned out and floor and gutters washed down by a copious application of water; this operation complete, and the clay boxes, already described, are immediately filled with turnips, five or six in each box, as a mess for the evening, and again at night, after turning out, the boxes are re-filled for morning. Sometimes, however, in addition to the turnips, a pound or more of cotton cake, or perhaps a proper quantity of oil cake, mixed with bean or Indian corn meal, constitutes the mess. This system continues until winter feeding begins, when, in addition to the food already mentioned, a sufficiency of oat straw is distributed. This is done generally by the women in a manner which, to say the least, displays small regard for the value of time. It is carried in the arms from the straw house at one end through the long byres, sometimes a distance of 150 feet, and deposited at the heads of the animals, an armful to every two cows. This performance, as will be readily seen, considered from a pedestrian point of view, is no insignificant feat, especially when we remember that the dairy may consist of seventy-five to 125 cows, and that it must be performed generally three times a day. In the counties of Wigtown, Kirkcudbright, and Dumfries very little hay is raised, owing, perhaps, to some unfavourable condition of soil or climate, but the oat is always a successful crop, and thus it transpires that oat straw constitutes the bulk of the coarse fodder. Every well-constituted Scotchman has a prejudice that oat straw is better relished by the dairy when newly threshed, and consequently each day's supply is threshed in the morning, except Saturday, when the supply for Sunday is run through in addition. Fortunately for these people, nature has supplied almost every farm with a water power,

of which he avails himself in the performance of this work; indeed, we believe that ninety per cent. of the dairies we visited own and ran their own threshing mills. Sometimes the turnips are sliced or pulped in a machine run by water, steam, or hand power, and the cut roots mixed with chaff. This method, I have no doubt, has its advantages, but when the mass is allowed to stand until it becomes sour, a practice I have observed on the part of one or two, it has its objections also; indeed, it seems to me highly obnoxious in the production of cheese, as I hold that all species of acidified food is detrimental to the quality of that product. The feeding is kept up with much regularity and care from some time in the month of November until about the middle of May, when the grass in the pastures has become large enough for turning out.

In that country the sensitive observer of dairy practices is not pained at the spectacle of the pinched and shivering herd wandering slowly in single file along the snow path, through the storm to yonder hole in the ice, where, one by one, on bended knees, the thirsty creatures eagerly transform themselves into animated suction pumps, and extend their bodies with a twenty-four hour supply of the life-giving fluid; an abundance of pure, living water is always at hand on the Scotch dairy farms.

BREEDS.

Perhaps it is unnecessary to state to this intelligent audience the fact that the breed of cows used in that country in dairying is universally Ayrshire; a breed which some persons who have investigated the subject claim to be a cross between the Highland Kyloe and the Channel Island breeds; nor is it necessary to say that every true Scotchman believes as firmly as he believes in the "Auld Kirk," in the superiority of that breed over every other for milk-producing qualities. Although an intensely nervous and excitable race, yet it must be said that for dairy purposes they rank with other breeds. For while they yield averages with that of any other, they are small-bodied and require less food, and are, doubtless, better adapted to the hills and climate of that country than any foreign breed would be likely to prove.

Every dairyman engaged in breeding has a strong

incentive to excel in that part of his business, for in addition to the natural advantages arising from success, a prize called the "Derby" is offered to every one who accomplishes a given feat in that direction. An animal, say of the age of one year, exhibited at the Ayr Show, with specifications of the purpose for which it has been selected, will entitle the owner, when the animal is returned to the exhibition two years later, to a prize of £5, more or less, if the object specified as that to be accomplished by the selection has been attained. As the "Derby" has been kept standing by the Agricultural Society for many years, great acuteness and perception has been developed among cattle breeders in the art of selection, or at least in the art of fixing up the exhibits to deceive the eyes and confound the judgment of the judges.

I attach great importance to certain peculiarities in the method adopted by these people in raising stock for the dairy. The calves selected for raising are fed on new milk for a long time, enough at least to start them on the road to a strong and healthful maturity. After the new milk supply has been kept up for a time long enough to warrant a change, a mess consisting of thoroughly-boiled bean meal and oil cake or other nutritious substance in scalded whey is kept up until the animal is old enough for the pasture. In this way the blighting and stunning effects of unwholesome and improper food are avoided, and well-developed and meritorious dairies produced; moreover, the cows are not generally milked until they have attained the age of three years.

LEASING FARMS.

A landed system similar to that which William the Conqueror introduced into England prevails. The great estates are divided into farms, large and small, as already described. These farms command a rent of from £1 to £3 per acre, a rent, it will be seen, enormously above the highest figures ever paid in this country, especially when we remember that this pays for nothing but the bare land and buildings. The leases are made for a term of nineteen years, and provide for semi-annual cash payments. The tenant having secured his farm, must provide himself with teams, farm implements, help, seed, and everything neces-

sary to the carrying on of the business. When this is done, if so inclined, he sub-lets the dairy to one called a boor, who, at a given price, say twenty stone (twenty-four pounds each), 480 pounds of cheese per cow, assumes its entire control and management, excepting the sale of cheese, which is reserved to the farmer himself. The boor having paid the stipulated rent, receives for his labour the entire products of the dairy, including swine. The farmer furnishes everything necessary to carry on the business; the boor being responsible for nothing but the work. There being no factory system in the country, each boor or farmer makes up his own milk. In the counties of Ayr, Dumfries, and Argyll, where the dairies are small, the factory system would doubtless prove advantageous; but in the other counties, where the dairies are quite large, I am not so certain. However, let the result be what it might, I doubt about the factory system ever obtaining a foothold in that country, owing to a thoroughly deep-seated prejudice in the mind of each individual in favour of his own dairy, every man knowing of a surety that his dairy produces better milk than his neighbour's. It seems impossible to make them understand that the market is always willing to pay something for the uniformity engendered by the factory system—for the character and quality which a single intelligence educated to the business is able to give to the produce of whole neighbourhoods, and that there is a great saving of expense in allowing two or three to perform the labour of fifty; nor can they by any argument be induced to see that these considerations in any manner compensate for the fancied superiority of every man above his neighbour.

I ask your indulgence now, gentlemen, for a little while, and I will close this paper with a brief history of my exploits in the "Land o' cakes," and you will pardon me, gentlemen, if, in doing so, I make a somewhat frequent use of the pronoun "I," as I am quite solicitous that in giving an idea of what is going on in the cheese-making world of Scotland, and my connection with it, nothing of egotism shall appear in what I have to say. I should have omitted altogether to say anything of myself here to-day had I not believed you would be interested in comparing my recent "Apostleship" to the Gentiles with my former experience

among you with whom I began first to preach and to teach.

With the considerations, correspondence, and the many, to you unimportant, circumstances that induced me to revisit the land of my birth, I will not take up your time; suffice it to say that a word spoken by a friend in my favour in that far-off land was the means of procuring for me from a gentleman well up in the cheese interest there an invitation to come over and assist him in his creamery. Having had for many years a desire to revisit the home of my childhood I embraced the opportunity, and on the 23rd day of February last embarked on the steamship *Devonia*, and was soon well out upon the stormy Atlantic. A pleasant passage of eleven days, and at the hour of 7 p.m., March 5th, our good ship laid her side against the pier in Glasgow, my native city. A hand-shake all round, and a heartfelt good-bye to the officers and passengers with whom I had shared the dangers and enjoyed the pleasures of our long voyage, and turning, I found at my side a gentleman who inquired my name, and said he had been sent to escort me to the residence of my friend. As I walked along the gang plank, and my foot touched the pier, that peculiar but indescribable sensation which is sure to thrill the heart of every genuine lover of his country who, after an absence of long years, returns, arose within me, and instinctively the words—

“Breathes there a man with soul so dead,
Who never to himself hath said :
‘This is my own, my native land.’
Whose heart hath ne’er within him burned
As home his footsteps he hath turned
From wandering on a foreign strand?”

came to my mind, and when afterwards in Edinburgh I stood before the magnificent granite pile erected to the memory of the great man who penned them, I repeated them again with something of the patriotism and pride which every son of Scotland has a right to feel.

After a few days spent in the society of a brother and sister, from whom I had been separated for nearly fifty-two years, I began my labours at the Dunragit Creamery, the only one in the country at that time in operation. This institution is conducted on principles somewhat different

from our factory system; the proprietors, a limited stock company, purchasing their milk on contract at a given price per gallon, ten pounds and a quarter answering to that amount. At the time I arrived there they were receiving from thirty to forty-four thousand pounds per day of milk, fair as to quality, but having a disagreeable flavour traceable to turnip and cotton-cake feeding. The methods of receiving, weighing, and testing, were similar to our own, but beyond this the general features of the factory were peculiar to itself.

From the weigh-can the milk passes into a number of receiving vats, from which, as required, it is drawn down one storey into three centrifugal machines which separate the cream, and from whence the cream is forced through a pipe into a vat near at hand, and the milk through another pipe into another vat close by. The cream is kept until such time as it is deemed sufficiently matured and then churned, but the milk is immediately drawn down another storey into the cheese vats. These vats, or two of them at least, were constructed upon a principle somewhat different from ours, the difference consisting solely in the application of heat. Instead of a coil of steam pipe under the milk, a large can of a capacity of forty gallons located at one end of each vat was filled, and then heat by means of a steam pipe extended into it, the steam passing from the pipe immediately into the milk. When the milk was raised to high but indefinite temperature it was dipped with a pail back into the vat from whence it had been taken, and thus by repeated heatings in the can the milk in the vat was raised to a temperature which was supposed to be proper for the application of the rennet, which was universally Hanson's extract. Coagulation and cutting complete, and the second heating was effected by dipping the whey from off the curd into the can already mentioned, and the application of steam as before. The whey, heated to about 140 degrees, was returned to the curd, and thus the process was carried on until the curd was ready for the press; the other general features of their method of making cheese not varying materially from our own.

It will be seen from this description that the method employed was of a crude and very objectionable character, the introduction of the hot scorching steam into the milk

itself, and the slow, laborious, and very unsatisfactory process of heating, making the road to success exceedingly difficult, not to say impossible.

After spending about a month in this creamery I effected an agreement with the Scottish Dairy Association, of which I have already spoken, by which I undertook, for a stipulated time, to give instructions to the dairymen throughout the counties of Wigtown, Argyll, Kirkcudbright, Dumfries, and Ayrshire, and immediately entered upon the discharge of my duties.

In order that the greatest advantage possible might be derived from my instruction, the Association planned for me a route which distributed the benefits as evenly as might be over the territory in the counties named. Having, as we have said, no factory system, it was necessary of course to reach as many private dairies as possible. Accordingly those having the matter in charge gave notice each week, through the papers, of the farms at which I would give instructions upon given days, and thus it transpired that upon every working-day I was met at a given place by a company of cheese-makers from the surrounding country, who came to watch my movements, ask questions, and listen to my instructions. The number of people whom I thus met daily ran from twenty to ninety-four, of whom the majority were women. Many came long distances to hear what I had to say, and a lively interest, I observed, was manifested everywhere. My pupils were generally intelligent, and a sharp fire of questions was usually kept up through the whole process. At certain points it was usual for my audience to agree that I had spoiled the curd, and later on to unite in manifestations of astonishment when they found I had not. "Had this been our curd," they would say, "we would have considered it ruined long ago," and again still later I was generally rewarded by an unanimous verdict of the company that the curd was the best they had ever seen. The point at which exceptions were usually taken was, first, at my method of ripening my materials, as I abstained altogether from the practice commonly followed by them of introducing sour whey for the purpose of advancing the work. Secondly, when the whey was drawn an animated discussion usually took place, in which it was contended on

the one side that it was not sour enough, and on the other that it was already too sour—the ministry (your humble servant) in the meantime being without a party in the house and *altogether* unpopular. Thirdly, I milled too soon. This resolution was generally unanimously adopted. Fourthly, in salting there was usually a divided house on the question of time, and an unanimous vote against me on the question of quantity; everybody knowing of a surety that I had used too much. This method of instruction afforded me a constant source of amusement, and furnished an instructive commentary on the system of every man his own cheese-maker, inasmuch as I was able to calculate that in a company of say fifty individuals there would have been at least fifty varieties of cheese produced, could each individual have his own way.

In going about from farm to farm I found great diversity in the character of the dairy tools and appliances, but there were some features common to all. Instead of the rectangular vat used in this country, a tub, sometimes of wood and sometimes of tin, from four to seven feet in diameter, by about thirty inches in depth, was universally in use. The tin tubs were sometimes heated by the application of steam to their bottom, but more frequently, indeed in seven cases out of ten, the heating was performed by pouring in the milk or whey, as we have already described. The presses were of a variety peculiar to that country, at least I never saw presses just like them in use anywhere else. They combine both the screw and lever power, the screw being used more particularly for the purpose of adjustment. Two presses were commonly included in one frame, in which sometimes four cheese might be pressed. They were very handy and did their work satisfactorily, but I think, upon the whole, I prefer our common screw press. A sink with a false slat bottom, and a strainer cloth, a utensil with which most of you are familiar, and which I regard as indispensable to the cheese-maker, I was unable to find in all Scotland, but wherever I went I caused them to be constructed. Curd knives, perpendicular and horizontal, of the handy and accurate sort used in this country, were conspicuous for their absence. Imagine a frame half round on one side and straight on the other, three feet long and two feet wide in

the widest part, and filled in with strips of tin about one inch wide standing edgewise and crossing each other at right angles, forming squares of about an inch, with a handle arising from the centre three feet long, and you have formed a good idea of one species of the Scotch curd knife. This implement, placed upon the surface of the curd with the circular side conforming to the bend of the tub and pressed downward with one motion of the hand, you will see, cut a large portion at once, and this movement repeated three or four times, and one part of the cutting was considered complete. Another instrument often used in reducing the curd was a shovel-shaped affair, the blade part being composed sometimes of wire, somewhat resembling a three-tyned fork, the tynes being traversed at regular intervals of perhaps one inch by bars of steel, tin, or wire. Strange as it may seem, the simple contrivance known to us as a dipper was a stranger in the land. There may be those here who have never seen a luggy, and for the benefit of them I will attempt a description of one. It weighs about six lbs. and is made of tin or oak.

When of oak, they resemble a medium sized sap bucket, with one stave standing up six inches higher than the rest and shaped for a handle. Its hoops, either of brass or iron, are always kept well polished. The tin ones are substantially the same in form, but whether of wood or tin they are always kept scrupulously clean. We venture to say that not one American in ten thousand who had not seen the luggy in operation would imagine its use. It is the Scotch milking pail. From the luggy the milk is emptied into the can, an institution about which I have my opinion. It is at least three times heavier than it ought to be, eighteen inches deep by a foot in diameter, having a bail of half-inch round iron, and weighs about fifteen pounds. They occupy a position on the floor behind the cows, from which, when full, they are carried in the hands through the long byres to the cheese-room, a feat requiring no small outlay of physical strength. As a means of shortening the average of human life in Scotland, in my opinion they rank well with a pestilence.

I pass now to Scotch *modus operandi* of making cheese, with which I propose to close this already lengthy paper. I remark generally, in the first place, that there is a uni-

versal lack of a knowledge of what may be called the philosophy of cheese-making; the whys and wherefores of the business seem never to have been investigated. Causes were known to produce certain effects, and those were treated arbitrarily, and with no consideration for a thousand external and internal influences and circumstances necessary to be understood in shaping one's course from the beginning to the end of the work. To illustrate: Rennet was known to produce coagulation, but its office and influence beyond this simple result was not understood and, consequently, in the estimation of quantity no thought was bestowed upon what was to be effected in the keeping quality of the article to be produced. The fact that a large quantity would produce decomposition and decay in the cheese sooner than a small one was not considered, and the additional fact, that salt might be so used as to regulate in a measure the power and influence of the rennet, I found was still among the mysteries of the business.

With reference to milking, and the custody of the milk, I have nothing censorious to offer, saving perhaps the one observation that in many instances I found the byre, the midden, and the milk and cheese-room in much too close proximity; no suspicion of harm from the odours arising from the former seemed to exist. Farther than this, however, I must say that neatness of the most scrupulous and painstaking character universally characterised Scotch dairies.

The milk was kept over night often in clay coolers, six inches deep by four feet long and two feet wide, and being exempt from some of the maturing causes incident to our factory system, was, I found, as a rule, much slower in coming to maturity than with us, and it was at this point that a want of intelligent action on the part of the operator became apparent. That milk must undergo a certain natural change before the step could be taken he knew well enough, but how to hasten this change in a natural and healthful manner he did not seem to comprehend, but resorted to the practice of introducing sour whey, as we have already described, and so brought forward to embarrass his efforts and taint their results the same mistakes and shortcomings with which he had to contend the day before. By so doing it will be seen that no day's mess was made up on its own

merits, but was inoculated with all the diseases and faults accumulated from the indefinite past.

Upon the subject of rennet and coagulation we have already made some observations, and we have also described, with some particularity, the instruments used in cutting. I will now speak of the utility of these instruments, and the Scotch method of reducing the curd. The first instrument described, which was used for the purpose of perpendicular cutting, performed its work in a very unsatisfactory manner. To pass it from the surface downward through thirty inches of curd was easy enough, but to withdraw it through exactly the space made in its descent was another and quite a different thing. Invariably in doing so thin shavings were cut away, and thus much irregularity was produced. Here, again, the operator exhibited his ignorance of cheese philosophy, not seeming to understand the benefits arising from uniformity in the size of his molecules. Having cut perpendicularly, the balance of the work was performed with a very little regard to system or results. Sometimes the operator broke with the hands, but, more frequently, recourse was had to the second instrument we have described, with which he proceeded to slash irregularly and at haphazard, until he had reduced the mass to particles not larger than clover seed. Fine cutting sometimes is necessary, in order that a superabundance of moisture may be the more readily removed, but in dairies fed on high and up-lying pastures it is apt to result in hard, dry cheese, a fault as much to be deprecated as any other.

While scalding, the operator expended a deal of useless labour in stirring; indeed, from the moment when the heat was applied until the curd was cooked—a time varying in length from an hour and a-half to two hours—he never left off. What his purpose was, I was never able to determine, but I saw from the look of astonishment which appeared on his face when he saw me accomplish better results with half the labour that he evidently had supposed it productive of something good. To conclude this laborious performance, he gave the contents of the tub a whirling motion, which naturally caused the curd to accumulate in a conical-shaped heap in the centre, when the faucet is opened and the whey drawn off. The convex

surface of the bottom facilitates drainage, which process is allowed to go on until the curd has become a solid mass. It is then cut and turned over without stirring, and when drained to the satisfaction of the maker is removed to the cooler, and subsequently ground, cooled, and salted. This method of draining, you will see, is very imperfect, not at all comparing with that which takes place when the sink we have mentioned is used, and, as a result, *too much acid* is developed, which remains to play a *mischievous* part in the subsequent history of the product.

The cheese are pressed, not in the bandage as with us, but in a cloth, as we were wont to do in time long since gone by. In form they are generally fifteen inches in diameter by twelve inches deep, but we have seen many that were seventeen inches deep by fifteen in diameter, and which weighed from 120 to 135 lbs. Three days are employed in pressing, during which time they are frequently taken out, the cloth removed, and a new one supplied. For the purpose of securing a rind, the first time they are taken out they are dipped in warm water, and the last time smooth cloths are applied to the top and bottom; but a bandage, such as we use, is never employed. When the cheese are ready for the shelves, they are bandaged in a manner exactly like that employed by a surgeon upon a broken limb. A cloth about four inches wide is taken in the hand and carried around the cheese spirally from bottom to top—the end held by a lap and the last by pinning or sewing.

The Scotch have perfected an idea for shelving and turning cheese worthy of imitation in this or any other country. A line of posts stand, say, six or eight feet apart across the curing room, between which a form of four shelves, supporting sixteen cheese, is supported by gudgeons resting in bearings in the posts, so adjusted that the whole form will revolve. The backside is traversed by bars, so that when the form is turned from a perpendicular to a horizontal position the cheese will not fall out. The space between the shelves is but little wider than the height of the cheese. With this arrangement, a half revolution of the form, accomplished by the simple raising of a latch and a single movement of the hand, turns sixteen cheese. Ay, it does *more than that*, for those

cheese which before were at the top are now at the bottom, and thus the irregularity of temperature always existing in the curing room is provided against.

Another undiscovered fact to the Scotch maker in cheese philosophy is the influence of temperature in the process of curing. That in every healthy cheese there is a sort of chemical life or activity always going forward, as necessary to its normal existence as the circulation of the blood is to the human body, which chemical life flourishes best under particular atmospheric conditions, is a fact upon which the dairymen of Scotland as well as America need to be read an impressive lecture. Their appliances for heating, I noticed, were of a strangely diversified and incompetent character. When boilers were in use, steam was generally employed, and was distributed by means of iron pipes, four inches in diameter, sometimes laid along the floor and sometimes attached to the walls of the department. This arrangement worked well enough when in operation, but in every case within my knowledge its benefits were lost by permitting the fires to go down as soon as the day's work was done. All the other methods employed, from the small and altogether inadequate coke burner up to the more imposing, but not more efficacious fire-place, coupled with the irregular manner in which the fires were kept up, proved how little the maker appreciated the value of a warm and even temperature in maturing and perfecting his product.

MARKETING.

Marketing with them is not the systematic and orderly arrangement established in this country, with its salesmen and Boards of Trade, but is altogether a game of haphazard—buyer and seller meeting as chance decrees. Sometimes parties wishing to speculate go about from farm to farm, examine and purchase, and sometimes the dairyman goes to the nearest town on market day in search of a purchaser, but always in the transaction I was pleased to observe a degree of confidence existing between the parties—rarely to be met with on our side of the Atlantic. The cheese are weighed in lots of from five to ten, and the actual weight of each draft is set down until the weight of the entire sale is ascertained, there being no practice like that

which we have of weighing each cheese by itself. It would frighten an American to see a Scotchman deliver his cheese. At any rate, were any dairyman in this audience, after having perfected a sale of his cheese, to load them into his waggon, without bandage or boxes, standing them on their edges, packed in straw, we venture to say his neighbours would think him a fit candidate for a mad-house; and yet such is the practice in Scotland.

By Act of Queen Victoria,
Chapter 50 & 15,
On each Byre Door in Scotland
The following must be seen:—

YE Dairymaids of Scotland,
High heads ye must not carry
Till once ye're faultless in the byre,
And perfect in the dairy.

Do ye drive gently in the cows,
And kindly speak and mild,
Calming the timid with a look,
And with a word the wild.

And charm them with a milking song
While free they fill the pail,
And playfully as best you can
So hold the sweeping tail.

Or do you hurry to the stake
And with a cudgel rule?
And when you make them stand about,
Is't a thunder from your stool?

And devils, brats, and bitches,
Are the only words that's used,
While they stand cowering up the back
Like creatures that's abused.

And if, unfortunately, the tail
Comes sweeping round your ear,
You seize it with a sudden jerk,
And give a furious tear.

And dashing milk from pail to can,
You throw and hurry past,
Regardless what is spilled around
Or o'er the side is cast.

And when you loose them from the stake,
They dart back like an arrow,
Knowing a blow is awaiting them,
And that escape is unarrow.

And if they maure chance to drop
Between the stake and door,
A stick comes whacking o'er their back
And curses on them pour.

If first-rate cheese you wish to make,
And honour wish to gain,
Let order, cleanliness, and peace
Within your dairy reign.

Your manner must be calm and quiet,
With gentleness and care;
No pushing forward of the work
Or bustle must be there.

Slowly the curd must be broke up,
And slow run off the whey;
Not with your hand disturb the tub
Or hurry any way.

And never think 'tis well enough,
Or do your work by guess,
Or that it is a perfect cheese,
If not straight in the press.

And bandage, trim, and wipe them well,
That they may keep their beauty;
Your works will then a witness be
That you have done your duty.

Have sense to rule with strictness,
Yet obey with ready will,
And a mind to rise above your work,
While your hand is busy still.

Ye Dairymaids of Scotland,
High heads ye must not carry
Till saints ye are when in the byre,
And angels in the dairy.

MRS. JAMES WHYTE.

Kirkcubrick, Wiglowshire.

A P P E N D I X.

THE HOT IRON TEST.

THIS test is used to determine when curd is sufficiently matured for pressing. It originated in 1845 with L. M. Norton, of Goshen, Conn., who was also the originator of pine-apple cheese, and was for many years kept a secret. After a while it became public and is now extensively used, and is the most accurate and reliable guide known for determining the precise stage in the ripening of curd at which it is proper to press it.

To apply the test, have an iron just hot enough to make water simmer when dropped upon it. Make a plug of curd and apply one end of it to the hot iron. If the curd is too immature it will not adhere to the iron; if it is just right it will stick to the iron, and when pulled away will draw out in threads from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch long. If too far advanced it will string out in very fine and long threads.

TESTING MILK AT FACTORIES.

As a protection against fraud in diluting or adulterating milk, every factoryman should be provided with a set of graduated glass tubes, which he can daily, or at short intervals, fill with milk from his different patrons, and observe and record the per cent. of cream which rises upon the milk in each. So long as the milk of every patron shows a fair proportion of cream, he need not make any further tests. Should the milk of any one show a deficiency of cream, tests should be made to determine whether it has been tampered with. To do this take a sample of milk from one or more herds which is known to be pure, and reduce it to the temperature at which the lactometer is made to be used, and note whether the lactometer sinks in it to the point (P), which denotes pure

milk. Do the same with the milk which showed a deficiency of cream, and note whether the point on the stem of the lactometer, which stood at the surface in pure milk, sinks, or rises above the surface of the milk being tested. If the point P rises *above* the surface, it may be considered pure, because pure milk which is deficient in cream is heavier than pure milk rich in cream. If it sinks below the surface, dilution may be predicted, because it is lighter instead of heavier than pure milk. Now take two per cent. glasses and fill one to the top graduated marks with pure milk, and the other with the suspected milk, and when the cream has fully raised on both remove it and insert the lactometer in the skim-milk in each, and note exactly how far it sinks in each, and make a record of the result for future use, if it should be wanted. If it sinks lower in the suspected milk than in the pure, turn water into the pure milk till the lactometer sinks to the same point it did in the suspected milk, and note the per cent. of water added. The per cent. of water added will show the per cent. of dilution.

RENNET.

In its general signification, rennet applies to the preserved stomach of any young quadruped. As used by dairymen in the United States, the term signifies the fourth division of the stomach of the sucking calf. If the stomach of any other animal is meant, the name of the animal is added, as pig's rennet, lamb's rennet, &c. The same word is also used to signify the liquid in which the stomach has been steeped. The fourth division, or part of the stomach used for coagulating milk, is the one next to the small intestines.

The coagulating power of rennets varies in strength and quality with the age, health, and habits of the animals from which they are taken. They are usually in their best condition when the calves are from five to ten days old, but they do not vary much in strength so long as the calves live entirely on milk. As soon as they begin to live upon solid food, the strength of their stomachs, as rennets, begins to abate. The stomachs of calves five days old are generally preferred by dairymen to those older or younger. To obtain the best rennets, the calves should be allowed to suck

a moderate meal 18 or 20 hours before killing. It is a good way to give the last meal at night, and kill the next day near noon. Some let them go 24 hours, and even longer, and the rennets are the stronger for so doing; but in going too long without eating, the stomach becomes inflamed and congested with blood, giving them a dark, reddish appearance, and the disturbed condition thus occasioned is carried with the steepings of the rennet into the cheese, and affects it unfavourably. The calves should live till the curd from the last meal is nearly dissolved, but no longer. As the curd disappears, the coagulating agent accumulates, not in the juices of the stomach as might be supposed, but is deposited on the inside of the stomach, forming a delicate coating, faintly flesh coloured and very tender, which breaks off in thin, flocculent scales upon slight friction. As this coating contains the concentrated strength of the rennet, it is desirable to preserve as much of it as possible. To this end, the sack, when taken from the animal, should be handled with great care. The contents should be emptied out carefully, sack turned inside out, and any specks of dirt or hairs that may appear on it picked off. If further cleansing is necessary, it may be wiped with a moist cloth, or very carefully rinsed by laying it in a dish of water and moving it gently. Water should not be poured upon it. When sufficiently cleansed and lightly salted, it is ready for drying, which may be done in any convenient way, so that it shall not waste by dripping, nor injure by tainting. It may be stretched on a crotched limb, or bow of splint, its ends may be tied and inflated, or it may be cut open and laid out on a dry board, which will aid in drying by absorbing its moisture. These modes of preserving are very much better than salting in a pickle, or filling with salt. If exposed to much heat, rennets lose strength quickly. But they are improved by freezing and thawing, and also by age, if kept open to the air. Rennets should not be used the same season they are saved. They are very much better for a year's age if they are kept open to the air, so that the strong odour common to green rennets can have time to be carried away. Their strength also increases with age, for a season or two at least. When prepared for use, they may be steeped in water. If in brine, it should be no stronger than

is necessary to protect them against tainting, as much salt is detrimental to their action. If the water is not pure, it should be boiled before using. Of whatever liquid is used, two quarts are enough for each rennet. Stone or earthen jars are the best vessels to prepare them in, and the preparation should be carefully covered, as liquid rennet soon loses its strength by exposure to light.

The first strength, which soaks from the vells, is better than the last. It is not only stronger, but it acts more vigorously upon the cream, so that it is better retained in the curd. It is very desirable to distribute the first soakings of the stomach through the whole of the steepings, and to have them of uniform strength from first to last, to secure uniform results in curding. To secure this, two or more jars or casks will be necessary. Three are preferable. Fill a jar or cask with brine, as before directed, and then take as many rennets as would last 15 or 20 days, and cut them open (some cut them in small pieces), tie them in a sack made of bandage cloth, and put them to soak in advance, for a batch to begin with, stirring and rubbing them every day, or oftener. Upon beginning to use this, put a second batch soaking in a second vessel in the same way, and take the sack from the first vessel and put it in with it, marking it so it can be distinguished. As the strength of the second vessel may be different from that of the first, to prevent making any mishap on that account, begin using some of the second before the first is exhausted, mixing more and more of the second with less of the first. In this way the strength of each jar will be readily known, and no mistake will be made in its use. Upon beginning to use from the second jar, take out the sack that was in the first, and after rinsing its contents, throw them away, fill it with new rennets, put to soak in a third jar, take the other sack from the second jar and put with it, and so continue through the season, always stirring the liquid before using. Careful inspection should be made in selecting rennets, to see that none that are tainted, or in any way objectionable, get into the jars to injure the cheese. All dark coloured or strong smelling ones should be avoided. In using the Bavarian rennets, the thick ends made by tying are often tainted and should be trimmed off and in American and Irish rennets, the small end of

the stomach is often left too long, and becomes objectionable by reason of bad odours and filth, and had better be cut off. The action of the extreme end of the stomach is always very feeble, and of questionable utility at any time, and should never be used unless in perfect order. There is no good reason why the active agent in rennet may not be extracted cheaply, and in a state of perfect purity and freedom from the objectionable animal matter which now always goes with it, and in a concentrated state and of uniform strength. Such preparations are now made in Denmark and Switzerland, and must soon be brought into use in this country, but until some enterprising chemist shall discover a cheap method of making an extract that will supply this demand, we must use the native stomach, and I give the best methods of utilising it, till its strength can be furnished in a better form.

PREPARING COLOURING FOR CHEESE AND BUTTER.

To prepare annattoine, take equal weights of annattoine, pure potash, and sal soda, and dissolve each separately in four times its weight of water. When fully dissolved, mix all together and let it stand four or five days for the alkali to cut the annattoine, stirring occasionally. It will then be ready for use. It is best kept in earthen jars. For cheese, $\frac{1}{2}$ pint to 1000 lbs. of milk gives a deep golden colour. For butter, one tablespoonful to six quarts of cream will give a deep colour to pale butter. For either cheese or butter find by trial exactly the quantity required to produce the desired hue.

TO PREPARE BASKET ANNATTO.

Make a strong ley by dissolving potash in water, and put in as much annatto as the ley will dissolve. Boil the solution and set by for the sediment to settle. Turn off the pure liquid for use. The sediment may be washed with ley, and the clear liquid used. Find by trial the amount of liquid required to give the desired colour. Basket annatto varies too much to admit of precise directions.

Annatto seed may be prepared in a similar way. The seed should be several times rinsed in ley or hot water to extract all the colouring.

BOARDS OF TRADE.

Associated dairying naturally led to associated marketing, where salesmen could become posted as to the market value of their productions, and thereby obtain better prices than by individual effort; consequently "Boards of Trade," or "Sale Days," became necessary for the protection of the interests of the dairymen.

The first effort in this direction was made in 1870 by T. D. Curtis, then editor of the *Utica Herald*, who advocated the organisation of such boards in the *Herald*, and in a paper read before the New York Farmers' Club, December 16th of that year. Mr. C. issued the first call for establishing a local market in the spring of 1871. A week subsequent to the call of Mr. C., a similar one was issued at Little Falls, N.Y., calling for an earlier meeting, and at that meeting the first Dairymen's Board of Trade was established, which is now known as the N.Y. State Dairymen's Association and Board of Trade. The call first issued matured a week later, and in obedience to it was formed the National Dairymen's Club, now known as the Utica Dairymen's Board of Trade. The fruit of this enterprise thus inaugurated has resulted in great good to dairymen, and numerous institutions of a similar kind have since been established. In view of the importance and rapid multiplication of such Boards, I insert a blank form to aid in their organisation:

RULES AND REGULATIONS FOR A BOARD OF TRADE.

1st. The payment of 5 dols. to the Treasurer shall constitute a membership of the Board of Trade of the _____ for one year.

2nd. Members only shall be entitled to all the privileges of the sales-room.

3rd. There shall be a register kept and a bulletin board arranged in a conspicuous place in the room for posting telegrams and other information of interest received from other markets, and to which register and board all members shall be entitled to free access. Also, all members shall have the privilege of posting upon said register a notice of any dairy or other produce they may have for sale.

4th. There shall be an officer appointed by the Club, whose duty it shall be to procure telegrams and other information deemed necessary by the Club for the bulletin board; to procure and issue tickets of membership; and to have the general supervision of the sales-room.

5th. There shall be a Board of Arbitration constituted for the purpose of settling all differences which may arise from time to time between buyers and sellers, and it is an express understanding that the decision of such Arbitration Committee shall be final. The said Board of Arbitration shall be chosen and constituted as follows: In case of difference between two parties or interests, the said parties or interests shall each choose one member of the Board, and the two members thus chosen shall select a third, and these three shall constitute the Board of Arbitration, and have appropriate jurisdiction.

6th. All bargains between members made at the sales-room or elsewhere, verbally or otherwise, shall be considered binding, and a failure of either party to perform his or their part shall be considered sufficient cause for expulsion from the Club and sales-room.

7th. For avoiding disputes respecting short weights, it is agreed that where a discrepancy is found in the weights of butter or cheese on arrival in market, a legally appointed weighmaster's certificate of such discrepancy, with expense of certificate attached, shall be considered a standard to settle by.

8th. It is essential that each of the foregoing rules be strictly observed by each member of the Club, and any violation of such rules shall be considered a sufficient reason for appointing a committee to look into the facts, and report what action, in their opinion, ought to be taken by the Club to avoid a repetition of the same.

9th. It is understood that where a factory has more than one salesman, either one or all of said salesmen shall be admitted on presenting the factory's ticket of membership, and that a buyer and his agent may be admitted on one ticket, whether owned by the principal or the agent.

10th. It shall be proper for a member of this Board to be accompanied, when admitted to the sales-room, by a neighbour or friend who is not interested in buying or selling, without additional charge; but it is understood

that this is a matter of courtesy, and any violation of good faith will be deemed a breach of the rules of the Board.

11th. The price of single admission to the sales-room, with the privileges of the Board for the day, shall be fifty cents.

12th. Amendments to these rules and regulations may be made at any regular meeting of the Board, by a majority vote, provided notice of the proposed amendment has been duly given at a previous regular meeting.

LIST OF APPARATUS.

In response to numerous inquiries by parties contemplating the manufacture of cheese in factories and dairies, I give below a list of the apparatus with prices, as now commonly used in a factory of 400, and a dairy of 30 cows, from which an approximate estimate of cost for a larger or smaller establishment can be made. The total cost is, of course, liable to vary by reason of change in prices and the introduction of new and improved apparatus, but it is believed that the tables will nevertheless be of value as an approximation to cost of outfit.

COMPLETE OUTFIT FOR A CHEESE FACTORY OF 400 COWS.

	Dols.	Cts.
1 3-Horse Power Boiler, with fittings complete	125	00
2 600-Gallon Vats, with inside steam pipes, at 75 dols.	150	00
Steam Pipe Connections and Fittings, 19 dols. to	20	00
16 Cheese Hoops, best galvanized iron, 15 inch, with fol- } lowers, at 4 dols. 50 cents	72	00
16 Cheese Press Screws, at 4 dols.	64	00
(Or Gang Press, costing per Hoop, 14 dols. 83 cents.) Timbers for Press Frames can be made by any good } mechanic, say	25	00
Curd Drainers	15	00
1 60-Gallon Weigh Can—large faucet	13	50
1 Tin Conductor	2	50
1 600-lb. Fairbank's Scales, with wheels, for weighing milk	28	00
* 1 140-lb. " " for weighing cheese, &c.	16	50
1 Curd Knife—13 Blades—20 in. long	7	00
* 1 " " Horizontal Blades, 6 x 20 in. long	7	00
1 Hoisting Crane—complete	14	00
1 Syphon and large Strainer	3	50
* 1 Bandager—(Patented.)		
1 Water Pail, extra heavy	1	00
1 Curd "	1	25
- 1 " Scoop	1	00

	Dols. Cts.
1 Dipper—gallon, extra heavy	1 00
1 Set Milk-Testing Instruments—comprising 3 Graduated Jars, 1 Lactometer, 12 Cream Tubes.....	4 50
1 Case Stencil Plate and Brush ..	0 60
1 Factory “ “ about	1 50
1 Set “ “ for dating cheeses.....	3 00
2 Stone Rennet Jars—15 gallons, 4 dols. 50 cents	9 00
2 Thermometers, at 50 cents	1 00
1 Factory Account Book—(as to size)—say.....	1 20
1 “ Slate—double	0 75
1 Rubber Mop.....	0 50
*1 Floor Funnel	1 00
*1 Curd Mill.....	23 00
1 Set Castors for Curd Sink.....	2 00
*1 Barwick Wrench.....	3 50
*1 Cheese Tryer—nickel-plated	1 00
*1 Curd Agitator.....	1 50
*1 Tinned Cheese Knife.....	1 00

In case a Factory fitted up as above for making cheese from 400 cows is converted into a Creamery where butter and cheese are made from the same milk, the following articles would be required:

	Dols. Cts.
1 3-Horse Power Engine	100 00
1 No. 9 Blanchard Churn.....	45 00
1 Butter Worker	25 00
Cooler Pails—as per time that milk is to set. It may be set in the Cheese Vats if only for 12 or 24 hours—at}	0 90
1 Butter Mould	1 00
Ladles, Skimmer, Bowls, &c.	3 00

Articles marked with a * may be dispensed with, though very much used.

FIXTURES FOR A CHEESE DAIRY OF 30 COWS.

	Dols. Cts.
1 120-Gallon Self-heating Vat, with hot water tank.....	82 00
2 Cheese Hoops, 15 inch, with followers, 4 dols. 50 cents....	9 00
2 “ Press Screws	8 00
1 “ Press, about	10 00
1 Curd Knife, 7 x 20 inches	4 25
1 “ Pail.....	1 25
1 “ Scoop	1 00
1 Dipper	0 75
1 Set Stencil Plates	3 00
2 Thermometers, at 50 cents	1 00
1 Rubber Mop.....	0 50

FORM FOR ORGANISING A DAIRY MANUFACTURING COMPANY OR ASSOCIATION.

We, the undersigned, hereby organise ourselves into an association for the manufacture of (Cheese, or Butter,

or both, as the case may be), under the name and style of (insert name, with P.O. address). It is agreed and understood that the stock of this association shall be divided into (number of shares, at the par valuation of —dols. per share); and it is hereby understood and agreed that each shareholder shall contribute his *pro rata* share of expenses, and receive his *pro rata* share of all net profits. All matters in the construction of the necessary buildings, furnishing them, the hiring of help, and the general management, shall be decided by vote of all shareholders present at a regular meeting, or at a special meeting of which all stockholders have been notified, the majority of stockholders represented determining the result. A special meeting shall not be held without at least three days' notice being given by the president to each member, either verbally or by written notice left at his place of business. The officers of this association shall be a President, two Vice-Presidents, a Secretary, a Treasurer, and an Executive Committee of three. The duties of the several officers shall be those usual to such organisations. We also hereby agree to abide by and observe all Bye-Laws, Rules, and Regulations which may hereafter be adopted by a two-thirds vote of this association, at any regular meeting—that is, two-thirds of the shares of stock represented at such meeting cast in the affirmative. For the faithful performance of all which we hereby subscribe our names, this the — day of —, 18—.

CHEESE ANALYSIS.

The parts separated in making cheese are shown by the following analysis made in Cornell University under the direction of Prof. G. C. Caldwell:

	1	2	3	4	5	6	7
Water.....	34.18	29.82	35.24	29.19	30.49	28.11	40.56
Fat.....	33.92	35.80	35.68	37.24	39.25	41.03	20.53
Ash.....	3.02	...	2.84	...	3.00	2.68	7.05
Protien.....	28.88	...	26.24	...	27.26	28.18	34.86

No. 1 was a factory cheese three days old, made at North Bridgewater, N.Y., July, 1875. No. 2, same, five

months old. No. 3 was a factory cheese one week old, made by Hon. Wm. A. Johnson, at Collins Centre, N.Y., August, 1805. No. 4, same, four months old. No. 5 was nine months old, made of half Jersey milk, at Winthrop Factory, Maine, Aug. 24th, 1874. No. 6 was well cured and made of all Jersey milk at same factory, Sept. 16th, 1875. No. 7, also margarine cheese, six months old, made at McLean, N.Y.

CHEESE SHIPMENTS.

The exports from Montreal, *via* St. Lawrence and Portland, from May 1st, 1884, to March 28th, 1885, aggregate 1,227,765 boxes, against 1,003,426 boxes corresponding period of 1883 and 1884, showing an increase of 224,339 boxes. From New York the exports during the same period were 1,674,924 boxes, against 1,788,797 boxes for the year previous, being a decrease of 113,873 boxes. The combined shipments from Montreal and New York during the past season were 2,902,689 boxes, against 2,792,223 boxes the year previous, which still exhibits the large increase of 110,466 boxes, a surplus which is quite sufficient to account for the untoward turn which the English market has of late taken. The estimated cost of the above shipments is 7,900,000 dols. from Montreal and 10,900,000 dols. from New York, or a total of 18,800,000 dols. During the past season of navigation 117,845 boxes of American cheese were shipped in bond *via* Montreal, but this has, to a considerable extent, been offset by the shipments from Western Ontario *via* New York, and from Montreal by the Canada Pacific *via* New York.

TENTH CENSUS OF THE UNITED STATES—NEW YORK.

Number of Milch Cows, Gallons of Milk produced and Pounds of Butter and Cheese manufactured in the year 1879, and Value of Live Stock in Dollars, in the various Counties.

COUNTIES.	COWS.	MILK.	BUTTER.	CHEESE.	LIVE STOCK
Albany	13,042	1,390,662	1,154,969	6,560	1,589,181
Allegany	38,484	11,181,824	1,835,065	48,915	2,778,712
Broome	29,398	1,113,619	8,659,982	25,068	1,835,138
Cattaraugus	51,370	13,580,083	2,068,221	294,332	2,914,343
Cayuga	22,805	900,689	2,494,775	61,175	2,572,662
Chautauque	50,735	5,830,404	5,122,756	355,634	3,342,930
Chemung	13,097	1,929,906	1,163,914	209	1,065,927
Chenango	53,489	7,248,061	4,723,247	97,625	2,746,533
Columbia	12,975	392,615	1,129,060	20,132	1,249,551
Cortland	13,764	515,698	1,396,595	8,972	1,789,247
Delaware	81,824	1,950,024	3,485,622	164,773	1,714,397
Dutchess	57,673	1,138,467	7,732,028	25,898	2,944,435
Duchess	26,269	6,892,808	1,409,331	17,354	4,981,382
Erie	43,400	8,747,124	2,386,032	410,160	3,560,438
Essex	10,638	75,256	998,970	45,909	1,058,286
Franklin	18,509	2,265,970	1,838,684	25,937	1,248,991
Fulton	11,558	1,690,948	823,415	38,420	900,984
Genesee	11,853	1,330,664	882,444	28,144	1,931,965
Greene	15,307	93,719	1,757,110	2,548	1,296,268
Hamilton	1,270	25,300	101,740	915	133,416
Herkimer	48,237	10,638,733	1,402,922	2,992,394	2,495,413
Jefferson	61,900	13,261,640	4,071,740	283,990	3,468,873
King	1,254	554,951	22,414	460	254,728
Lewis	35,834	7,533,915	2,009,126	252,545	1,903,505
Livingston	12,049	554,547	1,225,417	118,427	2,380,844
Madison	37,174	9,939,806	1,987,803	90,110	2,314,369
Monroe	17,244	1,449,440	1,773,172	14,484	3,004,279
Montgomery	21,250	6,758,671	1,128,088	247,850	1,524,959
New York	298	66,975	930	.....	65,385
Niagara	12,171	302,019	1,359,762	43,419	2,100,907
Oneida	68,049	17,503,801	3,193,616	402,824	3,933,071
Onondaga	31,703	4,330,051	2,815,718	300,733	3,100,906
Ontario	12,695	627,605	1,462,811	27,709	2,512,101
Orange	46,154	18,742,335	1,221,295	4,612	3,127,851
Orleans	8,400	150,626	915,979	19,305	1,457,002
Oswego	37,752	10,077,736	2,546,053	236,697	2,511,405
Otsego	48,827	5,355,117	4,578,784	404,626	3,125,696
Putnam	9,588	3,625,760	287,671	100	719,443
Queens	9,522	2,997,321	369,380	12,986	1,444,402
Rensselaer	18,539	2,156,125	1,376,749	126,119	1,929,294
Richmond	901	186,439	54,068	1,000	140,731
Rockland	3,446	440,930	277,413	324	401,738
St. Lawrence	93,369	15,528,219	6,973,020	389,405	4,755,039
Saratoga	16,170	542,694	1,558,090	33,221	1,772,489
Schenectady	5,568	336,516	537,343	9,245	612,045
Schoharie	21,000	880,991	2,729,633	22,009	1,689,120
Schuyler	7,553	129,261	902,145	22,726	955,780
Seneca	7,146	206,681	769,512	1,876	1,269,903
Steuben	37,254	2,742,300	3,886,985	138,830	3,468,328
Suffolk	9,305	382,296	667,906	2,318	1,359,047
Sullivan	17,798	1,030,855	1,611,273	15,981	1,418,309
Tioga	17,794	310,138	2,150,865	24,712	1,336,101
Tompkins	16,049	608,406	2,028,468	54,338	1,603,202
Ulster	21,337	1,366,839	1,757,699	8,502	1,944,161
Warren	7,054	192,886	640,705	12,770	660,632
Washington	21,762	2,927,190	1,793,243	104,914	2,102,459
Wayne	16,732	403,654	1,773,578	40,101	2,423,678
Westchester	19,168	5,637,072	616,825	2,540	1,895,838
Wyoming	25,507	7,091,440	1,030,824	259,933	1,955,151
Yates	6,636	61,156	731,351	31,638	1,180,352
The State	1,437,855	231,965,533	111,922,423	8,362,590	117,868,283

BUTTER AND CHEESE

Product and Bovine Cattle, according to the Census of 1880.

States and Territories in United States.	Butter on Farm.	Butter in Factory.	Cheese on Farm.	Cheese in Factory.	Milk Cows.	Oxen and other Cattle.
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>		
Alabama.....	7,997,719	.....	14,091	.....	271,443	479,747
Arizona.....	61,817	400	18,360	17,700	9,156	35,831
Arkansas.....	7,790,013	.....	26,301	.....	259,407	458,826
California.....	14,084,403	3,074,344	2,566,618	1,154,521	290,078	464,221
Colorado.....	860,379	.....	10,867	64,500	28,770	318,069
Connecticut.....	8,188,995	219,911	826,495	225,482	116,319	120,567
Dakota.....	2,000,955	5,800	39,437	700	40,472	100,243
Delaware.....	1,876,275	25,800	1,712	.....	27,284	26,268
Dist. Columbia.....	20,920	67,609	.....	155,460	1,692	275
Florida.....	353,116	.....	2,406	.....	42,474	428,196
Georgia.....	7,434,485	.....	19,151	.....	315,073	594,888
Idaho.....	310,644	3,500	20,295	97,000	12,838	72,029
Illinois.....	53,657,943	6,551,029	1,035,069	20,718,123	865,923	1,519,158
Indiana.....	27,377,797	334,519	367,561	1,309,264	494,944	868,616
Iowa.....	55,481,958	6,293,113	1,075,988	2,776,813	854,187	1,757,849
Kansas.....	21,671,762	11,482	483,987	791,384	418,833	1,032,724
Kentucky.....	18,211,904	49,100	58,468	.....	301,882	541,912
Louisiana.....	916,089	.....	7,618	.....	186,464	824,147
Maine.....	14,103,966	6,000	1,167,730	777,385	150,845	183,576
Maryland.....	7,484,871	229,325	17,416	62,000	122,907	139,643
Massachusetts.....	9,655,587	144,117	829,528	1,371,865	150,435	110,617
Michigan.....	38,821,890	43,216	440,540	3,513,045	384,578	506,053
Minnesota.....	19,161,385	83,450	523,138	462,000	275,545	386,505
Mississippi.....	7,454,657	.....	4,339	.....	268,178	459,167
Missouri.....	28,572,124	140,764	283,484	589,055	661,405	1,419,527
Montana.....	408,738	9,000	55,570	24,500	11,308	161,679
Nebraska.....	9,723,198	65,772	230,819	86,847	161,186	597,363
Nevada.....	333,188	3,500	17,420	.....	13,319	158,902
New Hampshire.....	7,247,272	99,068	807,076	.....	90,564	141,841
New Jersey.....	9,513,835	358,402	66,518	749,326	152,078	71,808
New Mexico.....	44,827	.....	10,561	.....	12,955	153,746
New York.....	111,922,423	8,955,778	8,362,590	120,801,124	1,437,855	901,866
North Carolina.....	7,212,507	1,000	37,380	.....	232,133	425,293
Ohio.....	67,634,263	2,088,243	2,170,245	30,361,438	769,043	1,093,244
Oregon.....	2,443,723	84,500	153,198	146,534	50,649	306,793
Pennsylvania.....	79,336,012	986,340	1,008,686	7,908,051	854,156	876,081
Rhode Island.....	1,007,103	.....	67,171	.....	21,460	14,124
South Carolina.....	3,196,851	.....	16,018	.....	139,881	223,828
Tennessee.....	17,886,369	3,500	98,740	9,000	303,900	489,774
Texas.....	13,899,320	.....	58,456	.....	606,176	3,478,429
Utah.....	1,052,906	12,020	126,727	140,022	32,768	62,548
Vermont.....	25,249,026	11,837	1,545,789	4,583,241	217,044	186,072
Virginia.....	11,470,923	29,500	85,535	26,000	243,661	432,123
Washington.....	1,356,103	47,963	109,200	70,000	27,622	105,932
West Virginia.....	9,309,517	.....	100,300	96,687	156,356	300,891
Wisconsin.....	33,353,045	489,291	2,281,411	17,253,913	478,374	650,767
Wyoming.....	105,643	.....	2,830	.....	3,730	274,343
Total.....	777,250,287	29,421,784	27,272,459	215,885,361	12,443,120	23,482,391

Grand Total—Butter..... 806,672,071
 " " —Cheese..... 243,157,850

Pounds of Product..... 1,049,829,921

VALUE OF AGRICULTURAL PRODUCTS,

Exported from the United States during five years, ending June 30.

1879.	1880.	1881.	1882.	1883.
<i>Dollars.</i>	<i>Dollars.</i>	<i>Dollars.</i>	<i>Dollars.</i>	<i>Dollars.</i>
546,476,708	685,961,691	730,394,943	562,216,511	619,269,449

STATEMENT SHOWING FOR THE UNITED STATES,
The Population, Number of Milch Cows and Dairy Products as
returned at the Census of 1840-1880.

CENSUS OF	Population.	No. of milch cows.	Pounds of butter.	Pounds of cheese.
1840.....	17,069,453	.....	.....	.....
1850.....	23,191,876	6,385,694	313,345,306	165,535,893
1860.....	31,443,321	8,585,735	459,681,372	103,663,927
1870.....	38,558,371	8,935,332	514,692,683	.....
1880.....	50,155,783	12,443,120	806,626,255	243,145,344

COMPENDIUM OF THE TENTH CENSUS OF THE
UNITED STATES—1880.

Value of farming implements and machinery.	Value of live stock.	Cost of building and repairing fences, 1879.	Cost of fertilizers purchased in 1879.	Estimated value of all farm productions (sold, consumed, or on hand) for 1879.
<i>Dollars.</i>	<i>Dollars.</i>	<i>Dollars.</i>	<i>Dollars.</i>	<i>Dollars.</i>
403,520,055	1,506,464,609	77,763,473	28,586,397	2,213,402,564

ACREAGE AND VALUES.

Acres of land, value of farms, number and value of milch cows, value of all farm products, as reported—1880; and the estimated value of all the milk products of the State of New York, for the year 1883.

Improved Land, Acres.	Value of Farms.	Number of Milch Cows.	Value of Milch Cows	Value of all Farm Products.	Estimated Value of Milk and its Products, 1883.
	<i>Dollars.</i>		<i>Dollars.</i>	<i>Dollars.</i>	<i>Dollars.</i>
17,717,802	1,053,176,741	1,437,855	48,165,142	178,025,695	56,349,065

VALUE OF

Corn and corn meal, wheat and wheat flour, exported during the nine months ending September 30, 1883.

Indian Corn.	Corn Meal.	Wheat.	Wheat Flour.
<i>Dollars.</i>	<i>Dollars.</i>	<i>Dollars.</i>	<i>Dollars.</i>
33,041,152	694,635	57,962,769	87,962,173

THE ONTARIO EXPERIMENTAL FARM CREAMERY.

NOTES OF PRELIMINARY TEST IN 1884.

(*Cream Gathering System.*)

1. The Building cost 3,000 dols. and Machinery 1,000 dols., in all 4,000 dols., as Capital Account.
2. The Building consists of a Receiving room, Wash room, Working room, Cream Vat room, Office, Ice room, Store room, Engine room, and four Dwelling rooms for the butter-maker.
3. The Machinery consists of two Cream Vats, two Churns (200 and 300 gallons respectively), one Butter Worker, one Boiler and Engine of 6 horse-power, the whole capable of making one ton of butter per day.
4. The Creamery was worked experimentally for 33 days in September and October.
5. There were 61 patrons, who gave cream from about 250 cows.
6. The Cans used were the common Shot Gun ($3\frac{7}{8}$ gallons, $8\frac{1}{2} \times 18$ inches for milk space), two inches of cream on which are said to be the standard for one pound of Butter.
7. The average daily receipt of cream from each patron was fully 2 inches or 4 on the can, from 4 cows by estimate.
8. The average price paid for the inch of cream (2 inches on can) was $20\frac{1}{2}$ cents.
9. This by estimate was equal to 10 cents per cow daily.
10. By estimate it took $2\frac{1}{2}$ gallons, or 23 lbs. of milk, to produce the 1 lb. butter inch of cream.

11. The average price obtained for the Butter was 28 cents in Britain, $29\frac{1}{2}$ in the States, and 25 in Canada, irrespective of cost of delivery.
12. The prices obtained for Butter per lb. from various agents were:—

London, England.....	28 cents.
Liverpool, „	28 „
Glasgow, Scotland.....	28 „
New York	29 „
Boston.....	30 „
Montreal.....	25 „
Toronto	26 „
Guelph	24 „

13. The average daily make of Butter was 125 lbs., by churning 50 minutes, the cream having been kept in vats for 12 hours at a temperature of 62° .
14. 1,763 gallons of buttermilk were got from 3,655 inches of cream, being in the proportion of $\frac{2}{3}$ of a gallon of buttermilk to every pound of butter, or every inch of cream may be said to have consisted of nearly *one half buttermilk*.
15. Buttermilk fetched 10 cents per gallon delivered in the city, and on an average is worth 3 cents per gallon for sale or pork feeding.
16. Butter was salted at the rate of 1 oz. to one pound, and packed in pine tubs of 62 lbs.
17. The average route in Cream gathering was $11\frac{1}{2}$ miles out and in, or 23 miles daily travelling for one team.
18. The skimmed milk left at home by this system is estimated to be worth half price, or $3\frac{1}{4}$ cents per gallon; thus for every inch of cream or pound of butter removed there was left 7 cents of skimmed milk.
19. From the accompanying estimate the following analysis of the cost of a pound of butter is obtained:

Gathering.	$2\frac{1}{2}$ cents.
Cream, cost.....	19 „
Making	$1\frac{3}{4}$ „
Marketing	1 „
	<hr/>
	$24\frac{1}{4}$
Less value of buttermilk.....	$1\frac{1}{4}$ „
	<hr/>
Actual cost of production.....	23 „

20. It costs the farmer about 5 cents in summer and 10 cents in winter to produce one pound of butter.

ESTIMATE FOR A CREAMERY SUPPLIED FROM 500 COWS.

RECEIPTS.

	Dollars.
Sale of 67,000 lbs. Butter at average of 27 cents (500 cows May to October).....	18,090
Sale of 30,000 gallons buttermilk, part sold and part feeding pigs, &c., at 3 cents, average.....	900
	<u>18,990</u>

EXPENDITURE.

	Dollars.
Paid for 65,000 inches of cream at average of 19 cents.....	12,350
Four gathering teams at 2 dols. 75 cents per day...	1,300
Butter-maker at 65 dols. per month.....	390
Assistant and occasional outside Inspector.....	250
Butter tubs, 1,300 at 35 cents.....	455
Fuel, oil, &c., for engine	30
Storing ice.....	40
Salt, colouring, and linen cloth	50
Repairs and incidentals.....	50
Books, postage, &c... ..	10
Freight on delivery of Butter at various markets....	325
Interest on 4,000 dols. invested capital.....	320
	<u>15,570</u>
Balance being profit	3,420
NOTE.—The patrons to pay for Tanks and Cans.	

NEW PATENT LEVERLESS CHEESE PRESS.

JOHN GRAY, Dairy Utensil Manufacturer, Stranraer.

[See next page for description.]

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2. Saving of Space in Dairy.
3. Saving of Labour.

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