THE DAIRYMAN'S MANUAL.

A PRACTICAL TREATISE ON

THE DAIRY.

INCLUDING

THE SELECTION OF THE FARM, THE CULTIVATION OF CROPS, THE SELECTION AND BREEDING OF COWS, MANAGEMENT OF THE MILK, MAKING BUTTER AND CHEESE, AND THE TREATMENT OF DISEASES INCIDENT TO DAIRY COWS.

BY

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PUBLISHERS' INTRODUCTION.

The dairy industry has advanced with greater strides during the last two decades than any other of the great agricultural interests. Formerly it was mainly confined to New England and the Middle States. Now, however, in the prairie States dairying has become a leading industry, and it is notable that in the more recently settled territories of the Northwest, the cheese factory or creamery is one of the earliest features in a new settlement. During the period referred to, the entire business of dairying has become almost revolutionized. The extension of the associated system, the invention of new and greatly improved implements and machinery, and new processes, have occasioned these radical changes. The present work embodies a full knowledge of improved methods, and all that is latest and most valuable in dairy lore. Its author has long occupied an advanced position in the march of dairy improvement, as a practical dairyman, a scientific investigator, and a writer for the press. The book embraces the entire subject, and will prove a trustworthy hand-book to every one who is interested in any department of dairying.

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THE DAIRYMAN'S MANUAL.

CHAPTER I.

DAIRY FARMING.

Dairy farming has always been, and will always be, the most profitable branch of agriculture. It is a manufacturing industry, and a skilled manufacture; and manufacturing finished products from raw materials gives the greatest profits to the labor and skill which the enterprising man devotes to the industry. It is so with all manufactures. The cotton planter, who grows the cotton for the spinner and weaver, is hard worked, lives poorly, and never has been known to accumulate a sufficient fortune to relieve him from work; but the cotton manufacturers, who work up the planter's product, are proverbially wealthy, and build up rapid and large fortunes from their skill and enterprise. It is so in all agricultural labor. The grain farmer is not only the slave and the victim of all the adversities of season and weather and markets, but he sees the richest portion of his land carried off in his exhaustive crops, while these leave him nothing where with to restore his fields to fertility; and he is in the unhappy condition—if he is a thoughtful man—of one who is living upon his capital, and is daily eating from a circumscribed and fixed store, the end of which he sees gradually approaching day by day, without any means in his power of averting the impending exhaustion. But when he feeds his grain, and alternates these crops with grass and feeding crops, and transforms them into cattle or sheep, horses or hogs, he becomes a manufacturer—partially so, it is true—and he immediately reaps not only a second profit from his products, but he finds in his manure heaps a permanent source of fertility which flows over and replenishes his soil.

The dairy farmer has a still further advantage in that he not only rears and feeds cattle, but he keeps cows from which he procures milk, and of this milk he makes butter and cheese, consuming by his young stock all the wastes of these manufactured articles, and selling from his farm a highly finished product in a concentrated form which carries away practically nothing in the shape of the fertile elements of his land. Moreover, he purchases cheap waste products and turns these into costly finished products, reserving the valuable wastes of them for the enriching of his soil. For instance, the farmer who sells a ton of hay for fifteen dollars has nothing but this money in return for his labor and a certain quantity of the richest elements of the fertility of the soil. It is the same with the farmer who sells thirty bushels of corn from an acre of land for the same sum of money. The farmer who feeds the hay or the corn to a steer or to sheep doubles his income, and retains a large portion of the substance of his crops, which is returned to the land. But the dairyman who makes cheese or butter trebles his income, and retains nearly everything of value which the crops he has fed to his cows have drawn from the soil, and he has expended nothing but his labor, for which he receives liberal pay. If he purchase hay from his neighbor, he makes a handsome profit from this; and if he buys bran or other feeding substances, he makes a profit from them; and thus turns his labor to the most useful and valuable account. "In all labor there is profit" is as true to-day as when it was written by the wisest of men, the only qualification being—as we may assume is implied in the proverb—that the labor is wisely and rightly directed. And thus the dairyman, who of all farmers expends the most labor upon his farm and in his business, must necessarily reap the most profit.

WHAT A DAIRYMAN SHOULD BE.

It is a trite but true adage that in all sorts of farming "there is more in the man than there is in the land;" and this applies in the most forcible manner to the dairyman. For he must not only be a skillful farmer, but a good judge of cattle; a careful, cautious man, and habitually regular in his habits; endowed with the virtues of patience and perseverance, and good sound common sense; he must be studious, of a retentive memory, and able to judge wisely as to points of his business which may be in dispute; a good business man; and of a certain refined disposition and habits, and exceedingly neat and particular in his person. All these characteristics are indispensable for success in his vocation, and for the following reasons:—

1st. He must be a skillful farmer, because he must grow a large variety of crops, and make his soil exceedingly productive by the aid of the large quantity of manure he may make and gather; and he must expend the crops he raises in the most economical and effective manner. He must understand well the character and uses of different kinds of soil, so that he may select the best suited for his purpose; and he must know how to manage such land as he can best select or procure with the greatest effect and success. His profit depends upon the raising of large crops, and those of the most valuable kinds for feeding; and he must thoroughly understand the different methods of culture for grain, grass, root and fodder crops. All this is indispensable for the successful prosecution of dairy farming.

2d. He must be a good judge of cattle, because the cows are the tools of his trade, and without the best tools no good work can be done. Moreover, there is such a large variety of breeds, and such a great variation in the quality of cows in use for dairy purposes, that without good judgment, and some accurate knowledge as a basis for the exercise of judgment in this respect, a dairyman would be at a loss how to make a proper selection, and would be very apt to make a serious and perhaps ruinous blunder at the outset. There are exceedingly great differences in cows, and yet, as a rule, good cows are easily distinguished from poor and unprofitable ones, and the distinguishing marks and characteristics should be well known to the dairyman who expects to make his profit from them. So, too, he should be able to choose the most promising calves from which to replenish his stock, and also to choose a good sire for his calves, that he may steadily improve his herd in character and value. It is also indispensable for full success in the dairy that the dairyman should be able to judge of the character of the cows he is feeding, that he may discard those which are not profitable and keep only those which pay the best for keeping; and while there are certain accurate tests by which this can be ascertained, yet it is a valuable acquisition for a dairyman that he can tell at a glance which cows of his herd are the best and which he had better get rid of as soon as practicable.

3d. Carefulness in every detail, cautious supervision over his stock, and in every little matter which calls for change or modification of method, are necessary qualifications in the dairy. A thousand small things are coming up at times which need foresight to guard against, and caution to avoid or evade. There are so many contingencies which are to be apprehended constantly, and so many accidents continually threaten to occur in this most intricate business, that unless one is naturally inclined to be careful in every matter of management, the accidents which will surely follow will be sufficient to rob the dairyman of his profit. For instance, a gate may be left open, and the cows thus get into a luxuriant clover field, becoming bloated or otherwise injured, and some of them be permanently ruined; or a cow may be left unfastened in her stall and spend the night roaming about the stable, molesting the other cows and perhaps injuring or even killing one or more of them. The feed box may be left open and the loose cow may be found dead in the morning from overgorging herself with the feed. The water trough may be permitted to overflow on a cold day and an icy spot thereby formed upon which a cow may slip and fatally injure herself. The root cellar may be left open and the roots become frozen, and this stock of indispensable feed be lost. The water trough may be leaking and the cows may go without a supply for the day, and half the day's milk be lost. And so on all through the daily routine of work there are many chances of damage which are to be avoided only by the exercise of great care and constant caution.

Regularity too in every detail must not be neglected. It is one of the rarest attributes of a man, to be constantly regular to hours and minutes, and to methods. And yet it is of the utmost importance in the dairy. A cow is a machine for making milk and butter. This fact should never be lost sight of. And the cow must be fed and watered, and supplied with every attention: milked, turned out and turned in, protected from storm and weather, and in every way managed with perfect regularity. She is an accurate time keeper, and if her feed is late she frets, and fretting wastes milk, and the milk loses cream. This fact was learned by the writer in a manner which could not be mistaken. It was the custom for years in his dairy to feed at five o'clock in the morning and to milk at six, every day but Sundays, when the work was delayed an hour, or somewhat more. As an accurate record was kept of every milking of each cow, it was soon found that the quantity of milk on the Sunday evening and Monday morning fell off considerably, as much as from two to four pounds per cow, some cows losing considerably more than this—one nervous, fretting beast, which could scarcely wait her turn to be fed, losing the most. The result was so closely connected with the cause that there could be no doubt of it; and yet out of regard for the day, and on the principle of doing as little work as possible on the day of rest, this loss was submitted to without complaint. The feed also, being prepared on Saturday afternoons for the whole of the next day and Monday morning, was not so fresh, and this irregularity had its share in the result. And so it is in other respects. The milk must be skimmed at regular periods; the cream kept at a regular and even temperature, stirred at every addition of fresh cream to keep the quality and acidity properly adjusted; the temperature in the milk-room must be regularly maintained at sixty-two degrees; and every other detail is to be kept even and regular from hour to hour and from day to day. If the man or woman upon whom such work devolves has not an instinct of regularity, or has not made a habit of it by constant discipline, the labor will be irksome, irregularity will soon prevail, and the dairyman will not prosper as he might and should do.

4th. Patience, perseverance and good common sense are requisite for success in the dairy. From the training of a calf to the last operation in dairying, patience is called for. The calves and cows should be well trained, and made docile and good natured. This cannot be secured unless the trainer is a patient man, able to control his feelings, and quell any rising anger stimulated by some accidental mischance. Impatience will make cows vicious, and their owners, at times, brutal. An accidental movement made by a cow, when the milker is careless or incautious, may cause a pail of milk to be overset. An impatient man will kick or beat the cow for his fault; for, as we have seen, he should at every moment be on his guard for such accidents, and always ready to avoid them. We should remember that the man is the reasonable animal, able to exert self-control and to think, while the cow has only a natural instinct, and that alone makes her suspicious and always on the defensive against danger or attack. An unguarded, hasty approach may cause a cow to kick or attempt to do it instinctively, and to avoid all such dangers the dairyman should, as we have already shown, be exceedingly cautious; but when they occur, the greatest patience is to be exercised. Cows should be pets, without fear, and with affection for their keepers; they are then most profitable to their owners; and to bring them to this desirable condition of docility the dairyman must exercise great and constant patience with them.

Perseverance and common sense will enable one to surmount difficulties and to apply proper remedies for them at the right moment. Dairy work is full of risks, and as few persons are able to meet every contingency until they have long experience, it is necessary to persevere in spite of disappointments, using good common sense to make the lessons learned from time to time available for future service.

5th. A dairyman must be studious, and remember what he learns, applying his gathered information to the better working of his dairy. There is no other business connected with agriculture which is so intricate and involves so many uncertainties, or which requires such constant application of special scientific experiment and of careful personal investigation and practice; and to meet successfully all these and other requirements of his work, a dairyman must have at least a fair knowledge of dairy literature, and know what other dairymen are doing, and what is done at the numerous experiment stations and by private investigations. At least he must have a good handbook or manual for reference in case of need, and must not be averse to learn something from every possible source of information. Besides, one man alone is weak and helpless, and knowing this, the dairymen have formed associations for mutual help and information. It is very necessary then that every dairyman should make himself competent to discuss at these meetings such questions as may arise, so that from a multitude of counselors he may find safety from the difficulties which he meets constantly in his daily work.

6th. The dairyman must be a good business man, and make himself acquainted with the ordinary principles of business; able to keep accounts, and discipline himself as much as possible in the strict rules of regularity and promptness which conduce so much to success in any avocation. He is a manufacturer as well as a farmer; a purchaser and a seller in the markets, and should therefore keep himself acquainted with the markets, and should habituate himself to weigh and measure accurately everything he buys, everything he produces, and all that he sells, keeping strict account of all these matters. Otherwise he cannot tell where he loses and where he makes profit; he will not know an unprofitable animal from a well paying one; he will not know which are the best and most profitable crops to grow for use, or the best foods to purchase; he will be groping in the dark all the time, and must necessarily suffer in pocket from his want of accurate knowledge of his business.

Lastly, he should cultivate a certain refinement of manner and disposition, a kind, considerate and thoughtful habit, and, above all, practice the most thorough neatness and cleanliness in his person and manner. These requirements should be so constantly cultivated that they will become a second nature, an instinct which is so thoroughly and completely a part of the man's character that they come into action spontaneously and without thought or effort on his part. For instance, the treatment of his cows should be instinctively kind and gentle, and the dairyman must so train himself to this habit, think of it so often, and make it so much a conscientious duty and a regular system of action, that he will never be tempted to act otherwise. Mr. Harris Lewis, President of the New York State Dairymen's Association, once remarked in reply to a question as to how cows should be treated, that every man should treat a cow as he would a lady; that is, with as much consideration for her comfort and happiness, and with the same gentleness and politeness. Politeness is simply the essence of thoughtful kindness, and this every dairyman should accord to his cows as a matter of common habit. Cows so used will well repay the favor, and in turn become kind and gentle, and never exasperate or annoy their owners with the common and troublesome vices of cows. Perfect cleanliness should be made a constant study, until it is so thoroughly a part of the daily life that a dairyman would no sooner milk a cow or handle milk or butter, or go about the work in the dairy, in an unclean condition or manner, than he would put a dirty hand in his food, or go to a social gathering all unwashed and with clothes reeking with filth. This scrupulous cleanliness is indispensable in the dairy, and it should be so made a part of the nature and disposition of the dairyman by constant self-training, that it will naturally apply itself to every part of the dairy work—the care of the stables, the management of the cows, frequent carding and brushing them, the washing of the udder when necessary, but always the wiping of it with a wet sponge or towel, the cleansing of the utensils, the careful protection of the milk from everything which would make it impure or offensive, the situation and care of the milk-house, the manner of milking, churning and preparing the butter, with every other of the various details of the work. In every way the most constant and perfect cleanliness being necessary, this habit must be so thorough and strong that no effort will be needed to accommodate one's self to it, and therefore it must be made a part of himself by every thorough and successful dairyman.

In the following chapters it will be made apparent how very great and important results hang upon the merest trifles, as one might suppose, in dairy work. But it is in regard to these trifles that most of the great affairs of nature and industry depend for their results. A spark of the smallest size dropped into a powder magazine may lay a town in ruins or destroy a great ship and a thousand lives. One single grain of sand will destroy the balance of a great mass of matter ; a single degree of temperature is sufficient to turn water into ice, or solid ice into liquid ; and is it strange, therefore, that little things should have an important effect upon the quality and the value of the butter, and so affect seriously the question of a man's success in business, or of profit or loss in it ? For this reason my readers will be asked to consider every supposed trifle mentioned in these pages to be of importance to them, because good reasons can be given for it, and my own experience has shown in every case that the little things which may be referred to are really not small by any means, but of serious importance in their result.

CHAPTER II.

DAIRY FARMS.

The choice of land for a dairy farm should be made with reference to some special points which have a great influence on the successful pursuit of the business. Some particular localities excel in this respect. Vermont, Western New York, Western Pennsylvania, the Western Reserve of Ohio, Central Wisconsin, and parts of Iowa, have become noted for the excellent quality of their dairy products, and have gained a high reputation as dairy districts. If we consider how truly these localities excel in this, we find they possess some special peculiarities of soil and herbage. All of them are underlaid by a limestone formation, and have a somewhat loamy open soil, which produces very sweet and nutritious herbage, consisting mainly of blue grass, or, as it is sometimes called, June grass, the *Poa pratensis* of the botanists, and Kentucky blue grass of the seedsmen. They are somewhat rolling or even hilly as to surface, are well drained naturally, and are well supplied with good pure water, more or less impregnated with lime, or as is commonly called, hard. As pasturage is the main reliance of the cows, the herbage and the character of the surface are important considerations; for the quality of the grass has much to do with the character of the milk, cheese and butter, and the ease of locomotion of the cattle over gentle slopes, and the general healthfulness of such ground, are equally important.

If we go abroad into foreign countries, we shall find that similar peculiarities of the land have conferred upon certain districts the character and reputation of excellent dairy localities. The English counties of Cheshire, where the famous Cheshire cheese is made, Derbyshire, where the first cheese factory in England was established, Leicestershire, where the exquisite Stilton cheese is produced, Wiltshire and Gloucestershire, where also fine cheese of peculiar excellence is made, and some other places, as Dunlop in Scotland, where Cheddar cheese was first made, and which had a reputation for its fine cheese a hundred years ago, are all noted for the very same peculiarities of geological formation, soil and character of surface and healthfulness. So that these circumstances being general, a rule may be predicated, that in choosing the locality and soil for a dairy farm, these characteristics should be sought in the land to be chosen.

But not every farm can be of this kind, and not one-tenth part of the number of dairy farms are located in these districts. These farms are found everywhere, and cheese factories, creameries and private dairies are scattered thickly over the whole face of the country, from the Atlantic to the Pacific; and even bordering on the sea shores. Nevertheless, there are certain requisites to be secured whenever a farm is sought for dairying, which the farmer who is turning his attention to this lucrative pursuit would do well to recognize and understand. The choice may be large and wide, if these certain necessary points are found. The land must be well-drained, or it will not grow full crops or the most nutritious herbage, and will not be healthful. If it is not so drained naturally, it should be done artificially and thoroughly. This is of the greatest importance, for often the richest and most fertile soil is in low bottom or swampy land, wanting only drainage to become productive of the best permanent grass, and such crops are the most valuable for feeding cows. The kind of soil is of less importance, because there are so many different ways of managing the business, that it is only necessary for the farmer to adapt his methods to his soil, to equalize whatever differences he might be obliged to meet. For instance, the cheaper lands, which are at a distance from the best markets, must be adapted to pasture, and the heavier clay soils of a somewhat moist character are preferable. Even a poorer class of soils, if they are adapted for grass and are cheap enough, may answer very well for dairy purposes; because it is the low cost of the product in localities which are distant from markets which enables dairymen to compete favorably with others whose land, nearer to markets, is more costly. Cheap land is a great advantage in dairying, for butter and cheese are concentrated products, and the cost of transportation is light. It was the cheap lands of the West which changed the center of the dairy business from Western New York to Wisconsin and Iowa; for they attracted the best and most enterprising farmers, who removed thither, tempted by this advantage of cheap soil, and there, adopting the best methods of practice, quickly lifted from Western dairy products the stigma of their previous low quality, and raised them to the highest point of value in the Eastern markets by the force of their high excellence. It is this, too, which is constantly moving the center of the business to the West, and will soon bring the cheap and rich lands of the South into competition with the Eastern districts.

But while this is true, the system of soiling and high culture of the land enables the owners of higher priced farms in the more thickly populated East to carry on the business profitably, by producing goods of fine quality, and supplying the best classes of consumers and the dealers in fine groceries with small quantities in a perfectly fresh condition, and by catering to the special wants of these purchasers, who desire their butter and cheese put up in attractive forms. For this purpose the kind of soil is of little account, as this class of dairymen are skillful farmers, who generally own fine stock, and know how to manage their farms in the most suitable manner for the production of soiling crops; and they are near the markets where cheap concentrated food can be procured.

Some of the best fancy dairies are found near the large cities, upon light and inferior soils which are unfit for pastures and permanent meadows, but which are made to produce heavy crops of roots, fodder corn, clover, orchard grass, millet, mixed peas and oats, and other kinds of fodder; and which, by the aid of the practice of ensilage, are made to support, in many cases, one cow or more to each acre the year round. In some localities, manure from the cities and special fertilizers are procured to aid in keeping these light lands in the highest state of fertility; so that, on the whole, it may be said that in choosing a dairy farm the experienced dairyman is not bound by any circumstances, but may safely take the best situation for his purpose, a favorable location being of the greatest concern to him.

In general, however, the dairyman would safely choose a moderately level farm, well watered, having a somewhat firm clay loam soil, lying in a compact shape, with a convenient spot near the center of it for his buildings, and as near to a railroad station as possible. If there is a permanent cool spring upon it, that would be a great advantage; and if the spring is located near the dwelling, and in a convenient place for the milk-house, it would be still better.

Perhaps the plan of the author's farm, given at figure 1, might be suggestive of what can be done in laying out a farm for a dairy, which at first seemed to offer many disadvantages. The soil is a light sand and far from fertile naturally, but a swamp meadow contributed ample supplies of rich muck, and a railroad station a few miles only from New York City gave good facilities for procuring abundance of manure to aid in growing root and soiling crops. A public road ran along the front of the farm and another divided it into two nearly equal parts. By fencing in an open wood lot and seeding it down with mixed grasses, a shaded pasture, supplied with a permanent spring, was made for the exercise of the cows. A small pasture field was made by seeding with orchard grass and clover near the barnyard, and a gate on the road gave easy access to it. Another lot seeded to mixed grasses was made at the back of the barn, and a gate opened to it from the yard. A small grass lot was

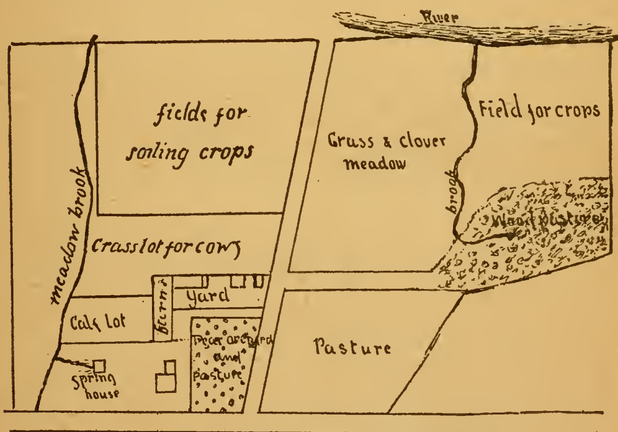

Fig. 1.—PLAN OF A DAIRY FARM.

kept for calves adjoining the calf pen. These lots were fenced, but the rest of the land was all thrown into two fields, which were cultivated for fodder and root crops. A brook supplied the calf lot and one grass lot with water ; a spring and a small run supplied the woods pasture. A dwarf pear orchard near the house made a run for calves and poultry, of which a number of light Brahmas were kept for market chickens. The barnyard contained half an acre ; the barn, sheds, bull and calf pens, and stable, formed a right angle facing to the south.

The yard was surrounded with old shady cherry trees on the south side, and a lane gave an outlet in front of the yard to the road. A gate opened from the yard into the road, opposite the lane leading to the woods pasture. A spring near the house gave an opportunity for making a convenient milk-house with a cool deep pool for setting deep pails, and an apartment for churning, and storing butter, pails, etc. The dairy-house was in a grass plot upon which calves were occasionally tethered, and this was shaded by apple trees. Access from the house to the barn and to the milk-house was open and unobstructed with any obstacle, excepting the small hand gates through the two yards—a second yard being enclosed in front of the cow yard; it contained the horse stable and the poultry house.

This plan was gradually grown up to by various additions which were made as the farm, at first exceedingly poor, was brought into better condition. The farm was not designedly purchased, but came into the hands of the author by accident. It was almost hopelessly barren, but the land was located near a village and had some extrinsic value on that account. It was taken in hand for the purpose of an experiment designed to prove if it were possible to make a poor farm fertile in such a way as to pay for the improvement, and by what means this improvement could be made most easily and rapidly. The author's previous experience in dairying led him to choose this as the most effective means for arriving at the desired end. Previously one cow only was kept on the farm. This number was at once increased to fifteen, and a milk dairy was established. The food was wholly purchased, and an attempt was made to make the cows pay all the expenses from the milk, and so supply the badly needed manure for the improvement of the farm. Clover, roots, corn, and fodder corn were at first grown by the help of artificial fertilizers. The attempt was wholly successful. The income from a milk route, the milk being sold at six cents a quart, more than paid expenses, leaving a large quantity of manure, increased in amount by liberal additions of swamp muck, to go upon the land. The surplus earnings were spent in procuring pure bred Jersey and Ayrshire stock, and the business was changed to the making of butter instead of selling the milk, which provided means for rearing valuable calves. All this work was a labor of love, and gave excellent facilities for the study of dairying, and a great many experiments, numerous investigations—chemical and microscopical—into the nature and behavior under varied circumstances of milk, butter and cheese, and observations were made upon the habits and disposition of the cows and calves, and the values of feeding stuffs used, all being taken from the practical standpoint of the actual work in the dairy.

That a farm of this uninviting kind could be used for a dairy farm, and brought up to a fair degree of fertility in a few years, will serve as a reply to numberless inquiries constantly being made as to the possibility of doing this—making the dairy pay expenses from the first, though all the food and most of the fodder be purchased. The fact shown is quite pertinent to the subject of this chapter, although it may seem to be somewhat of a digression from it, as tending to prove that a person with some experience, and of a cautious, patient, persevering and economical disposition, may have an exceedingly wide choice in the selection of a dairy farm, so long as it may have fitness in some respect for the purpose designed. For a novice, however, a choice of this kind would almost certainly be disastrous, unless he felt that he was all that a dairyman should be, and conformed fully in this respect to the qualifications described in the previous chapter; and, moreover, unless he began in a small way, feeling his path as he went along, and learned as he went to profit by any probable mistakes he might make.

In concluding these remarks upon the choice of a farm for the purpose of dairying, some especial reference should be made to a greatly neglected portion of the country, which offers unusual facilities for enterprise in this direction. This is that region, blessed with a most favorable climate and abundance of cheap land, in the midst of good markets for the produce, commonly called "the South." From Virginia southward to the Gulf of Mexico stretches a country which has been for a century given up to the exhaustive culture of tobacco and cotton, and which has procured its principal food supplies, and all its butter and cheese, from the North and West. Yet no other part of the United States is better adapted for the growth of feeding crops, and for the keeping of cows for dairy purposes; while its mild winter climate renders it most especially fitted for winter dairying and the production of fine butter at a season when the northern part of the country is buried under snow or frozen solid with the intense cold. In the very center of the Southern States is the southern mountain region, where the excessive heat of the South in the summer and the intense cold and the snows of the North are both unknown. It is an elevated, undulating plateau averaging in hight 2,500 feet above sea level, and in some localities reaching 3,700 feet to the base of the still higher mountains which rear their tops from 5,000 to 6,500 feet above the level of the sea. The whole region produces all the grasses, corn, wheat, clover, roots, and every kind of fodder crop, to perfection. It is abundantly watered with innumerable streams and springs of the purest water; the air is pure; mosquitoes and other noxious insects are unknown. Cattle can find subsistence in the forest ranges the whole year, thus affording a specially favorable climate for open pasturage during the winter, when the cultivated grasses are grown for feeding dairy cows. The highest temperature of the summer rarely reaches eighty degrees, and then only for a few hours in the middle of the day, while the nights are always cool; the lowest temperature of winter is from ten above to eight degrees below zero, and this occurs only very rarely at night and during a few hours, for at noon following the warm sun will melt the snow and ice formed in the night, and make the air agreeably warm. Snow rarely lies on the ground more than three or four days, and an exceptional fall of snow may be three or four inches deep, and will begin to melt off as soon as the clouds clear away. Everything invites the dairyman to this pleasant and healthful locality. Cheap land, rich soil, natural herbage, a most favorable climate, and a central position as regards all the large cities and towns, and the cotton fields, in the Southern States, to which the supply of butter and cheese is brought from the Northern markets. Florida, with its large floating winter population, is twenty-four hours only from the region, and affords a most profitable market for fine butter, an article unknown in the Southern cities, excepting as a few pioneer dairymen in the mountain country are beginning to supply the active demand for it, and the market is practically unlimited.

A few words of encouragement might also be given to the family dairy, where one cow is kept for the domestic supply of milk and butter. In such a case the farm may be a plot of one acre or more in the suburbs of a large city, or town, or village; and the pleasure and profit of having such a small dairy farm tempts thousands of people from the close streets of a city to the broader and sweeter lanes of the suburban vicinity. This work is intended to meet the wants and desires of this large class of dairies, and to encourage more of them, by showing how the work is to be managed, and also how a cow may be kept with profit upon an acre of land under cultivation, and the clippings of a lawn, with the aid of the surplus vegetables from the garden. This is entirely possible, and it has been done for several years by the author at his residence, a few miles distant from his farm, where a family cow, chosen from the herd for its docility and productiveness, has been kept to supply the needs of the family. And in choosing a rural residence the prospective owner should be careful to consider the possibilities of his little farm for this desirable purpose.

CHAPTER III.

COWS FOR THE DAIRY.

One notable source of ill-success in dairying is inferior cows. It is said that even in the oldest and best dairy districts of New York, one-third of the dairy stock will not more than pay the cost of its keep. This is not to the credit of good dairymen, and shows they do not give proper attention to their account of profit and loss. Poor milk-yielding cows are "a crying evil," and the annual loss from this cause keeps many dairymen in straitened circumstances; and so long as they persist in retaining this kind of stock there is for them but little hope of bettering their fortunes in the dairy.

Inferior milkers are not wholly confined to the scrubs and common cows of the country, for they are found among all breeds of thoroughbred stock. Prof. Roberts, in a recent address at a dairy convention, affirmed that much of the thoroughbred stock of the country is a positive damage in the dairy. Weak in constitution, with the milking habit bred out, they transmit these characteristics to their progeny, and thus become the source of infinite mischief and loss to the dairyman who is trying

Fig. 2.—CHAMPION MILKING SHORTHORN COW "RED CHERRY."

to improve his herd by introducing pedigree blood. Every inferior cow when found out, he said, should have its head cut off, and not be turned away indiscriminately to cheat and cause loss to other dairymen. No matter how renowned its pedigree, let it go to the shambles or to the beef producer, but not to the dairyman. Harris Lewis facetiously urged at the same convention, that any dairyman having a poor milker would make money by giving her away, and if he had scruples in this regard, "he might make *a present* of the beast to his mother-in-law."

Some years ago one of the best dairymen in Herkimer County, New York, desiring to ascertain the profit he was realizing from different cows in his herd, instituted a series of tests. He had found from actual experiment that the average cost of keeping his dairy stock through the year was at the rate of thirty-five dollars per head, and this sum was embraced under the following items:

Two and a half tons of hay at eight dollars per ton	$20 00
Pasturage during the season	7 50
Two hundred pounds ground feed in spring	8 00
Interest on cost of cow at forty-five dollars, and depreciation, ten per cent	4 50
Making, per cow, a total of	$35 00

Now selecting five of his best cows and five of his poorest cows, and measuring the quantity of milk on certain days of the month during the season, he found that the five best cows yielded five hundred and fifty-four gallons of milk each, which realized, in butter and cheese sold at market rates, an average for the season of eleven and a half cents per gallon, or a total of sixty-three dollars and eleven cents per cow. This gave him, after deducting cost of keep, twenty-eight dollars and seventy-one cents per cow, clear profit.

On the other hand, the five poorest cows yielded only two hundred and forty-three gallons of milk each, which at eleven and a half cents per gallon amounted to twenty-seven dollars and ninety-five cents each, or seven dollars and six cents less than the cost of keep. As a result of this test, it is needless to say the poor cows were not kept over the second season. If this result was obtained by one of the best dairymen, what could be expected from the herd of the average dairyman ?

There are cheese dairymen who are keeping dairies averaging from twenty-five to thirty cows, who obtain, one year with another, a yield of six hundred pounds of cheese per cow and often more, while other dairies in the vicinity do not get a yield of much more than half that amount per cow. It must be evident that herds like the latter are not rapidly bettering the fortunes of their owners. And yet this thing goes on from year to year without the proper effort to get out of the rut.

The statistics of the cheese factories in the State of New York show many inferior herds that do not yield on an average much above three thousand five hundred pounds of milk per head during the year, whereas the average should be at least five thousand pounds. The milk of every cow should be tested as to quantity and quality, and inferior cows discarded. It is better to pay a good round price for a superior milker than to take a poor one at any price, since the cost of keep on the latter will most likely insure loss. There are instruments which will determine quickly and easily the percentage of butter in any sample of milk, and with sufficient accuracy for all practical purposes, so that by weighing the milk, from time to time, the real value of a cow as a milk producer may be known ; and such tests are imperative if the best results in dairying are to be obtained.

Dairymen should breed their own stock as the surest way to get superior milkers at moderate cost; but in breeding dairy stock care should be taken that calves be raised only from *deep milkers,* and it is quite as important that the sire should be of a deep milking family as the dam.

The choice of stock is so large that there is danger of the dairyman being bewildered in the great variety, and of finding difficulty in making a selection of any one pure breed for the improvement of his herd.

THE NATIVE COW—so called—is necessarily the basis upon which the dairyman must form his herd, and fortunately this stock is good enough, not only for the purpose of being crossed by pure bred bulls of different breeds for special uses, but for careful selection and improvement within itself. It has, since the first settlement of America, been reared from imported cows, which, there is reason to believe, were the best of their kind, and the progeny of these have been crossed again and again with bulls of every kind, until the native cow has a mixed blood the origin of which is impossible to distinguish. The preponderance of blood is clearly the Shorthorn, or, as it was formerly called, the Durham, which was imported systematically seventy years ago, and has been largely intermixed with the native stock in many localities, chiefly in New York, Pennsylvania, Kentucky, and Ohio. In New England the preponderance of blood is Devon and Ayrshire, these lighter cattle being better fitted for the rougher and less luxuriant pastures of the East. These three breeds seem to be chiefly mingled in the native stock, and if a most careful selection had been made, with a set purpose to get useful cows, no better choice could have been made. Occasionally may be seen the white face and brick-red color of the Hereford, and more recently the Jersey and the North Holland (or, as it is now called, Holstein-Friesian) breeds have become largely intermixed with the native stock. But it is wrong to suppose that a mixture of many excellent breeds will produce a race of cattle combining all the good qualities

Fig. 3.—THE AYRSHIRE COW "FLORA."

of the progenitors. Unfortunately, the contrary is the case, and all the bad qualities are more likely to be perpetuated. Trying to improve the native race within itself is usually unsatisfactory and a slow process, the better way being to select the best of the cows and cross them with a well-chosen pure bred bull of a suitable kind, either for milk, cheese, or butter. It is a matter of considerable importance for the dairyman to select the right breed for his purpose.

THE SHORTHORN BREED is, perhaps, the most valuable of all those used in dairying. If there is any one breed which may claim to be the most suitable for general purposes, as for milk, cheese and butter, and beef, when no longer profitable for these, it is the Shorthorn. Half-bred or grade Shorthorn cows are more largely kept for milk dairies and for cheese making than any others, because they are good milkers and fatten quickly when dry, and then make good beeves, usually bringing for slaughter as much as, or more than, the original cost. This breed originated in the north of England about one hundred years ago, and was then noted for the excellence of its cows; the best of them producing as much as twenty-four pounds of butter per week and forty quarts of milk daily. It is claimed that the breed came first from Denmark, Holland, and the north of France, where it laid the foundation of the highly productive herds of various races in those localities. At the present time, however, with the exception of a few families noted for productiveness of milk and butter, this breed has greatly deteriorated in this respect, having been bred for beef, and the milking character having been neglected. The engraving, figure 2, gives an excellent and accurate portrait of a cow of this breed, which won the champion prize for the best yield of milk two years in succession at the English Dairy Farmers' Association. She is not sufficiently pure bred for entry in the Herd-book, but shows very well the special peculiarities of form of the pure Shorthorn in its best condition as a dairy animal. Her product at the exhibition was fifty-one pounds and twelve ounces of milk, which contained 3.26 per cent of fat, equal to a product of about one pound and twelve ounces of butter daily.

THE AYRSHIRE BREED deserves the next place as a valuable dairy cow, not because it is the largest milker, but is a very profitable cow for both milk and butter, and is adapted to a large range of locality and varying circumstances. This breed originated in the southwest part of Scotland, in the rich vale of Ayr, and has a large infusion of the same European blood in it which was bred into the Shorthorns. It dates back for more than a century, and is the basis upon which the noted dairy business of Ayrshire, or the Dunlop district, famous for its excellent cheese and butter, has been built during a hundred years. It has been greatly improved by careful selection, and is now a model dairy cow. Without depreciating any other breed of cows, she may easily take this position. She will not displace the Jersey in the fine butter dairy, nor the Dutch cow in the milk dairy; but she will fill the place of both of these in the cheese dairy, and while she will not compare with the latter in amount of milk product, she will greatly surpass the former. She is *the* farmer's cow. Her milk makes a superior cheese, and, being rich in cream, it can easily be turned to profitable butter production. Her average milk product will amount to at least 5,000 pounds a year, and some of the best cows will yield from 6,000 to 8,000 pounds between two calvings. She is easily kept; she is a good and hearty feeder; she is remarkably hardy; her coat is thick and close and warm enough to resist exposure to the most severe winter storms, and it can sustain the great heats of even the West Indies without discomfort. One of her good points is that she holds on to her milk production nearly up to the time of again calving, and although a cow may not be an excessively large milker in her first freshness, yet by a long-continued and well-sustained product the total average is eminently satisfactory to the owner. An example of this may be given in the cow Bolivia (in the herd of the author), a typical Ayrshire cow. The following figures, taken from the record of her milking with her first calf, dropped when the dam was less than two years of age, give the daily product for the first, the fifteenth, and the last day of each month in a year, during which her whole product was a little more than 3,000 quarts:—

1879.	1st. lbs.	15th. lbs.	30th. lbs.
March	33	31	30
April	31	34	33
May	29½	31½	30½
June	30½	30½	32⅛
July	31	29½	29½
August	29	28	26½
September	26	24	21
October	21	20½	19½
November	18	18	20½
December	21½	20	19½
1880.			
January	20	19	19
February	18	18½	17½

Her second calf was dropped in April, 1880, and it was necessary to feed dry hay only, in very limited quantity, to dry her off before she began to spring again.

The Ayrshire makes a very good cross upon any breed. With the native cow, the produce is nearly equal to and sometimes surpasses, in productive value, the pure breed; with the Shorthorn, the cross has made some noted cows, one especially having a record of one hundred pounds of milk in one day. The Ayrshire-Jersey cross

Fig. 4.—THE FIRST PRIZE HOLSTEIN-FRIESIAN COW "NETHERLAND QUEEN."

makes a most valuable family cow, and has been bred for this purpose for many years; one in the author's dairy has given twelve pounds of butter weekly regularly for twenty-two weeks after calving, and then gradually decreased, until her product in the year was nearly four hundred pounds. Several cows of this cross have given two pounds a day through the summer season, and have continued productive until within a few weeks of their next calving.

THE NORTH HOLLAND—Holstein, Friesian, Dutch, and now called Holstein-Friesian as a compromise among the breeders—is the largest milker existing, whole herds having made a record of more than eighteen thousand pounds of milk in a year. These cattle are brought from Northern Holland, where they have been bred for dairy use during many years, and where the pastures are unsurpassed for luxuriance. A large number of these cattle have been imported of late years into the United States, and have become very popular. They are black and white in color, of large size, handsome form, with deep, capacious udders; but, as may be easily supposed, require very liberal feeding to enable them to make the large yield of milk and butter which many have done. The owners of herds of these cattle claim that they are superior to any other breed in regard to the product of milk and butter from an equivalent of food; but as the friends of every other breed make the same claim, it is not necessary to burden these pages with the mass of figures which have been published to show the remarkably large yields of some of these cows. For the milk dairy they are certainly unsurpassed in point of yield; and they are rapidly becoming popular for cheese and butter dairying. Not a small advantage of this breed is that it is of very large size, equaling the Shorthorn in this respect, and takes on flesh and fat easily, so that the steers make good beef, and the cows may be turned off to beef without loss. This use, however, seems at present quite distant, for the high price of the stock and its scarcity forbids it, and will do so for many years to come.

The Jersey Breed has taken the most prominent position in the dairy during the past ten or twelve years. Previously it was the fashionable cow of the rich amateur farmer who could afford to pay hundreds of dollars for one of these elegant animals as an ornament to his lawn and well kept pasture, and for the supply of cream and butter for his domestic use. Gradually it became the fashion for these wealthy persons to establish fancy dairies, and to make the choicest quality of butter, which was put up in attractive forms, for sale to consumers who could well afford to pay a dollar per pound for a product which was certainly known to be clean, pure, and of the most perfect flavor and appearance. It was a new departure in dairying, and has had a most beneficial influence in compelling the makers of butter to follow the example set in this way, or in inducing them to do so, in the hope of securing higher prices for their product. A wholly new business, commonly known as fancy butter making, has sprung up, and this has led to the extensive introduction of winter dairying and a large variety of improved apparatus. It is a new instance of the improvement in agricultural methods which has been brought about by the use of improved stock; and just as the Ayrshire breed in Scotland, or the Dutch breed in Holland, induced a remarkable change for the better in the pastures and in the culture of the soil, as well as in the farm buildings—and by reflection, as it were, in the farmers themselves—so the Jersey cow has revolutionized the butter dairy, and has improved it more in the past ten years than every other influence had done from the beginning up to that time.

The Jersey cow, sometimes wrongly called Alderney, is native to the island of Jersey, the largest of the group known as the Channel Islands, which are situated near the coast of France, in the English Channel. These islands are Jersey, Guernsey, Alderney, and Sark; the last two being mere islets. The three first mentioned are each noted for a special breed of cattle, much alike in character, but yet sufficiently different to be distinct; the chief characteristic in all of them being remarkable elegance in form and color, and exceeding richness of the milk.

The island of Jersey, with a total area of about three hundred square miles, contains more cows than any other equally small part of the earth; and they are more highly valued than those of any other breed, averaging probably $300 or $400 each. So many have been imported into the United States that there are more cows of the breed here now than there are in Jersey—viz., about 10,000—while the half-breds or grades, which are almost as valuable as the pure breed, number perhaps 100,000 or more; at least they are so numerous as to be seen on almost every well-managed butter dairy farm in the special dairy districts.

Several State herd records are in process of establishment for the pure bred Jersey cattle, because the American Jersey herd book is too cumbrous for convenience, from the large number of entries which have been made in it. No other cows in existence have been so highly cherished and cultivated as the Jerseys, and some of them have made the most extraordinary records as butter producers. The highest authorized record is that of Princess 2d, owned by Mr. Shoemaker, of Baltimore, Maryland; viz., forty-nine pounds of butter in seven days. Several cows are known to have produced from thirty pounds in a week down to twenty-four, twenty, eighteen, and sixteen pounds, and there are over a hundred cows which have a certified record of fourteen pounds weekly.

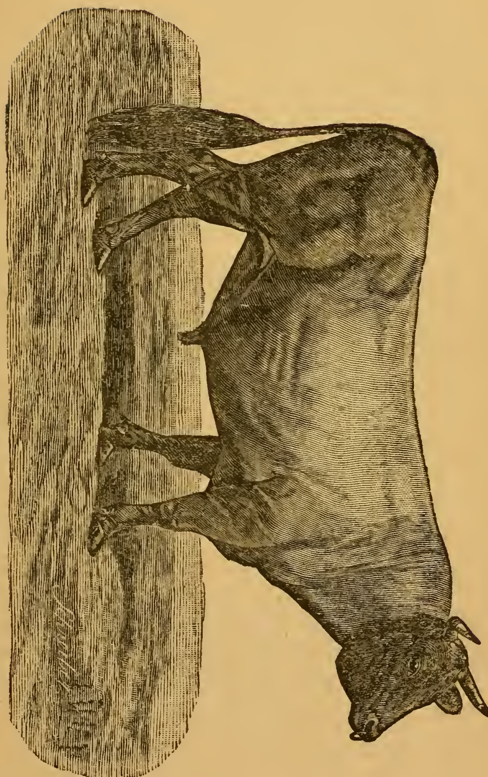

Fig. 5.—JERSEY BULL "PEDRO."

The cow Nellie, bred by the author, made 625 pounds of butter in twenty months between two calves, and from her first calf on December 27, 1879, to the end of her third milking season in December, 1883—that is, in exactly four years—she produced 1,649 pounds of butter, which was all sold at an average of fifty cents per pound, yielding the sum of $824.50 in the four years, besides rearing two heifer calves. Some remarks have been made derogatory to the high prices asked and paid for Jersey cows. This instance of the actual intrinsic value of a cow may be taken as a fair example of what a cow of this kind ought to be worth simply for the money value of her product. Any dairyman could well afford to pay $500 for such a cow, for her butter-making worth, leaving the value of her calves out of the question. For the private dairy, where one cow is kept for the family supply of milk, cream, and butter, this fact is also worth thinking of, in case the owner has ample means for procuring the best animal for his purpose. The consideration is worthy of notice also by farmers who are interested in improving their dairy stock; for a good bull is worth as much more than a good cow, as the calves got by a bull are more numerous than the one calf of a cow in any one year. This remark is not applied solely to the Jersey breed, but to whatever breed may be supposed by a dairyman to be the best for his purpose.

The Jersey cattle are of medium size, very graceful in figure, having slender limbs, a thin neck, a fine head with broad forehead, dished face, large black eyes, a gentle expression, and fine, small, curved horns, usually black in color, setting forward over the forehead. The fore-quarters are light, the abdomen deep and large, the hind-quarters large, the back broad, the thighs thin and set well apart, giving room for a broad udder, which has a loose skin hanging far up behind and giving great capacity for holding milk; the milk vein is large and spreads well at its entrance into the front of the udder; the teats are usually large, and well and squarely placed on the udder; the tail is long and slender, and the whole form partakes of a wedge shape, and is well balanced and pleasing. This description may be taken as applying to any good cow, and when a yellow skin, fine coat, yellow ears, and a mellow soft feeling under the skin are added, the whole indicate a cow which may be expected to excel both for milk and butter.

The color of the Jerseys varies from a light fawn mixed with white in patches, to a darker yellowish fawn or a mouse color, with a black muzzle and an orange colored ring around it. The tongue is also black in many of them. When this is the case the eyes, horns, switch and hoofs are also black, making, with the tongue and muzzle, the "full black points," which are considered by some Jersey breeders the *sine qua non* of an excellent animal of this breed. The dairyman, or the owner of a family cow, will scarcely give much weight to these points except for appearance, and then only when accompanied by the best milking character.

Much has been said about the escutcheon as being an indication of superior quality in cows. This may be considered as a fancy more than a reality, except when it accompanies the hereditary marks which are transmitted from a cow or a bull to its calves, and is accompanied by all the other inherited good qualities. A good cow, or a bull which is known to have sired good cows, which has a well-shaped escutcheon and transmits it to the calves, may be expected, along with it, to transmit to the progeny all the other good qualities. It is not safe to go further than this and depend wholly upon the escutcheon alone, as some have done, and do, for a certificate of good character. The escutcheon is simply a reversed growth of the hair from the udder and inside of the thighs up to the rump; and sometimes this growth takes the form of curves and curls, where it meets the usual position of the hair. It is difficult to believe from any physiological connection that this growth of hair has any direct influence upon the milking quality, or this upon that, so as to be considered in any light further than as has been above suggested.

THE GUERNSEY CATTLE differ from the Jerseys chiefly in their color, which is dark yellow verging to red, and their figure, which is coarser than that of the Jerseys. They are usually larger milkers and on the average more productive of butter than the Jerseys. They do not, however, possess any special qualities which make them more valuable in the dairy than the Jerseys, and there are comparatively few of them in America. For the family dairy, however, a Guernsey cow is doubtless the very best animal to be procured.

THE ALDERNEY is a smaller animal than the Jersey, and is not at all suited for the business dairy. They are fawn-like in their build, and fawn and white in color, and are small but very rich milkers. They are a distinct race and are sometimes confounded with the Jerseys, which are called Alderneys, but wrongly and unreasonably so. But for this confusion of names this breed, of which but few are in America, would not be worth notice here.

The last three breeds mentioned, viz., the Jersey, Guernsey and Alderney, are natives of the group of small islands on the coast of France, but belonging to Great Britain, which have been previously referred to. These islands enjoy a remarkably even and pleasant climate, and a rich soil which is exceedingly well cultivated. The farms are very small, mere garden plots for the most part, and there are few pastures, properly speaking. The cows are tethered in the small fields, and are accustomed to strict discipline and familiarity with their owners. Hence their disposition is naturally gentle and docile, and no other dairy cows are so easily reared and

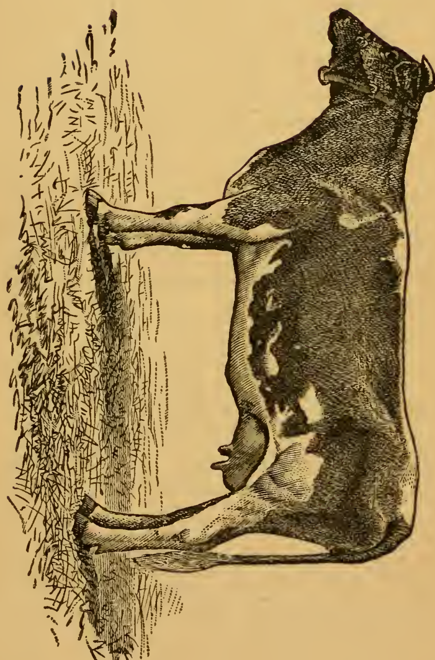

Fig. 6.—GUERNSEY COW "MARIE."

handled, more desirable for the private dairy, or the business dairy when butter is the object desired.

The Dutch Belted or Blanketed Cattle are natives of Holland, having the black and white colors of the so called Holstein-Friesian breed, but curiously disposed, so that the white is distributed, not in patches, but in a broad belt around the middle of the body. These cows have been carefully bred by the wealthier Dutch people for more than a century. They have been kept in the Orange County, New York, dairies many years, where they have acquired a high local reputation as profitable cows for milk and for butter. They are also kept in considerable herds in Delaware and Pennsylvania, and are sufficiently numerous to have required a herd book for recording their pedigrees. These cattle are smaller than the largest North Holland (Holstein-Friesian), consume less food, and are more suitable for the average dairy farm where the pastures are not rich or luxuriant enough to support the larger and more exacting breed. But this smaller cow is considered as very desirable, where milk for sale is the point aimed at.

The Swiss Cattle are noted for the dairy as good producers of milk, butter, and cheese. Switzerland is essentially a dairy country, and its pastures are of the greenest and the richest. Consequently its cows have been bred and cherished for many years with the greatest care. Pastures make cows, while the cows turn the pastures into rich products. Hence in such luxuriant pastures as those of Switzerland excellent cows may reasonably be expected. Their domestication is so complete that the disposition of Swiss cattle is docile, and gentleness is one of their marked characteristics. This again reacts upon the productive character, and thus the Swiss cows are very desirable dairy animals. Some of them were imported into Massachusetts a few years ago, and were found very well adapted to our American climate. From Massachusetts they have spread into other States, and are now kept in sufficient numbers to gain a wide reputation for butter product. The average yield of a Swiss cow is 2,700 quarts in a year, but the milk is rich in cream. The largest yield is from twenty-four to thirty quarts daily, and the product of butter varies from a pound to two pounds daily. These cows are brownish in color, of solid build, and make very good beef animals. The portrait given, figure 6, is one of a cow of the Simmenthal breed, which is considered the best in Switzerland.

The Devon Breed is said to be the oldest pure race of domestic cattle in existence. This may be true, for no other breed reproduces itself so true to type and with such slight variations. The color of a pure Devon is a rich dark red, solid and without any mixture. The horns are long and fine, and on the whole this breed is especially well and handsomely formed. As "general purpose" cattle they are second only to the Shorthorn, being very fair dairy cows, giving an average yield of milk, and rich, high-colored and highly-flavored butter equal in quality to that of the Jersey cows. The oxen are the best for the yoke, being active, docile, sagacious, easily trained, and of good size. The Devon beef is considered the best of all kinds, being tender, sweet, and well marbled with fat. For the purpose of the farm dairy these cows will probably be more suitable than any other kind; but for special dairy purposes, where the most butter from the least feed is required, the Devons will rank lower than the best. A pure Devon cow five years old, in the author's dairy, gave eight pounds of the best quality of butter weekly for three months, when the yield fell off quite rapidly; at the same time Jerseys and Ayrshires were giving ten pounds weekly and only fell off slowly, keeping up a profitable yield for fully eight months in the year. These yields, however, were from well selected animals, fed as highly as they could safely bear.

The Polled Norfolk is a red cow much like the Devon in appearance, but having no horns. For some very good reasons horns are not desirable in the dairy, and their absence from the cows is a point in their favor which goes a long way to make up for any deficiencies. But the Norfolk cows are said to be excellent dairy animals. There are several herds of them in America. Most of them have sprung from recent importations from England, where they are highly valued for milk and beef. They are certainly no better than the Devons in the dairy, if as good; but the absence of horns goes some way to balance the deficiency. While this breed is mentioned, it is more for the purpose of avoiding any charge of prejudice against a breed of useful cattle which are considered by those who keep them quite valuable for the dairy, than to class them on a par with the special dairy breeds previously described. If a dairyman wants a herd of cows which are without horns, he can find such cows among the polled Norfolks.

While considering this matter of horns, it might be said that there are many weighty reasons to be urged in favor of hornless cattle. Horns are offensive weapons of the most dangerous character, and may be suddenly turned against an unwary owner as quickly as against other cattle in the herd. Numerous distressing accidents occur every year in this way, and very great damage results to cows, calves, and other animals from the pugnacity of cows and bulls who use these most injurious and often fatal weapons offensively in every sense of the term, and never defensively, as nature intended, but which are not required under domestication. Then the question arises, how can the cattle be deprived of these offensive and threatening horns without injury, damage, or inconvenience? A horn has a bony center, which is a

Fig. 7.—A SIMMENTHAL (SWISS) COW.

part of the skull, a prolongation of the frontal process, protected by the smooth covering known as the horn. In a young animal, a calf of a month, the horn is unformed, and becomes developed slowly, beginning to grow outwardly at the age of six to eight weeks. At this time it first appears upon the surface as a horny plate, which is not attached to the skull, but is a growth from the skin, with which it is identical in composition. If this horny plate be cut loose from the skin and removed, and the wound be touched for an instant with the point of a hot iron, the embryo horn is at once destroyed and no further growth takes place. If, then, it is desirable to have hornless cattle, there is no necessity to select any inferior animals simply because they are devoid of horns, but to rear the best calves and dishorn them when it can be done easily and painlessly; the operation being very simple, and free from all but a momentary pain which is by no means intense. The operation of emasculation, which is considered necessary, but no more so than that of dishorning, is greatly more painful and the pain is much longer continued.

These dishorned animals, bred together, soon produce hornless progeny, which in the course of time inherit the polled heads. If the horn must go, in the march of improvement and in the interests of humanity, by all means let it be effected in this easy and humane manner. No doubt the valuable product of any herd of dairy cows would be increased at least ten per cent annually, and the cattle could be managed with much less trouble and annoyance, if the animals were devoid of the cruel horns.

The list of the recognized pure bred dairy breeds is by general consent of leading dairymen confined to four only, viz., Holstein-Friesians, Ayrshires, Jerseys, and Guernseys. While these are certainly the most noted and valuable cattle for the dairy, it is equally true that if the dairy business of the world were confined to these four

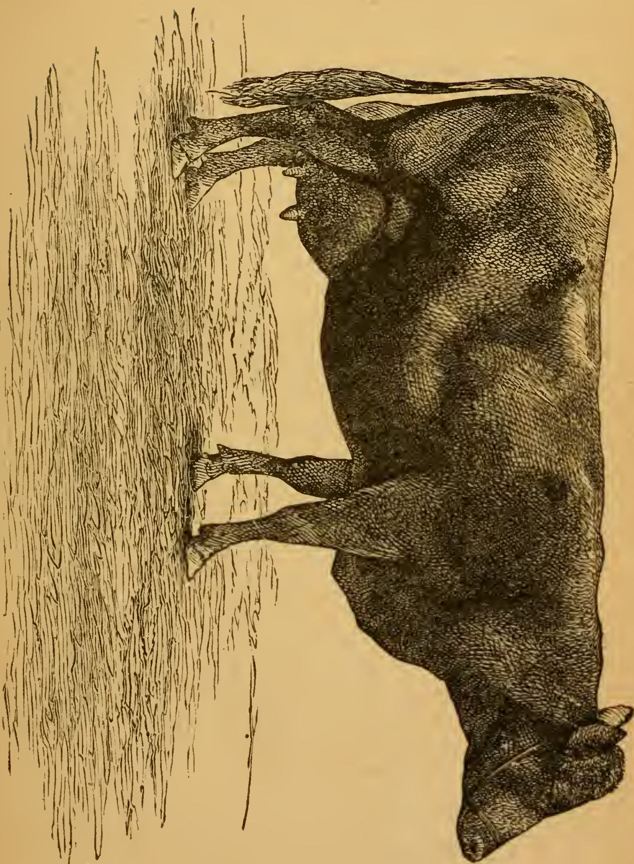

Fig. 8.—RED POLLED COW.

breeds, butter and cheese would be very scarce commodities, and worth at least five dollars per pound, until the slow increase of these pure bred cattle supplied the general demand. Of the 11,000,000 cows in the United States, there are not more than 100,000 cows of these pure breeds. The 10,900,000 left are the natives, so much despised by the breeders of the herd-book stocks. They are the foundation and material of the grand structure of our dairy industry, and supply the public demand for dairy products, the pure breeds are the gilding and ornamentation of the structure. It is important then that dairymen and farmers should give their most careful and untiring efforts to the improvement of what is known as our native stock—to which it is the fashion of some thoughtless breeders and writers to apply the offensive, opprobrious, and wholly undeserved name of "scrubs"—and to add to their productive value by skillful selection, judicious breeding, liberal feeding, and the exercise of the most considerate care and rearing. In future chapters this part of the business of the dairyman will be as fully considered as space will admit.

CHAPTER IV.

BREEDING AND REARING DAIRY COWS.

The cows are the dairyman's machines for changing food into more salable and valuable products. As machines are valuable in proportion to the effective work they perform, so cows are to be valued for the amount of milk and butter they can produce from a certain quantity of food. The cow which yields half a pound of butter daily is worth no more than half as much as one that produces one pound per day, and in fact less than that, because while two such cows have to be fed for the same equivalent of product, and the cost of the butter is thus doubled, there is twice as much labor spent in gathering this pound from the two cows. All this is clear to the commonest understanding, but it is necessary to emphasize the trite statement to show the great importance of the home breeding and rearing of the cows kept in a working dairy. It is not possible to purchase the best cows; the owners know their value and will not sell them except at high prices which the dairyman cannot afford to pay. He must, therefore, rear his own herd, and make it so valuable that it will repay all the care and cost expended upon it.

The art of breeding is governed by a few rules, which are simple and easy to understand.

The first and most important of these is, that "like produces like," by which is meant that animals of certain peculiarities of form, color, disposition, habit, and quality, when bred together, reproduce their own characteristics in their progeny. This rule has been so uniformly and constantly proved by practice, and is so reasonable and natural, that it may be taken as a safe guide in the rearing of dairy cows. Every person may see it proved by practice every day of his life. There is more or less of family likeness in persons as well as in the lower animals. The progeny of a Jersey cow is always a Jersey, and the same is true of all other breeds. A good rich milker produces calves that are good milkers, and that bear a close resemblance to herself in all valuable points. It is the fashion to assert that only pure breeds have this physiological power of propagating their own characteristics. This is nothing more than a claim made without sufficient reason by the breeders of these cattle, for the purpose of raising the market value of their stock; a legitimate way, perhaps, of doing business as it is now done. All animals possess this power to some degree, and by a careful course of selection this natural proclivity may be encouraged, developed, and strengthened, until the breed, as it is then called, has this power in an eminent degree, and the progeny partakes very closely of the character of the parents. This is the point to be aimed at by dairymen, who should first learn by careful tests which are their best cows; then feed them liberally to develop their qualities to the fullest extent; breed them to males of known hereditary excellence; and pursue the same plan with their progeny. The male should be selected from some pure breed, not at haphazard, but after careful investigation of its antecedents, and especially of its parentage. Milking quality is the only point to be considered, for this alone brings the profit desired. A dairyman should look to his special business for his profit, and never be induced to compete with professional breeders in the rearing of stock for sale. Hundreds of dairymen have been misled into disastrous losses, during the progress of what might be called the Jersey speculation of the last seven or eight years, by purchasing at high prices animals belonging to certain families which were popular at the time, but whose popularity was soon eclipsed by new favorites. Speculation of this kind cannot fail to bring losses upon a dairyman who gives it precedence over his legitimate business.

It matters not what breed is chosen. If it is the Shorthorn, or the Holstein-Friesian, for the production of milk or for cheese, or the Jersey, Guernsey or Ayrshire for butter, as good a bull as can be afforded should be secured. As a rule a calf should be purchased, and this may be safely done if the pedigree is right, and the milking quality of his dam and both granddams has been found satisfactory. It is more profitable to pay a large price for a good animal than a small price for a poor one. The bull is half the herd as regards the calves, and more than that when it is procured for the purpose of improving native stock. The spare male calves may be easily disposed of to neighbors who are not so particular, or are less experienced in this respect, for some advance on the value of the common stock, that will in good part repay the cost of the sire.

Breed is undoubtedly dependent upon feed. Feeding and training have given the value to the breed, and this value must be kept up by feeding and training. The mistake is often made of getting a pure bred animal and subjecting it to all the careless management which is given to the common stock, and expecting that this animal, by virtue of its parents' character, can lift up the common herd and double or treble its value in a few years. Such a hope is doomed to disappointment from the outset. When a pure animal is brought into a herd its care should be at least equal to that which it has been used to, and the very same system of feeding and general management should be followed with the whole herd. If this practice is followed, success will be sure, and the desired end will be reached.

A bull over a year old may serve ten or twelve cows in the season; the next year twenty or twenty-five services will not overtax his powers; but overwork is to be avoided. It is better to ask a fee of five dollars per cow for outside service, and admit two or four cows, than take one dollar each for ten or twenty. A service is usually valued at what it costs, and is more thought of at five dollars than it would be at one or two dollars. The owner of the cow will be apt to take more care of the calf, and value it more, if it costs him five dollars, and the higher fee will be of service to him in this respect, and he will get good value for it in more ways than one. My way of managing a bull has turned out convenient, safe, and satisfactory. A pen and yard adjoining the cow stable and barnyard were provided for him, and he was kept in it, not having the freedom of the barnyard at any time, except when driven to the water-trough while the yard was empty, and he was at once returned to his own yard. It is a good practice to employ the bull at light work, which keeps him docile, and makes him more certainly useful. A one-horse tread-power may be provided, in which he may work a fodder cutter, or, if no work is to be done, may take exercise. If a harness is provided, the bull may be trained to work in a cart, and draw fodder from the fields to the stable, or remove manure, or do other useful service.

When his attention is required by any cow, this animal is led to the bull's yard with the halter on its head, and is tied in a corner specially provided with a strong ring. The bull is then let out of the stall and left with the cow. The bull's yard is closed in with a tight board fence eight feet high, but a slide opening is made in it, through which the animals can be observed. When the service has been effected, the bull is driven into his stall and shut up, and the cow is taken to a separate pen with a loose stall, provided for the purpose, and is kept there until she recovers her usual condition, when she is returned to the stable. This avoids considerable annoyance and is a security for the effectiveness of the service.

A bull is never to be depended upon, and should never be approached by any person, not even his keeper, unless he be armed with a stout, sharp rawhide. A bull should be kept in constant subjection, and when at all slow in obeying an order the rawhide should be administered sharply and swiftly, but never cruelly. As a sharp reminder of pains and penalties to come, a cut with the rawhide will always be effective in securing prompt obedience. This cautious and safe training and discipline should never be relaxed, or a life may be lost or serious injury be done at a moment's warning. It is always dangerous to pet a bull, and although he may have cost his owner $500 he should never be permitted the least freedom on that account.

The cow once safely in calf should be fed in accordance with the new demands upon her system. The method of feeding will be found particularly described in the chapter devoted to the feeding of cows, and it would be desirable to follow the directions there given as closely as may be convenient. The calf partakes of the disposition of the dam, and if the cow has any special failing or fault this should be averted by the most careful treatment, and every effort made to insure a docile and gentle disposition in the coming calf.

Liberal feeding should be a paramount rule, for as it has been the means of building up the breed it cannot be dispensed with in the progeny. The food supplied should be of a nutritious kind, and while it is given without stint it should never be given in excess. Excess of food has a directly opposite result from that which is intended, and is one of the frequent mistakes in rearing calves which should be carefully avoided. By developing the character of the calf through liberal feeding, and gentle and kind treatment, a capacity for digesting large quantities of most nutritious food, and such a disposition as renders the animal easily subject to necessary discipline, are secured, and in time become characteristics which will be inherited.

The proper development of the milk organs is a point which must not be neglected. The young animal should be bred early, to give a precocious habit to the race. At two years old the first calf may be dropped; but an interval of at least eight or nine months should elapse before she is bred again. This tends to give persistence in the secretion of milk, and lengthens the period of profitable milk production, upon which the value of a cow very much depends. The second calf then comes at three and a half years of age, when the young cow is well developed, and is able to give a large product of milk and butter.

It is advisable that the calf should be taken from the cow very soon after it is dropped and removed to a pen provided for the purpose. In the plan of the farm given in Chapter II. there are shown two of these pens, each of which is divided into four stalls separated by partitions four feet high, of upright bars three inches apart. This secures ample ventilation and gives the calves companionship, which keeps them from fretting. The cow is removed to a roomy box-stall nine by seven feet, at the extreme end of the stable, away from the calf pens, a few days before her time expires, and is kept there four days after the calf is dropped, when the milk is fit for use. Six hours after the calf is taken away the cow is milked and the milk is at once given to the calf. This method tends to make the cows naturally oblivious of their calves, and avoids the trouble, so common in dairies, of cows holding up their milk. It also makes the calf docile and attached to its keeper, and enables it to be trained with much ease. After a few years of this kind of management the cows will evince no disturbance at the loss of their calves, and will come into the dairy at the right time without any difficulty. The calves are made more gentle, and the habit soon becomes confirmed and hereditary.

In the selection of a cow for breeding the following points should be considered. A model useful dairy cow may be known at a glance by an expert. She has a fine long head, broad between the eyes, and a thin wide muzzle; the eyes are large and of a mild expression; the neck is thin and long; the ears are thin and covered inside with a deep yellow skin; the fore-quarters are light and thin, and the whole body has much of the shape of a wedge, increasing in size to the rear; the legs are thin, with fine bone; the belly is large and deep, with large capacity for food ; the back is broad and straight, and the ribs are well rounded towards the rear ; the bones of the rump are wide apart ; the tail is long and thin ; the thighs are thin, and are set widely apart ; the udder is large and full, especially behind; the teats are of good size and set wide apart upon a broad level udder, and the milk vein—so called—which is the large vein leading from the udder and passing into the abdomen, and which is an indication of the amount of blood circulating through the milk glands and contributing to the milk secretion, should be full and tortuous in its short course. A fine horn, a deep yellow skin, and a general elegance of form, without any heaviness or beefiness in any part, are also important indications of good quality in a cow for the dairy.

The bull should have the special characteristics of the cow, differing, however, in development as becomes a male animal. The form of the head and body ; the large, mild eye ; the fine, clear, waxy horn ; the yellow lining of the ears ; the yellow skin, and the general lightness and elegance of form, all go to indicate a good animal for the dairy.

A good calf should be of slender build, long and thin in the body, with a long head and limbs, a bright, large eye, thin ears, fine thin skin, and smooth hair, without any noticeable brisket. The teats should be placed widely apart, and the undeveloped udder should be loose and skinny.

Many breeders place great weight upon the form of the escutcheon, or the hair which grows upwards on the back part of the thighs and udder. A well-shaped escutcheon can do no harm, but there are numerous excellent cows which have no escutcheon to speak of, and the business dairyman may very well afford to ignore it.

The portrait of the Jersey bull Pedro (figure 5), and that of the Holstein-Friesian cow Netherland Queen (figure 4), give an excellent idea of what the typical form of a dairy bull and cow should be. That of the Ayrshire cow Flora (figure 3) is excellent, except in one respect, viz., the rather short teats, which are common in this breed.

The breeding periods of the cow occur at intervals of twenty to twenty-one days, and usually begin at the age of twelve to fourteen months; some Jersey calves (this breed is naturally precocious) have bred at the age of seven months or even earlier. Fleming, in his excellent work on Veterinary Obstretrics, states that seventy-nine per cent of cows are fertile and twenty-one per cent sterile. My own observations certainly differ from this author, for of twenty-eight herds, including my own, with which I have been intimately acquainted, and in which were altogether nearly 500 cows, there were but three cases of absolute sterility.

The cow carries its fœtus about 280 days, or nine months; the period of pregnancy, however, varies in cases from 240 to 301 days. Of 1,062 cases noted at a French agricultural school 15 calved in 241 days; 52 from 241 to 270 days; 119 from 271 to 280 days; 544 from 271 to 300 days; 230 from 281 to 290 days; 70 from 290 to 300 days; 32 went beyond 301 days. The longest known period is from 330 to 353 days. The averages given by many observers are 283, 286, 280$^1/_2$, 284, 282 for female and 288 for male calves; and all these coincide in the belief that a male calf is carried several days longer than a female.

The cow rarely has multiple births; but occasionally twins, and even more, are produced. Twin births seem to be hereditary, and it is believed by some prominent veterinary practitioners that this peculiarity may easily be made habitual by a course of selection in breeding. Cases are cited in which the progeny of multiple bearing cows have produced twins, and in one case seven calves were borne by one cow within twelve months, and six of them survived. This cow had twenty-five calves at eight births, one producing six, but none of them lived.

Accidents of birth are rare among cows which are well cared for and kept in good condition. In nearly ever case of mal-presentation and difficult parturition, the cause has been traced to chasing by dogs, injury by other cows, or some violent accident. Extreme care should be taken to avoid such accidents, which are all preventable.

In the case of twin births, the popular belief that twins of opposite sexes are sexually imperfect is supported by observation and facts. But when the twins are both of one sex they are normally perfect in this respect. When a male and female calf are twinned, the female is almost always imperfectly formed and will not breed. Such females are popularly known as free martins and may be considered worthless for breeding.

CHAPTER V.

CROPS FOR DAIRY FARMS.

The feeding of the stock is of paramount importance in the dairy, and a suitable selection of crops for feeding is one of the subjects which require careful study. Some crops are more productive than others, and are consequently more profitable. As a rule the dairyman should aim to grow fodder and not grain, purchasing the grain and other concentrated foods with the proceeds of the larger crops of fodder grown. Fodder cannot be purchased, it is too bulky for carriage, and no farmer has any surplus of it to spare; but grain-feeding substances can be often purchased more cheaply than they can be grown. Hence it is that the question of crops for fodder becomes of great importance to the dairyman.

Grass is the first crop to be considered; but it is so important in its several uses, and there are so many valuable kinds of it, that a special chapter should be devoted to it.

Fodder Corn follows grass in rank as a feeding crop, either green for summer use, or preserved as ensilage, or dried and cured for winter use. It is one of the most productive and nutritious plants when properly grown and cultivated. It has yielded from twenty-four to forty tons of green, and five to eight tons of cured fodder. It requires rich land and good cultivation, however, to make this yield ; but on poor land helped by artificial fertilizers a very profitable yield can be made. In such a case a poor sandy farm which was badly run down produced, with 600 pounds of special corn manure to the acre, twenty-four tons of Evergreen sweet corn and twelve tons of Early Narragansett sweet corn per acre. It is quite possible to grow both of these crops on the same ground the same season ; for the early corn will be ready for cutting in fifty days from planting, and the later kind planted in July will mature in September, thus giving thirty-six tons of green fodder, or eight tons of cured fodder, per acre. It is this rapid growth which makes the crop so valuable.

Fodder corn has acquired a bad reputation by reason of the mistaken manner of growing it; viz., by broadcasting the seed at the rate of two or three bushels per acre, by which the crop is so crowded that it makes a pale, watery, rank forage, quite devoid of nutriment and worth but little more than wood shavings. Cows have been known to reject fodder thus grown, which is a convincing proof of their natural sagacity.

When grown in rows three feet apart, and with four to six seeds dropped eighteen inches apart, the fodder is entirely different. It is green in color, mature in its growth, full of sweetness, and a large proportion of the stalks will have ears in what is known as the roasting stage, and as the fodder is cured these may be dried, if the proper precautions are taken in the curing. The author has taken over 10,000 ears of sweet corn fit for market per acre from a crop of Evergreen sweet, and this product, gathered and sold from farms near large cities, is exceedingly valuable, frequently selling for $1.50 per 100 ears, and if late in the season, and of good size, for nearly or quite twice as much. Thus this crop is a very useful one for dairymen who are near a market for this kind of truck.

The crop is cultivated precisely as field corn is. At the proper time, which is when the ears are in the milk, the corn is cut close to the ground in the usual manner and left for two or three days to dry. It is then bound in small sheaves of about twenty stalks in each, with bands of rye straw, then set up in small shocks and bound securely at the top, the bottom being spread to admit the air. It is thus left until the stalks are quite dry and the ears shrunken, when it is put up in small stacks of about 1,000 bundles or less, built around a frame made like three ladders meeting at the top and spreading at the bottom, by which air is admitted into the center of the stack and mildew is prevented. When fed green the stalks are cut up in a fodder cutter with the ears, and make a most valuable food for the cows. They are very productive of milk of good quality. Sweet corn ears in the cooking stage make excellent food for butter-making cows, and the butter is of fine flavor and quality.

In growing the second crop the land is plowed as fast as the first one is removed, the swivel plow being the most convenient implement, and is harrowed and planted as soon as a space wide enough to start on is ready. The Acme harrow prepares the plowed ground very quickly and perfectly, and the Albany corn planter drops and covers the seed, and marks the rows, at one operation.

Thus no time is lost and the crop comes in rapidly. As soon as the seed is planted the fertilizer should be sown over the surface and left for the first rain to carry it into the soil.

Clover is the next crop in value to be considered after fodder corn. This has the advantage that it may stay in the ground two, three, five or more years, as it may be rightly managed. On good land clover is a perennial, while on poor land it dies out the third year and is thus a biennial. The most profitable kind is the common red clover; the annual crimson clover (*Trifolium incarnatum*) is useful in some sections, but only for green fodder. It matures and ripens its seed the first year. At the South it is sown in autumn and cut the following spring.

Clover may be sown alone or with some grain crop, or with turnips. It can be sown in April on well prepared ground and make pasture or a cutting in the fall, or it may be sown then with oats, or in July with buckwheat, or in the same month alone or with turnips. But this crop will not succeed upon poor land, and it is a waste of time and seed to try it. Fodder corn will do better in such a case. But clover may be grown upon well manured or liberally fertilized soil, well plowed and thoroughly harrowed, with 500 or 600 pounds of superphosphate per acre and 300 pounds of plaster. One peck of seed should be sown to the acre.

When it is sown with orchard grass it becomes more useful, and the two together yield three times as much fodder or hay as the clover alone. If cut for hay, it should be mown when in full blossom and before a head has turned brown. It is then in its most nutritious stage. The author's practice is to begin cutting as soon as the dew has dried off, and cut up to three or four in the afternoon. The clover is then gathered with the horse rake into large windrows, where it is left until the following day. As soon as this is done, cutting is resumed until sundown. The next morning cutting begins again as before, and the windrows are gathered into cocks holding about 300 pounds each, which will make them about four feet in diameter and six feet high. The cocks are covered with hay caps made of brown sheeting fifty-four inches square, and fastened down at the corners by long thin wooden pins thrust into the hay. The hay is thus safe against the weather until the whole crop is cut and put up in the same manner. It is then taken to the barn or barracks. The cocks are thrown open and aired for an hour, then loaded and put into the mow and trampled down firmly. It will sweat and heat a little, but this improves the quality of the hay and increases its digestibility.

When there is plenty of straw, clover may be cured in an easy manner by taking it up as it is cut and packing it in a tight mow, in alternate layers of about a foot in thickness, with dry straw. The clover heats slightly, and impregnates the straw with its sweet flavor and odor, thus making the straw more palatable, so that both can be fed together.

There are several other excellent feeding crops which may be made available for dairy farming, but as these will be referred to in Chapter VII., under the head of "Soiling," no further mention need be made of them here.

MILLET is a valuable crop for hay as winter feed. It is sown in June or July, and is fit to cut in six weeks. Half a bushel of seed is sown per acre, and the crop is cut when in early blossom, or it becomes hard and unpalatable.

ROOT CROPS are the main dependence of the dairyman for winter feeding, and are indispensable for complete and profitable success in the business. Winter dairying cannot be carried on without a good supply of roots.

The roots mostly grown for the purpose are mangels, sugar beets, carrots, and parsnips. The method of culture is the same for each.

The soil for roots must be rich. A corn stubble liberally manured in the fall, and plowed so as to cover the manure in even layers intermingled with the soil, and lying at an angle of forty-five degrees, and so remaining during the winter, then cross-plowed and thoroughly harrowed in the spring, is the best preparation for a crop of roots. The manure becomes thoroughly incorporated with the soil and decomposed, and affords excellent food for the roots. The land is plowed early in May, and immediately harrowed deeply to make it mellow and fine. The seed for mangels and sugar beets, four to six pounds per acre, according to its freshness and reliability, is sown by a hand drill in rows twenty-seven inches apart. The drill leaves a roller mark over the seed by which the rows can easily be seen. As soon as the seed is sown, 600 pounds of salt and 300 pounds of the best superphosphate per acre are sown evenly over the surface. The horse hoe is started in the spaces between the rows a week after the seed is sown, the roller marks serving as guides. When the plants are up in the rows a garden hand cultivator is run across the rows, with the cutters set to ten inches in width. This is run back and forth, leaving four-inch spaces between the cultivated rows in which the plants are left. A great deal of hand hoeing is thus saved, and the hand cultivator may be used as frequently as the horse hoe is, to mellow the soil between the plants, and to prevent weeds in these spaces. The cost of the crop is reduced one-half by this method of cultivation.

When the crop covers the ground and the leaves meet in the rows cultivation ceases. When fully grown the roots are harvested as follows. A man with a sharp, heavy hoe goes along one row and clips off at a stroke the leaves from the roots on his right hand. It is easier to do this when the man walks backwards. At the end of the row he turns and retraces his steps in the same row, thus gathering the tops of two rows in one. Another man follows, and with a digging fork turns the roots out into the empty space on his left or right hand, as the case may be, gathering two rows of roots into one space. There are thus alternate rows of roots and tops. It is most convenient for the roots to be thrown in heaps between the rows, leaving spaces wide enough for the passage of a horse and cart, in which they are lifted with a broad blunt fork, with tines bent somewhat, to hold the roots.

The tops are gathered and put in heaps in a convenient place, covered with straw and then with a little earth, in which manner they may be kept fresh for several weeks, and will afford excellent fodder. The roots are put up in conical heaps in trenches two feet deep and four feet wide, covered with straw and then with earth, thus keeping in perfect condition until June of the next year. Care is to be taken to avoid heating, by putting ventilators in the top of the heaps to afford an escape for the heated and damp air which gathers in the pits from the sweating of the roots; round drain tiles, or bundles of smooth straight straw, make excellent ventilators.

Carrots and parsnips are more difficult to grow than beets and mangels, but with care they will yield a heavy crop of most valuable fodder for winter feeding. Of mangels the best kinds are the long red and the yellow globe; of sugar beets, Lane's improved, grown by Hon. Henry Lane of West Cornwall, Vermont; of carrots, the long orange, the Belgian and Altringham are most suitable for field culture; of parsnips there is but one kind. Parsnips may be left in the ground all the winter with safety, and thus a large part of them need not be harvested in the fall. Turnips of all kinds are unfit for use in the dairy except for dry cows, young cattle, and bulls, and as they are inferior to the roots mentioned, no further notice will be given them.

CHAPTER VI.

GRASSES FOR PASTURES AND MEADOWS.

Grass is the most important crop for the dairyman. In the great majority of cases pasturing must be the main dependence for the summer feeding, and the meadow furnishes the hay for winter. Consequently, the method of culture of grass should be well understood. As a rule the sowing of grass of various kinds is made with some grain crop, and usually in the fall with wheat or rye. This method, however, is not just to the grass, nor is it favorable for the best results to the seeding. The so-called foster crop very often robs the grass and exhausts the soil of its needed nutriment, and a very poor catch is the result. If the soil is thoroughly well prepared by manuring and sufficient tillage, the two crops may grow together very well, and the grass make a good stand. But this is seldom the case, except with a few good farmers who need no advice or suggestion upon the subject. The great majority of farmers need to study this subject and understand the requirements of the grass for its successful culture.

The preparation of the soil should be very thorough. The land should be plowed deeply, and a liberal coat of manure turned under, not buried, but with the furrows laid over at an angle of forty-five degrees, so that the manure lies between the layers of soil standing on edge in a sloping manner. The harrow, run along the furrows, works the soil and manure together, mixing them and making them fine and compact. The harrowing should be continued until the whole surface is as smooth as a garden, and the soil is quite fine. If the land is clayey and lumpy, it should be rolled between the harrowings.

Sowing the seed alone is preferable. If any grain crop at all is used, it should be oats in the spring, or buckwheat early in July, as may be most convenient. Excellent seeding has been made early in August with a pound of turnip seed to the acre. This shelters the young grass during the winter; and dying, the turnips decay in the spring, and afford a most useful fertilizer for the crop. Timothy and clover, orchard grass and clover, or the three kinds mixed, and orchard grass alone, have been sown in all of these three ways with better results than when sown with fall grain and subjected to the risks of the winter weather.

In sowing grass and clover seed an even stand is desirable, and, to secure this, great care is to be taken in the sowing. A very good practice is to make the last harrowing with great care, evenly, and with the marks all parallel. Then the sower can follow these marks, first taking the edge of the field and returning six short paces distant from the first course; then returning on the second course, and always sowing with the right hand to the left. Six feet for each cast is as much as can be taken with light seed—as orchard grass, blue grass, red-top, etc.—and as much as should be taken with timothy. The quantity of seed taken may be readily gauged to the width of the cast. The cast is made with each movement of the right foot. When the wind is blowing, even slightly, the casts should be made low to avoid irregular dropping of the seed, and when the light seeds are sown it is easier to walk across the harrow marks, when the tracks made are easily seen; and as the wind may carry the seed to one side, the sower may go out of the straight track to accommodate the wind, and on returning can easily distinguish the foot marks of the previous track in the soft soil.

A broadcast seeder is a convenient implement which costs but little, and can be carried by the sower with ease. It drops the seed low, and if the sower goes face to the wind at the start the seed is not spread unevenly. When, in spite of all care, an irregular seeding is anticipated, it is well to sow half the seed one way, and cross the sowing the other way, when vacant spaces may be covered. An inexperienced sower should practice on the snow, using sand, which can be easily seen on the white surface, and in two or three attempts he will be able to make the sowing quite evenly. The sowing should be done as soon as the last harrowing is finished, when the seed sinks in the loose soil or is covered by the first shower. A smoothing plank is a good thing to cover seed with. It may be eight or ten feet long, and is provided with a tongue and two stiff braces. The tongue is fitted to the plank on the level, so that when it is raised the front end of the plank is elevated a little. This prevents the plank from gathering stones or sods in front of it, and causes it to ride over them. It leaves a smooth even surface. Rolling the land after sowing is sometimes useful and advisable, but is so often injurious that it may be dispensed with quite generally.

Few American farmers know how many varieties of grass and foliage plants are in use in agriculture. Timothy and red-top, with red clover, are the first and the last and the whole list in common use upon the majority of farms. Orchard grass is sometimes sown by a few of the most progressive farmers, and blue grass, tall oat grass, and meadow fescue are occasionally used in a small way in some localities where they are not indigenous, but grow almost spontaneously. Yet really the kinds of grasses available for farm culture in permanent meadows are quite numerous. An English seedsman's catalogue enumerates considerably over 100 varieties, the seeds of which he offers for sale in regular trade, and all these are grown more or less by the English farmers, either for annual fodder crops, for intermediate rotation, or for permanent pastures and meadows. Included in this list there are three species of agrostis, four of avena, five of bromus, eleven of clover, ten of fescue, three of lolium, seven of poa, three of oat grass, and fourteen different forage plants for mixture in pastures.

We here refer to some of these grasses which, from our own knowledge or actual tests, we have found useful and available for meadows and pastures and upon various soils, and which we believe are indispensable for the use of American dairymen. The leading seedsmen are offering various mixtures to meet the demand which has arisen. It is not, however, to the best interests of farmers to take whatever selection is offered to them. It is better that they should select for themselves, with a knowledge of their own soil and climate, and of the grasses they would wish. The following grasses are the most valuable for cultivation under the conditions and for the purposes mentioned:

Agrostis stolonifera, or white bent, is the most valuable of all the grasses of the genus to which the well known red-top belongs. It is often called Rhode Island bent, and in the South fiorin. Its creeping root gives it a permanent hold upon suitable soil, which is damp and rich loam, and it is therefore valuable for pastures. It has an early and late growth, and is exceedingly productive, having yielded on a rich reclaimed swamp as much as 17,600 pounds of green grass or 7,740 pounds of hay from one acre, cut at the time of blossoming. When the seed was ripe the produce of uncured herbage was 19,050 pounds per acre. The yield is still heavier when sown in reasonable proportion with other grasses.

Agrostis vulgaris, or the common red-top, is well known as a useful grass on low, moist lands, and as light and useless upon dry, poor uplands. It has a creeping root, and is a good grass for pasture upon reclaimed swamp lands.

Poa serotina, fowl meadow grass, is a most valuable grass for moist soils. It has a fibrous, creeping root, an early growth, and renews itself quickly after cutting or pasturing. It is eagerly eaten by cattle, and patches of it in a meadow will be eaten closely while red-top is left untouched. It is very productive, and we have had it four feet tall, with broad, abundant foliage, upon a rich, reclaimed, peaty, moist meadow.

Phleum pratense, or timothy, is too well known to need any description. Its bulbous root is unfavorable for long-continued growth, and it is not a suitable grass for permanent pastures or meadows, although it is the best of all kinds as an intermediate crop for hay.

Avena elatior, or *Arrhenatherum avenaceum*, the tall oat grass or evergreen grass of the Western States, is a most valuable kind for permanent meadows and for woods or shaded pastures. It is very early and productive, rather coarse but nutritious, and has produced over three tons of hay to the acre when grown alone, but like its relative, *Avena flavescens*, the yellow oat grass, it succeeds better in company with other grasses. These grasses are suitable for all kinds of soil, but do their best in moist, rich clay loams.

Alopecurus pratensis, or meadow foxtail, is one of the best meadow and pasture grasses. The root leaves grow rapidly after having been eaten down, and it makes a dense matted herbage. It is one of the best of grasses for damp, rich lands and irrigated meadows, and has a luxuriant growth, almost equal to timothy in value on rich soil. It blossoms in May and is thus mature for cutting along with orchard grass. Over 12,000 pounds per acre of green fodder has been produced by this variety, the hay from which amounted to more than three tons, with 2,500 pounds of second growth hay. Like timothy, this grass is most nutritious when the seed is ripe.

Cynosurus cristatus, crested dog's tail, is a very close growing grass and makes a dense sod ; it does well upon all kinds of soils, and especially upon irrigated or moist, drained meadows. For lawns it is one of the most valuable of all the thick-growing fine-leaved kinds. It is not very productive, but its late growth, being in blossom in June and July, makes it valuable as affording a succession of feed after the earlier kinds have been cropped. It is strictly a pasture grass, and has many of the valuable qualities of the Kentucky blue grass for this purpose.

Dactylis glomerata, the well known orchard grass, is without exception the most valuable hay and pasture grass for sowing alone. We have grown it upon good sandy loam soil at the rate of 16,000 pounds per acre of green herbage, and have seen it growing upon moist, low, rich soil at least twice as dense as this, in appearance. In England it has been known to yield nearly 28,000 of green grass and 11,800 pounds of hay per acre, with 12,000 pounds of green aftermath. It thrives on all kinds of soil, but does best in rich lowlands. We know a field still as productive as at first, which was sown thirty years ago, and has produced hay and afforded full pasture every year since, but has been liberally top dressed every second year. The hay, cut when in blossom at the end of May, is sweet and palatable to horses and cattle, and for cows there is no better pasture than this in the aftermath. It does well under shade, and, as its name implies, grows well in orchards and wood lots. Its habit of growth, which is stooling and tufty, is the only objection to it when grown alone, but when sown with other kinds the vacant spaces are filled.

Festuca elatior, tall fescue, grows naturally upon river banks and moist places, and is suitable for reclaimed or irrigated meadows. It is exceedingly productive and has been reported to have yielded upon an English "water meadow" over 50,000 pounds of green grass and 17,800 pounds of hay per acre, with a second growth one-third as large. It is an early grass and does well when sown alone or in mixture.

Festuca pratensis, meadow fescue or English blue grass, is natural in that country to moist, low alluvial meadows, where it forms a large proportion of the herbage, and is the most productive pasture and hay grass where it is grown largely in Kentucky. It is equal in every respect to rye grass, without any of its defects. It is found growing spontaneously in many parts of the Eastern and Middle States, and forms a large proportion of the ordinary meadow grass and roadside herbage. It is of strong growth and robust habit, but never grows in tufts; is strictly perennial; lasts as long as orchard grass, and is an excellent kind to sow with this grass. In Kentucky it is considered next in value to the famed blue grass.

Poa pratensis, the blue grass of Kentucky, is the finest permanent pasture grass existing. Some of the meadows of Kentucky have been in pasture from the first settlement of the State and are still as good or better than at first. Its value is shown by the magnificent cattle and horses reared upon these old meadows. It succeeds over a large territory, Ohio, Indiana, Missouri, Kansas, Tennessee, and the eastern and southern mountain region, notably in Southwestern Virginia. It does not succeed as well in the North and East; nevertheless, the famed dairy localities of Central New York, Vermont, and Western Pennsylvania owe their reputation to this grass.

Other valuable grasses for permanent meadows are:

rye grass, a variety known as Pacey's rye grass and perennial rye grass being the most valuable; *Poa nemoralis*, or woods meadow grass; *Poa aquatica*, or water sweet meadow grass; *Poa*, or *Glyceria fluitans*, or floating meadow grass; *Poa trivialis*, or rough stalked meadow grass; *Milium effusum, Festuca rubra, Festuca duriuscula*. All have valuable qualities for permanent meadows, either dry, moist, or irrigated.

The following table will be found useful in selecting grasses for experiment, and for reference in regard to the kind of grasses most suitable for different soils, the time of flowering, the yield of fodder and hay per acre, and the quantity of seed sown per acre alone and in mixtute.

TABLE OF GRASSES FOR PERMANENT SOWING.

FOR WET OR IRRIGATED LAND.

Variety.	*Time of Bloom.*	*Hay, Yield Alone.* lb.	*Seed, Yield Alone.* lb.	*Seed, per Acre. Mixture* lb.
Anthoxanthum odoratum	June	1,000	--	1
Agrostis stolonifera	July	4,000	24	5
Poa aquatica	July	6,000	--	10
Poa trivialis	June	1,000	--	4
Poa fluitans	May	4,000	--	5
Agrostis vulgaris	June	4,000	24	5
Lolium Italicum	July	1,500	30	10
MOIST AND RICH SOILS.				
Alopecurus pratensis	May	3,000	--	5
*Avena flavescens	June	2,000	--	10
*Dactylis glomerata	May	6,000	24	10
*Festuca pratensis	June	4,000	24	6
*Lolium perenne	July	1,500	--	5
*Poa pratensis	June	----	24	10
Agrostis stolonifera	July	5,000	24	5
Festuca elatior	June	6,000	24	6
Phleum pratense	July	6,000	10	3
DRY RICH SOILS.				
Arrhenatherum avenaceum	June	4,000	20	5
Cynosurus cristatus	June	500	--	5
Festuca duriuscula	June	3,000	--	6

and those above marked with a *

TABLE OF GRASSES FOR PERMANENT SOWING.—*Continued.*

DRY, GRAVELLY, SAND SOILS.

Variety.	*Time of Bloom.*	*Hay, Y'ld Alone.* lb.	*Seed, Y'ld Alone.* lb.	*Seed, per Acre. Mix.* lb.
Dactylis glomerata	May	4,000	30	15
Lolium perenne	July	1,500	30	10
Poa pratensis	June	----	30	10
Festuca rubra	June	1,000	--	5
†Kœleria cristata	June	----	--	4
Festuca ovina	June	----	--	5

WOODS, PASTURES, AND ORCHARDS.

Arrhenatherum avenaceum	--	----	30	10
Dactylis glomerata	--	----	30	15
Milium effusum	June	----	10	5
Poa pratensis	--	----	24	10
Poa nemoralis	June	----	20	5
Agrostis vulgaris	June	----	--	10

Where figures are not placed this indicates that the variety referred to is not used in the way mentioned. It is not intended that all the varieties mentioned should be sown; if this is desired the quantities of the grasses maturing at the same time should be reduced one-half. The full allowance, however, is desirable of the kinds which mature early. The large quantity of seed mentioned is necessary for mixed sowing, because one kind follows the other, and a full growth of each is desirable.

The character of these grasses in regard to the nutriment contained varies considerably; it varies also with the fertility of the soil, the grasses grown upon fertile and suitable soils being far more nutritious than those upon poor land. The following table gives the quantity of nutriment contained in the best quality of these and some other grasses. For the sake of convenience and comparison the analyses of some other feeding plants are also given.

† This grass resists extreme droughts.

NUTRITIVE ELEMENTS CONTAINED PER CENT IN THE FOLLOWING:

AIR DRY PLANTS.	*Water.*	*Ash.*	*Fat.*	*Carbo-Hydrates.*	*Fiber.*	*Albuminoids*
Common Vetch	14.30	7.71	4.53	35.36	13.06	25.14
Japan Clover	14.30	3.88	3.76	44.82	23.32	12.92
Red Clover in full bloom	8.55	7.60	4.38	47.42	14.55	17.50
Red Clover in early blossom	9.45	8.05	5.25	42.30	11.85	23.10
Red Clover aftermath	6.00	10.55	3.72	41.78	13.10	24.85
Red Clover in seed	8.15	6.75	3.65	49.90	17.55	14.00
Alfalfa before bloom	8.28	8.92	3.95	41.40	17.85	19.60
Alfalfa full bloom	6.55	6.25	2.63	47.94	20.78	15.75
Peas, dry substance	——	4.01	2.52	65.98	7.58	19.91
Narrow-leaf Plantain	14.30	6.42	3.82	47.52	18.82	9.12
Crow-foot Grass, *Eleusine Indica*	14.30	6.49	1.83	29.15	26.58	11.65
Bermuda Grass	14.30	8.49	1.83	46.06	20.16	9.16
Crab Grass	14.30	10.81	2.42	36.59	27.50	8.38
Barny'd grass *Panicum crus-galli*	14.30	5.98	1.34	46.44	24.78	6.66
Fowl-Meadow Grass	14.30	4.46	2.95	49.00	21.73	7.56
Wire Grass, *Poa compressa*	14.30	3.63	2.43	56.40	17.87	5.37
Quack Grass	14.30	7.99	3.02	48.22	16.63	9.84
Kentucky Blue Grass	14.30	4.46	2.45	44.96	23.94	9.89
Red-top, early blossom	6.65	7.05	3.38	50.84	20.20	11.88
Timothy, young	7.85	8.00	4.20	50.05	18.35	11.55
Timothy, early blossom	5.60	5.70	3.63	54.01	21.43	9.63
Timothy, seed ripe	5.95	9.90	3.20	47.09	22.48	11.38
Orchard Grass, young	5.75	9.70	3.88	47.94	17.68	15.05
Orchard Grass, early bloom	7.35	7.65	3.03	50.32	23.78	8.92
Sweet Vernal Grass	6.45	6.80	4.55	49.96	19.80	12.44
Rye Grass	5.82	10.38	2.18	48.72	19.25	13.65
White Clover	16.50	6.0	3.50	33.90	25.60	14.50
Salt Marsh Grass	10.70	7.60	2.45	41.30	31.90	6.10
Hungarian Grass	13.40	5.70	2.20	38.50	29.40	10.80
GREEN FODDER PLANTS.						
Good pasture	78.20	2.20	1.0	10.10	4.0	4.5
Fodder Corn	84.00	1.00	0.5	8.4	4.7	1.4
Green leaves of trees	61.1	4.00	1.5	15.2	13.0	5.2
Oat Fodder	81.0	1.4	0.5	8.3	6.5	2.3
Pea Fodder	81.5	1.5	0.6	7.6	5.6	3.2
Corn Ensilage	83.5	1.1	0.9	8.9	5.3	1.2
Clover Ensilage	79.2	2.1	2.2	6.4	5.9	4.2
Mangels	88.0	0.8	0.1	9.1	0.9	1.1
Sugar Beets	81.5	0.7	0.1	15.4	1.3	1.0
Carrots	85.0	0.9	0.2	10.8	1.7	1.4
Parsnips	88.3	0.7	0.2	10.2	1.0	1.6
Sweet Potato	69.7	1.1	0.3	26.3	1.7	1.9

The above table is most interesting and important. It needs perhaps a few words of explanation. The valuable nutritive parts of the various substances mentioned are the fat, carbo-hydrates, fiber and albuminoids. The fat, it is believed, is absorbed directly from the digested food and passes into the circulation, and consequently into the milk of cows. This is a most important fact to remember. The carbo-hydrates consist of starch, sugar, and gum, and are all composed of carbon and water combined. These furnish the carbon required for the maintenance of the vital heat, and to some extent may furnish material for the development of fat in the wonderful chemical changes of the animal digestion and nutrition. The fiber consists of cellular tissue or woody substance, but a large part of this is digestible, and is changed in the animal system into heat and fat. This is unquestionable, for the beaver, which is one of the fattest of animals, lives almost wholly upon the bark and young wood of trees. The albuminoids are perhaps the most interesting of all these substances. Vegetable albumen, fibrin and legumin are all of precisely the same chemical composition, as will be more fully shown in a succeeding chapter; and it has been thought probable by some competent physiologists, that these substances, of which the albuminoids of the food are composed, are converted directly in the animal system into the fibrin of blood and flesh, and the caseine of milk. Thus the foods which contain a large proportion of digestible albuminoids must be of the highest value to the dairyman, and hence it is of great interest to know which of the grasses are the best for use in the dairy, and in what condition they are taken for food. A study of the above table is therefore of much interest and use to those who are concerned in the dairy business.

It should not be passed without calling special notice to the fact, that grass in its early stage of growth is much more nutritious than at any after period. Good pasture, it is seen, contains in its fresh state four and a half per cent of matter which nearly all goes to make up the chief solid substance of milk, viz., the caseine, and also the large proportion of one per cent of fat which goes to furnish the cream of the milk. Hence it is that fresh young pasture in early June—the "Queen month" of the year, when the meadows are in all the glory of their fresh and tender verdure—produces the most and the finest butter of any season. The dairyman then should take pains to provide a succession of such tender and nutritious feeding, by growing a succession of grasses in his fields which will afford the needed aliment for the best and largest product from his cows.

The same remark applies equally to the grasses grown for hay, and in making hay the dairyman should be guided by the knowledge conveyed in this regard by the figures above given. The making of hay is then a subject to be well studied from this point of view. It is not simply a mechanical operation—the mere cutting and drying of the grass—but a chemical one, in which the character of the grass is changed. Grass contains a small proportion of fiber as compared with the other carbonaceous matter; but the reverse is true of hay. The carbonaceous elements of grass consist of woody fiber, starch, gum and sugar. These consist of carbon and water, and hence, as has been said, are called carbo-hydrates. These substances, which appear to any ordinary person so unlike in character, are really identical to the chemist, as they are all composed of precisely the same quantities and proportions of carbon and water. The chemist may take the woody fiber, sawdust, cotton-wool or any other vegetable tissue, and by a certain process change it into starch. He can change the starch into gum and the gum into sugar. These changes occur in plants. But the chemist cannot reverse this order and take sugar and bring it back to the condition of gum or starch or woody fiber. His art is powerless to make these transformations. But Nature can produce them and does; and it is done in the drying of grass into hay. Exposure to the sun's heat and light destroys the green color of the grass first; the bright green pales and becomes lighter at first, and in time changes to a brown. This green color consists of a substance in the cells of the plant called chlorophyll, or leaf green. It is an oily substance, and under the influence of oxygen changes to a yellow. It is supposed that this coloring matter of the fresh grass imparts the yellow color to butter. Grass butter is yellow, but hay butter is white; that is, if the hay is made in the common manner by sun drying until the green color is lost. The chemical change in the making of the hay has destroyed this coloring matter. This is one of the changes. But the operation of drying the hay changes the sugar, gum and starch—in part—back to woody fiber. Hence hay contains a considerably larger proportion of fiber than grass does, and less sugar, gum and starch. The fiber is much less digestible than these substances, hence hay is not as nutritious as grass is.

This is one of the facts known in relation to grass upon which the proper process of making hay is based. Hay may be made so as to retain all the good qualities and nutriment of the grass. This is done by cutting the grass—or clover, or any other fodder crop—when it is in its first stages of blossoming. It then contains the most of the valuable nutritious elements, and the least of the indigestible matter. And to preserve these nutritious elements from loss, the grass must be cured in the shade without exposure to the sun's light or heat, and dried by some heating process. In England the very best of hay is made by drying the newly-cut grass by artificial heat in a machine constructed for the purpose. The grass or clover is cut and dried at once, and retains its bright green color, its fragrant odor—given out by the essential oils contained in the grass, and which are absorbed directly into the cow's system and pass into the milk, and go into the cream and butter—and its contents of starch, gum, and sugar. With our favorable climate we do not need this drying apparatus; we can gain the same ends without it. We cut the young grass or clover, leaving it on the ground a few hours only to get rid of the outer moisture and wilt it thoroughly, and then put it up in heaps or cocks, cover it with hay caps made of squares of strong cotton sheeting fifty-four inches wide, and leave it to ferment and heat slightly, which it does naturally. This heat drives off the moisture, and cooks—so to speak—to some extent, the woody fiber, and changes it into starch and gum and sugar, and makes it easily digestible and nutritious. If it does not actually produce these changes, it prepares the fiber for digestion in the stomach of the cow, so that it can there undergo the change by which it is converted into the sugar of the milk and the fat of the cream. Thus it is that the making of hay is really a very important business to the dairyman. It is not only the gathering of a harvest, it is also the performing of a chemical process by which the crop is improved in quality and is made more digestible and nutritious. And in performing this work, the thoughtful, studious person cannot fail to be interested in the most pleasing and instructive manner as he becomes acquainted with one of the wonders of nature, and learns how simple but yet how amazing are the changes wrought in the plant by the force of natural laws which are incomprehensible to him. He knows that these changes occur, but not how they are induced or perfected; he cannot tell how they are directed; he can understand that they depend upon the wonderful mechanism of vegetable structure, and upon a living principle of which he is entirely ignorant except that it exists. What is this principle? It is called vegetable life. It exists in the dry seed and germ; it wakens into action by the influences of heat and moisture, and controls the growth of the plant through a succession of changes until it dies and leaves again a seed. What it is we know not; it is an amazing mystery.

CHAPTER VII.

SOILING AND SOILING CROPS.

The practice of soiling is adapted for high priced lands near large cities, where the market for milk and fine butter affords a sufficient compensation for the large investment of capital and the other expenses which appertain to highly improved localities. As seven acres of pasture are required, on an average, to supply one cow in fully profitable condition, it will not pay to feed cows in this way where land costs more than $100 per acre; and indeed $50 per acre may be made the limit of cost in this respect. Where land is cheap, the products of it are cheaply raised, and where the land is higher, necessarily the products are more costly in proportion. Hence the dairyman whose farm costs him four to ten times as much as that of a Western or Southern farmer, cannot possibly compete with him in making butter or cheese, because the cost of transporting those products to market by rail is much less than the difference in cost. But the case was worse than this, for the dairymen in Iowa and Wisconsin have had their goods brought to market in competition with those from New York and Vermont, and even New Jersey, at an actually less cost per pound for freight. This increased cost for less carriage was another of the burdens which forced dairymen in the East to resort to the practice of soiling that they might reduce the cost of their products.

Again, our hot dry summers very quickly burn up the pastures, and in July the feed becomes hard and scarce, and the milk product necessarily rapidly decreases. Hence, some adequate provision must be made to meet this emergency, and nothing serves so well as what are known as soiling crops, which are cut and carried to the cows on their pastures to help out the feed, or to yards or feeding lots where they are kept and fed wholly upon this green fodder. A very large product of milk of the best quality is thus procured, and the cows are kept up to their fullest productive ability by abundance of succulent food, helped by the use of such concentrated foods as can be purchased cheaply and are suitable for the production of milk of excellent quality. The average product of the cows may thus be easily doubled, while the increased cost of the service is not more than one-fourth, and in many cases, not one-tenth. In the author's dairy the yield of the cows has been brought up from five pounds to ten pounds of butter per week, by means of soiling, while one acre of land under crops has been made to support a cow during the entire year, and less than half an acre per cow has been used for pasture and for the needed runs for exercise. The profit has thus been not only in the increased product but also in the decreased area of land required, and in another way, viz., in the making and saving of a large quantity of manure, the advantage of this system has been very considerable. But there are many persons living in suburban localities whose homestead contains but a few acres, one or two, or three, and this limited area is all that can be afforded to provide room for horse and stable, garden, and ground for keeping a family cow, a most indispensable necessity in semi-rural and rural districts. The practice of soiling meets such cases exactly, for if one acre of land can be made by any sort of management to support a cow through the year, or even the summer, a most important object is gained. And soiling will make this possible. For the practice of soiling some suitable arrangements are necessary. A yard provided with feed racks and a supply of water, adjoining the stable and furnished with an open shed for shelter; and for large herds some adjacent grass lots are required. The remainder of the land is unobstructed by fences and is all under the plow. Where soiling is only partial, and for the support of the cows while the grass fails for two or three months only, nothing more is required than suitable provision for growing the crops and feeding them in some convenient manner, either in the pastures or in the yards or stables.

The crops that have been found most suitable for the purpose are rye sown in the fall, orchard grass, clover, oats or barley and peas mixed, field corn, sweet corn, millet, alfalfa (lucern), and hay and roots for winter feeding. These crops are grown in succession; that is, rye sown early in the fall makes the first feeding, either for early spring pasturing or cutting as soon as it shows the heads; this is followed by orchard grass, which is a permanent crop and may be pastured or mown as soon as the rye is exhausted. As the rye is cut off in strips across the field, the land stripped is at once manured, plowed, and planted with early sweet corn—Narragansett being preferred, because it is nearly as early as the earliest, and is larger in growth and in every way excellent. As soon as another strip is cleared of rye, it is treated in the same way, until the whole of the rye ground is planted. Clover comes into use with or after the orchard grass. These crops as a rule should be cut and not pastured, as there is an economy of fully twenty-five per cent in cutting over pasturing. The clover lasts until the first sweet corn is ready early in July, and from that time there will be abundance of fodder from the corn all summer. As the ground is cleared of corn it is manured and plowed, and replanted with Evergreen sweet corn, or with early

Canada field corn, or some good variety of flint corn, as the Sanford, which yields an abundance of fodder. My own preference, after several years' experience, is for Evergreen sweet corn, which meets every requirement of the case, and is more palatable and nutritious than field corn. Some of the ground is sown at the earliest opportunity in the spring with oats or barley and peas mixed, two and a half bushels of the former with one and a half of the latter per acre. This crop comes in early in July when the clover is exhausted, or is ready for cutting for hay. Mangels or sugar beets are planted late in May or early in June, and are reserved for winter feeding, the tops of these roots being the last green food of the season. The surplus of all these crops is used for winter feeding, or a separate provision for the purpose is made of fodder corn, grass, millet, and other crops.

For the purpose of procuring a large quantity of butter in the milk, which is advisable in every branch of the dairy business, and for the family supply as well where but one cow is kept, some of the concentrated foods are purchased. A proper selection of these foods will be made in reference to their cost and feeding value; for the market values are very often less and sometimes more than the feeding value, and judgment is exercised as economy and experience may dictate in the choice of these foods. Information in this respect is given in the chapter on Foods. As a rule, bran and corn meal are the best staple foods. Pea meal, cotton seed meal, malt sprouts, brewers' grains—when they can be kept sweet—and other similar foods may be used when circumstances are favorable.

The management of a dairy herd under the soiling system is a matter of considerable importance, for the cost and effective results depend upon it to a large extent. The author's method has been as follows, and has been found economical and satisfactory in every respect.

The buildings were arranged as will be described in the chapter on Dairy Barns and Buildings. The methods of feeding are as follows: The first crop in the spring is fall-sown rye. When this is in head cutting begins. A one-horse mower is taken to the field, and two days' supply is cut. The mower is left in the field, covered with a waterproof sheet for protection. A cart or light wagon for the one horse is taken to the field, and the supply for two days is drawn to the barn. One day's supply is always kept ahead in the barn and one is left in the field as a precaution against bad weather. This is cut at night the first day, and afterwards each day's cutting is left in the field, put up in cocks and covered with a large hay cap, and when it is brought into the barn another cutting is made and left ready. The second day's feeding is thrown into a heap on the barn floor; it will heat a little, but this is beneficial rather than otherwise, as has been explained in the previous chapter.

The fodder is cut in a fodder cutter; for a large herd the horse or the bull may do the cutting, a tread-power being kept in an annex to the barn, with a shaft or belt passing through to the fodder cutter in the stable. A large feed-box receives the cut fodder. This is wetted, the water being procured from a pump connected with a cistern or well or spring, as the case may be; but a cistern is preferable and most economical, being supplied from the barn roof. The grain food is mixed with the wet fodder. This is kept on the floor above, and is let down by a spout over the feed-box which is closed by a draw slide. The food is well mixed with a five-tined fork, so as to distribute the meal, etc., evenly. A large grain scoop will hold enough for a ration for a cow. The food may be carried to the feed troughs close by in the scoop, or in a bushel basket; one heaped bushel being the usual ration for one meal.

When a strip a few rods wide is cut off, the land is at once plowed with a swivel plow, the furrows being all turned one way. To avoid heaping up the soil near the fence, an open furrow is first plowed a few feet from it, and then closed, leaving the surface level; the land is then plowed close to the fence—if one is there—and then the other land is turned, leaving no open furrow or back furrow, as the furrows are all turned one way. Narragansett sweet corn is then planted, with the Albany planter, in rows twenty-seven to thirty inches apart, the seed being dropped about twelve inches apart, and three to five grains in a hill. The land is kept well cultivated to keep it free from weeds, and to help the crop. A boy of eighteen is able to do all this work for a herd of thirty cows, the expense being no more than his wages. The other farm work is done by the ordinary help; the boy's work being to cut the fodder, feed the cows, and, with needed help, to replant the crops at intervals of about a week or less; some plowing may be done every day. Thus the work goes on all summer.

In the winter, the fodder is cut in the upper part of the stable, and the cut feed is dropped down a large shoot into the feeding box under it on the floor below. The large, roomy stable has ample storage for hay and fodder above, and, as it is connected with the barn and other buildings, the fodder is easily brought to the stable when a fresh supply is wanted. The roots are kept in a cellar under or connected with the barn, and for twenty or thirty head, or less, it is no difficult matter to slice a sufficient quantity every day in the feed box with a spade ground sharp on the edge. Half a bushel daily is the regular ration, given at noon. The cut roots are sprinkled with the usual meal, and some salt. All the stock are fed in the same manner; the bull and the young heifers having their proportionate rations. The bull gets the same as a cow, being kept in serving condition at all times, as in a dairy kept for full profit, and especially for fine butter, the winter should be the most productive season. The slack time in the author's dairy—kept for the supply of fine butter for sale to private families in New York City—has always been in mid-summer, when customers are usually in the country, and away from home. This gives favorable opportunity for attending to the crops, and gives a rest from butter-making at the most troublesome season of the year.

The disposal of the manure is a matter of importance in this system of dairying. A large quantity of manure is made, as the cows are fed in the stable for most of the time, and the most perfect cleanliness is to be observed in all ways. The floor of the stable is air tight, as will be described hereafter. The gutter is kept constantly supplied with absorbents; dry swamp muck dug in winter from the swamp meadow is freely used; and plaster—a barrel is kept in the stable for the purpose—is liberally scattered in the gutter and on the floor to absorb the ammoniacal odor which would otherwise prevail. Twice a day the gutter is emptied into the manure cellar under the stable, where it is completely covered, at short intervals, with swamp muck, already stored in the cellar for the purpose. When the manure is wanted for the land, which is quite often, it is removed from the cellar, or when not wanted it is taken to the fields, and is piled with swamp muck and a liberal sprinkling of lime to make compost.

In this way the manure is never offensive, the abundant use of plaster keeping the cellar and stables free from odor, and the cellar floor is well covered every time it is cleared. As the growth of large crops requires abundance of manure, there is rarely ever more than a load or two in the cellar, except in the winter; and the supply is scarcely ever sufficient, but needs to be augmented by a good deal of artificial fertilizer.

The yield of crops under this system is about as follows: of rye, eight tons green; of sweet corn, early kind, eight to twelve tons green, two and one-half to three dry; of Evergreen sweet corn twenty-four tons green, five to six dry; of oats and peas, eight tons green, three dry; of millet, eight tons green, three dry; of orchard grass, three tons of hay; of clover, ten tons green, two and one-half tons of hay, and more in favorable years, the second growth giving at least one-half as much as the first crop. Mangels yield 800 to 1,200 bushels per acre as the season may be favorable, and sugar beets—Lane's Imperial, which is a large growing kind—yielding 600 to 1,000 bushels. The French sugar beet is extremely sweet, but is small, and yields only 300 to 400 bushels to the acre; it is consequently not profitable.

In the Southern States, soiling can be carried on with the greatest profit. There are several crops which may be grown that are not suitable for the North. Pearl millet, teosinte, cow peas, millet (this thrives especially well), Bermuda grass (this affords the very best summer pasture, and, if fertilized, yields an enormous quantity of feed); *Festuca pratensis* (Meadow Fescue, Randall grass or Evergreen grass) grows luxuriantly and makes the best pasture; rye may often be pastured all the winter; the native wild grasses, Crab grass (*Eleusina Indica*), Finger grass (*Panicum sanguinale*), Barnyard or Dooryard grass (*Panicum crus-galli*), sprouting Crab grass (*Panicum proliferum*), Texas millet, *Panicum Texacum*, and the common—far too common—beggars' ticks (*Bidens frondosa*), and the—also too common—beggars' lice (*Desmodium molle*), all furnish a most abundant pasturage. The large amount of woods pasturage, containing much grass of various kinds and a wealth of leaves of young timber, more nutritive than any grass or forage plants, also affords excellent subsistence for a large part of the early portion of the year; while for winter feeding, with hay and other fodder, the abundant sweet potato and the cheap cotton seed meal make the very best substitute for the Northern roots and grain feed. Butter can be made in the South for ten cents a pound, more easily than it can be for twenty cents in the North; and the markets there are far better, and better prices can be obtained than in any part of the North, excepting in some of the largest cities. Of this fact the author can speak from a few years' personal experience in the Southern States upon his North Carolina farm, as well as from several years spent in the dairy business in two Northern States.

CHAPTER VIII.

ENSILAGE OF FODDER.

ABOUT sixteen or seventeen years ago the author, then one of the editors of the *American Agriculturist*, wrote the first description of a silo for the preservation of green fodder printed in America, in an article published in that paper, the pioneer agricultural journal of America. In that article was given a description of the then very imperfect process of making "sour hay" from corn stalks which were buried in pits in the ground and covered with the earth taken out. Several years previously (in 1855), the author, then traveling in Europe, saw at the agricultural school at Grignon, and at a large farm attached to a sugar beet factory, a number of silos of the same rough and ready character, in which clover, lucern, and the leaves of the beet were preserved.

This practice had descended from the ancient Romans, who, on their peaceful Italian farms, thus stored their fodder for use in the winter season, and who, as was their wont, changing the plow and the hoe for the sword and the spear, spread over Europe a conquering host of the most skillful warriors, and carried with them to the conquered countries their civilization and their peaceful arts, thus laying the foundation for the future progress of that continent. In this manner the silo was introduced first among the Huns in Hungary, and then into Germany and France, where it remained until 1872 in the same condition. Then M. Goffart, an enterprising French gentleman, built the first silo of masonry, with solid air-tight walls, and a covering of planks weighted down with heavy stone. This cover, with constant pressure, is the great improvement made by M. Goffart in the silo; and to him also is the system of ensilage indebted for the practice of cutting the green fodder into short lengths so as to cause it to pack more solidly in the silo, and when taken out to be in convenient form for feeding. When this form of silo is operated expertly the green food should not pass beyond the saccharine stage of fermentation, and when taken from the silo and exposed to the air the alcoholic fermentation soon begins. In this state the ensilage (preserved fodder) is in its best condition for feeding, and its food value is probably equal to what it would have been at the time of packing in the silo—that is, the changes have improved its digestibility as much as fermentation has reduced its weight of dry substance.

M. Goffart published a book on the subject which was translated and published by Mr. J. B. Brown, of New York (President of the New York Plow Company, and an accomplished farmer), and it is through Mr. Brown's unselfish efforts that the practice became extremely popular, and in time reached its present stage and condition.

In 1879 Dr. J. M. Bailey, of Billerica, Mass., built the first double silo of concrete masonry, and stored about 125 tons of corn ensilage, which gave him much satisfaction in feeding. His report stimulated inquiry and experiment in the new process.

At the beginning of 1880 this process was much discussed by the agricultural press (following the lead of the *American Agriculturist*), and the result was the building of some fifty or more silos in different parts of the country, most of them substantial, and many of them in the most durable form. This was most remarkable progress for a new system to make in a single season. Probably 8,000 tons of corn ensilage were preserved. The reports from these various experiments were nearly all of them favorable, many of them very enthusiastic, as to its economy and value. Some very extravagant estimates were made as to the tons of corn raised upon an acre, but these estimates were soon reduced to solid fact by the measurement of the compressed contents of the crops in the silos. Forty-six pounds were found to be the weight of a cubic foot of ensilage after compression under 1,000 pounds to the square yard, and the content of the silo was easily measured, and thus the yield per acre determined. The yields noted ranged from twenty to thirty-three tons of green corn per acre. Thirty tons may be considered an excellent yield of green corn. This is equal to about five tons of water-free food, which is nearly five times the average yield of dry food per acre of our ordinary meadows. But it must be noted that the dry food of corn ensilage is not as valuable per weight as that from meadow grasses.

Yet it must be admitted that the success of the silos built in 1880, in the ensilage of green corn, was very remarkable, and gave this new system a respectable standing in American agriculture. But the final verdict upon the system was only given when it was applied practically to the preservation of meadow grasses and thus proved itself worthy of being considered a system in stock feeding.

The cost of the ensilage at that time was found, in practice, to be from sixty-six to seventy-five cents per ton for the harvesting and putting in the silo, and the whole cost from beginning, to the ending in the cow's stomach, from one to two dollars per ton. This is equivalent to about seven dollars per ton for hay in the barn, at the extreme limit in disfavor of ensilage and in favor of hay. The result was found, by many farmers who had tried the process for several years, to be that one cow could be fed upon a ton of the ensilage per month, and twelve tons per year; thus making it possible to feed two cows upon one acre of crop, amounting to twenty-four tons of green fodder corn. Corn was found to be the cheapest but not the best fodder for this purpose, and in time other crops were preserved in this way, such as clover, millet, green rye, oats and peas; and in England, whose moist and changeable climate favored the innovation very much, the ordinary field grasses were thus secured, wet from the field, in a safe and satisfactory manner, instead of being made into hay.

The antiquity of the process gives security that it may be made permanent, and removes all fear that, like the abandoned cooking of food, it might be found impracticable for ordinary practical use by farmers. During the past few years the practice has been much simplified, the costly and cumbrous stone and cement silo has been adandoned, and a common barn mow, closed tightly with matched boards doubled, and building paper between, and the method of heating the fodder by spontaneous fermentation, have been substituted for the old and more laborious system. The new process also gets rid of the acid and preserves the fodder in a sweet condition; the heat of the fermentation destroying the germs which produce acidity and to some extent improving the fodder in regard to its digestibility.

The following description of a silo is given by Mr. B. S. Hoxie, a dairyman in Wisconsin.

"If the silo is to be detached from the barn, make a low foundation wall, just high enough to prevent any surface water ever coming in contact with the ensilage. Fill up the floor to the level of this wall, and finish off with clay well pounded down, or a cement of water lime. Next lay your sills of two by eight inch joist, flat on the wall, and bed them well in lime mortar; have them so firm that there will be no chance to spread or get out of place. On the joists place two by eight inch studding sixteen feet long, as this is a proper hight for the silo, and sixteen inches from center to center. Toenail firmly at the bottom of the sill. The object of placing the studding this distance apart is to accommodate the width of tarred paper, for a perfect silo must be perfectly air-tight on sides and bottom. Now put good tarred paper on the inside of the studs, lapping as it will so as to make tight work; cover with good, sound matched flooring, and see to it that the corners are made secure, so that there will be no spread or give to let in the air. Inclose the outside surface with tarred paper same as inside, and good drop-lap siding, as it is called, or any similar method; being careful to make it tight and firm. The roof is made as any ordinary barn roof, and the building may be finished up on the outside to suit the owner's fancy or pocket. A very good size for a silo would be sixteen by thirty-two feet, or, if more room is needed, make it longer and put in a cross partition of plank. This partition should be made so it will slip down into place and be held by cleats at its ends. The sides must be secured with one or more iron rods to keep the building from spreading. A convenient size for the door would be four feet wide in one end and made in sections of two feet each, sliding down in grooves so as to come out from the inside as the silo is emptied. These doors, as well as all inside work, must be made so as to form no obstruction to the settling of the fodder, with the boards and tarred paper which form the cover to the pit. This is one of the cheapest methods of construction, and is essentially as good a one as can be built. If a farmer has stone handy he can build one of solid masonry, but it would not keep out the frost or air better than one of wood. One end of a bay in the barn can be used, by observing the same precautions to have it air-tight."

The experience of Mr. John Gould, of Aurora, Ohio, a most intelligent, practical and well-known dairyman, is given as follows :

"The corn plant is the great ensilage forage, as it is of sure growth, and in all seasons, wet or dry, can be depended upon for a fair product, and in average years will give more than twice as many tons per acre as any other crop that can be matched against it. Another point in progress is in recognizing the fact that the corn plant grows to develop an ear of grain, and if it is deprived of this function by overcrowding, it has no aim in life, and refuses to gather up rich stores of sugar, starch, and other elements out of which to perfect the ear. So we can safely put the difference in feeding value between a dwarfed, crowded stalk of corn with no ear, or no attempt to produce one, at about one-third that of another, that had more room, and has brought its ear to the 'roasting' stage. Instead of sowing broadcast two and three bushels of corn (168 lbs.), one-half bushel (28 lbs.) will be ample if drilled in rows three and a half feet apart. The result will be that the weight of fodder and ears will exceed that of a field sown with from 112 to 168 lbs., and possess fully three times its feeding value. Maturity is another essential in good ensilage. The half-grown crop is little better than a mass of cellular tissue, filled with water; but the mature crop has brought the food elements forward to perfection. So we find that the time of greatest food value is when the crop has begun to glaze, as it then has the sugar element present in abundance to aid in its preservation. If properly put up, the fodder becomes canned green-corn fodder, and not the ensilage of the past—soggy, sour and rank-smelling material, for the reason that it was made of matter that underwent great change chemically, because devoid of preserving qualities.

"The silo has also made a great advance towards simplicity and cheapness, and any farmer can now have a silo ; for they are no longer classed as the rich man's monopoly. The best silos are now built wholly of wood above ground, building the frame of two by ten inch studding. The inside lining is made of two thicknesses of inch boards, with tarred paper between, or it may be lathed and plastered, using cement instead of white lime. The outside is covered with ship-lap siding. This leaves a dead-air space, which *should not* be filled in with sawdust. The contents of a silo will not freeze in any Northern State, and the sawdust will—if filled in—gather moisture from being between the warm ensilage on the one side and the colder outer air on the other, and is a damage rather than a benefit. In localities where small stones and sand are abundant, it may be best to build concrete walls for the silo. They may be rough-faced on the inside, with strips of wood set up, and a lining put on to make an air-space and afford better protection from the influence of the walls. Or the walls may be cement-faced. Of whatever material the silo is built, the walls must be perpendicular and smooth-faced, so that the ensilage shall not be resisted in settling. The silo, however, must be strong enough to withstand the lateral pressure of the ensilage. If built of timber, two by ten inch studding, set sixteen inches apart, will be none too strong, especially if the silo is sixteen feet in depth. Now that more mature fodder is put up, there seems to be no limit to the depth of ensilage that can be safely stored, as there is no pressing-out of the juice of the fodder, as was once the result of deep filling.

Twenty feet will probably be the practical limit in depth. The silo should be so built that surface water can not come in from the bottom, as air-proof walls and a water-tight and air-proof bottom are the first two essentials in silo building. The best way is to put in cross-sills two by ten inches, to tie the footing of the studding, and after the silo is built fill in between these sills with water-lime and small stones, raising it an inch or so above the level of sills, making a smooth level floor.

"The silo should be twice as long as wide, and at least twelve to sixteen feet deep. This enables it to be filled without delay, and also insures the *cooking* of the fodder, which is now considered essential. The silo needs a partition, dividing it into equal-sized rooms. An ensilage cutter is provided with a carrier which hoists the cut fodder up over the walls into the pits. The plan is to cut into one pit one day, say from twelve to twenty tons of green fodder, and by slightly turning the upper end of the carrier, deposit the next day's cutting into pit No. 2. It is *not* necessary to tread or tramp the cut fodder, only to keep it level in the boxes. The tramping should be done along the side and corners, to make the sides settle as fast as the center. No more fodder should be added until the first filling has reached a temperature of 125 degrees, when another layer should be added. This is the cooking process. The addition of cold, fresh ensilage reduces the temperature of the first to about eighty degrees, and it cannot re-heat, or ferment, unless it is again exposed to the oxygen of the air. This alternate filling and heating goes on until the pits are full. The heating has rarified the air that was mixed in with the ensilage, causing it to escape upward, and a very dilute gas takes its place. The heating has also caused the ensilage to settle very compactly; and at last, when the pits are full, it is only necessary to let the last day's filling heat up, and then level off the surface of the silage, cover it with strips of tarred paper well lapped, and cover this with common rough inch lumber. This will keep out the air, and all that is necessary is to weight this cover with a ton or two of hay, sawdust, or even moist clay, to insure the cover remaining firmly upon the mass beneath as it settles, and to prevent the entrance of the air. Within three weeks the mass will cool down to about eighty degrees, where it will remain—a fact that guarantees it from danger of freezing. When ready to feed, remove the cover entirely from one pit, and feed evenly from the surface. It is not advisable to open the door at the side of a silo all the way to the bottom, and begin to shovel it from the floor. This lets the air into the side of the ensilage, and it commences to re-heat. We have knowledge of two farmers at least who opened at the side, and came very near losing the entire contents of a pit, and only saved it by prompt leveling down of the ensilage, and tramping it very hard and restoring it to a level. The side door to a silo should be made in sections of about eighteen inches each; these can be removed one by one, as the surface level is lowered by feeding. A great many silos are now built in the interior of the big barn, using a whole or part of a bay. Nearly five times as much forage can be put into a given space in the form of ensilage as can be stored in the same space if the crop is dried—fifty cubic feet of ensilage weighing a ton—500 feet or more are requisite for a ton of hay.

"The value of ensilage as a stock ration is now undisputed. Nor can it be longer urged that it has, if put up 'sweet,' or reasonably so, any deleterious effect upon milk or butter. The great question is: How can we get it into the silo the cheapest and best? The concurrent testimony of the great ensilage feeders is that the crop can be grown, harvested, and put into the silo for $1.25 per ton, all legitimate expenses included. And three tons of ensilage having the full feeding value of one ton of the best hay, and a crop of from twenty to thirty tons of fodder corn per acre being an every-season's occurrence, the vital question now coming up to be decided is: 'Why should we continue to feed expensive hay to our cattle and sheep, when we can, under average conditions, supply of "roughage" ample in amount to an animal for three cents per day?' And if we add four or five cents more for bran, to make a perfectly balanced ration, we have a food for our stock that in cheapness equals summer pasturage."

This may be supposed to be somewhat enthusiastic and overdrawn, but the fact that the practice is rapidly spreading among practical dairymen who run their dairies for their daily bread, and has never been abandoned by any who have tried it, gives good evidence, and the best of all proof, that it is both useful and economical.

CHAPTER IX.

DAIRY BUILDINGS.

The buildings for a dairy farm must be arranged skillfully for ease, convenience, and the best effective results in the business. The barn for the storage of grain and fodder for winter feeding is not necessary for a dairy, the accommodation of the cows being of the most importance, and the grain to be stored being usually of minor consideration. The points to be considered are the comfort of the cows, the easy maintenance of perfect cleanliness, the convenient handling and distribution of the food, economy of room, and facility for ingress and egress to every part of the buildings. My cow stable, built after several years' experience and with a view to securing all the points above mentioned, and which has been found very convenient and satisfactory in every way, is arranged as follows:

The main building is fifty feet by twenty-four, and is intended to hold thirty cows in two rows; but so far only fifteen have been kept in it on one side, leaving a wide feeding passage, through which a one-horse wagon or light cart can be driven with loads of green fodder used in the summer when soiling the cows. Along the middle

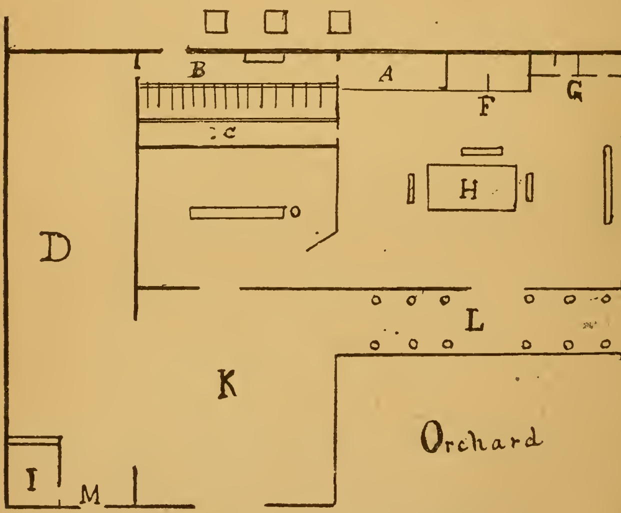

Fig. 9.—PLAN OF COW STABLE, YARD, AND PENS.

of the barn is the feeding trough, eighteen inches wide, and the feeding floor, *B*, is on the north side of it. Then comes the platform for the cows, *C* (figure 9). This is five feet wide, and slopes two inches in this distance to keep the floor dry. Back of this is a manure gutter, fourteen inches wide and eight inches deep, and then a walking platform four and a half feet wide, making up in all half of the width of the barn. The southern wall has broad windows, four feet apart, the whole length, that let in a flood of sunlight in which the cows bask in comfort when the rough winds of winter howl without. These windows are furnished with green house-blinds for protection against the sun in the summer, and are furnished with wire screens to exclude flies and admit air, when in the warm weather the lower parts of the windows are removed. The stable is then darkened, and by the observance of cleanliness and the liberal use of Persian insect powder, the cows are able to rest in peace during the middle and hottest hours of the day, lying unmolested and making milk liberally in return for the comforts afforded.

There is a manure cellar under the whole barn, and the gutter is emptied by trap doors in it. The floor is double and water-tight, and a coat of tar is laid between the two plankings. The cellar is closed in by windows and tight doors, so that the stable is kept free from cold drafts in this direction. The whole building is air-tight, and the upper floor is of matched boards, so that in the coldest weather the manure in the gutter does not freeze. The broad, roomy feeding floor is occupied by a fodder cutter, meal bins, and a large feed box for mixing feed. A pump, connected with both a cistern and a spring, stands near the feed trough. On the west side of the barn is a building, *D*, occupied as horse stable, carriage and wagon house, tool and store room. This has a door on the south end and a passageway from it past the stables and through the other places to the cow barn. At the other end of the cow barn are the large doors opening into an open shed connecting with the calf pens and bull pen and yard, and the small door for the entrance and exit of the cows. The yard, *E*, is provided with a long water trough, supplied from a pump connected with a spring near by. This trough is pivoted at the ends in frames, so that when not in use it is turned bottom upward and kept free from snow and ice. The yard is on high ground and the water is carried from all the buildings into cisterns, so that the yard is always dry.

The cows stand fastened in short stalls by means of chains stretched across the front of the stalls and having a ring at each end, which slides on long iron bars in the stanchions, and a ring and snap hook in the middle. The cows have strong leather straps around their necks, with a ring fastened in each. This ring is fastened to the snap hook in an instant, and the cow can move her head very freely, but cannot reach over into the next stall to rob her neighbor or punch her. The feed trough is also divided by a prolongation of the partition of the stall, so as to confine each cow's food to herself. A sloping board along the front of the feed trough guides the cut feed emptied from the feed basket, which holds a bushel, into each section. It is a very few minutes' work to mix the cut hay or fodder, prepared the night before, with the water and the meal in the feed box and distribute a basket of it to each cow. We have done this easily before breakfast in fifteen minutes, feeding the whole fifteen cows, and the bull and several calves besides. This arrangement provides everything convenient for the cows and the owner, and leaves nothing to be desired. There is ample room for work, for the cows, and for the feed. The floor is dry, warm, and easily kept clean and free from odor. The gutters are emptied very quickly, swept out with a stiff broom—of the kind used for city streets, and which fits the gutter—dusted freely with plaster from a barrel kept on the floor at the far end, and is at once littered with clean sawdust, leaves, or cut straw from the storeroom at the end of the stable. Ventilation is provided when it is needed by opening the windows a trifle at the top or bottom, or by opening slides in the wall opposite the cows. A ventilating shaft, which can be closed in stormy weather, also aids in removing any disagreeable air which may gather; but on entering the stable in the morning there is nothing of this kind perceptible.

The cows, trained to it, walk into the stable and take their proper places without trouble, when they are fastened from the other side of the feed trough, where a partition three feet high closes in the stall, and they can be let loose in the same way. When the weather is too rough the cows are watered in the stalls from the pump in the stable. At other times the cows are turned out in the yard for water and for a run of two or three hours, or they may lie in the open shed, which is well littered with dry leaves from the wood lot.

This arrangement has been the result of a gradual growth of practice and experience during many years, and has been found satisfactory, with perhaps one exception, and that is the addition of a silo for preserving green fodder for use in the winter. This, however, we look upon more in the light of an experiment to be tried, as with a roomy cellar under a part of the barn for mangels and beets, which are used in the winter, a silo may be easily dispensed with.

The plan of the stable is shown at figure 9. The main building is the central part, and every other part can be reached by the outer door, *M*, which is next to the dwelling. Near this door is the cow's hospital, *I*, where calving animals are kept for a few days until ready to go in the dairy. The open shed is at *A*, and a door leads from this into the feeding floor, and from this a door leads outside into the pasture and another into the buildings, *D*. The bull pen and yard are at *F*, and the separate calf pens at *G*. A gate is made in the end calf pen through which the cows may go at times into the field in the rear. At *H* is the manure shed with feeding racks near it. The outer yard is at *K*. A large gate affords entrance into this yard and through the lane, *L*, into the road and the fields across it, as shown in figure 1. The numerous doors and gates are made self-closing by means of springs, so that accidents (?) from neglected open doors cannot happen. A number of hay and fodder barracks are at the rear of the stable, in the field which is within easy reach.

Stable Floors.—The most important part of the stable is the floor. As a rule, the earth is the best floor for a stable of any kind. If it is hard enough, a firm clay or gravel, it will soon become so solid as to need no repair. But it is not often the case that such a naturally solid floor can be found. It is, therefore, necessary to reinforce it by some covering of concrete or cement. This is done as follows: The floor is first graded in a suitable manner to the gutter; two inches in four and a half or five feet, which is the right width of a floor for cows, is a sufficient slope. The most of this slope should be made near the gutter, where it is most required. The floor is then covered with a mixed concrete of sand and gravel, with common lime first properly slaked and well worked together with a hoe, and left in a heap after working once a day for several days. This makes it tough and durable. Some coal ashes well worked in, after being wetted, makes the concrete still more durable. Sawdust, first soaked with water, also adds to the strength of the concrete, and plenty of short straw will have the same effect. Good, tough clay, worked well into a stiff puddle with sawdust or short straw, or both, makes a good material for a stable floor. Hydraulic cement, in the proportion of one barrel to three barrels of sharp sand, and five or six barrels of coarse gravel, makes the best and most durable floor, and if saturated with hot gas-tar will be completely water-proof and rat-proof. The work is done as follows: The common lime is properly slaked in the usual manner; after it is cold the sand is worked in as for building mortar; twice its bulk of coal ashes or coarse gravel, first wetted, is then well worked in. The more it is worked with the hoe and shovel, and left in a heap, the tougher it becomes.

For a clay floor, the clay is worked up with a hoe in the same way, coal ashes, gravel and short straw being worked in until a stiff mass is made. For a cement floor, the cement is mixed dry with three times its measure of dry, clean sand, and is then wetted and made into a thin mortar, to which is added the coarse gravel wet. Only as much is mixed as can be spread at one time and within fifteen minutes, as it sets and hardens very quickly. As any one of these materials is spread it is well rammed and beaten down, with a rammer made out of a round log, and the handles set into holes bored with a one and one-quarter inch auger.

After the floor is spread it is smoothed over with a plank. Water is poured on, if necessary, and the more the surface is rubbed the better it will be. If any one of these floors is finished with the gas-tar it will be found very serviceable—the odor tends to keep all sorts of vermin at a distance, and, as it will not absorb the liquid manure, is easily kept clean.

A very excellent floor is made of round stone well rammed into the ground, and covered with a coating of mortar of either of the kinds described above, then well rubbed over and finished with the gas-tar.

The gutters should have a fall to the outlet of the stable, where the liquid manure can drain into a manure pit; or the gutter should be kept well filled with some dry absorbent or litter, as chaff, leaves, straw, pine straw, or dry muck from a swamp. It is an excellent thing to bring in the manure from the horse stables and put in the gutters to absorb the liquid, which is more abundant in cow stables, and so to mix the two and thus improve both. When the cow stable has a cellar under it the floor must be of plank. To make this floor in the best manner, it should be double and laid with a gutter in it. The planks are necessarily laid crossing the beams, but to prevent drip into the cellar, and to save all the liquid, the planks should be laid double, with the joints broken. To make the floor in the very best manner, and quite water-tight and most durable, the first one should be well coated with hot tar, and the upper planks laid in this, getting the joints filled with the tar. A

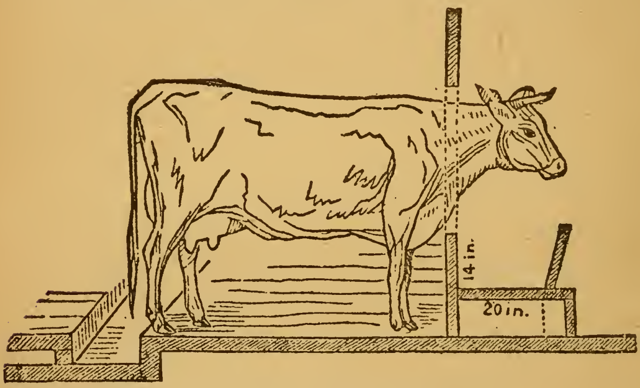

Fig. 10.—PLAN OF STANDING FLOOR.

floor so laid will last for twenty years, or three times as long as any other. It is a good plan to give a plank floor a coat of whitewash under and on the top once a year, as the lime prevents decay. A floor thus treated would probably remain sound as long as the rest of the building. Such a plank floor should slope the same as any other, excepting that the gutter may be level, as the manure will be emptied through trap-doors into the cellar below. The manure is easily removed by drawing it forward to the doors with a broad hoe, when it falls, without further trouble. The plan of a stable floor is shown at figure 10.

The next matter of importance is the yard. A yard must be roomy. For twenty-five cows, half an acre is not too much. This space gives ample room for the cows to be safe from the attacks of the master animals, who are always exceedingly spiteful to the weaker ones. It gives ample room for fodder racks, for a milking shed, for a manure pit, and for watering troughs, which can be used safely by the weak cows. No other animals should be permitted in the yard.

In the center is the manure pit, to be hereafter described; at each end of this is a watering trough, to be supplied, if possible, by a pipe from a spring, or from a cistern and a force pump. Around the yard are fodder and straw racks, in which the roughness or coarse feed is given. At one corner is a milking shed, in which the cows are tied for milking, or where they may find shelter from a rain. It will be a great advantage if the yard is shaded by trees planted around it, as shelter from the winds as well as the sun, for the yard will be needed in the summer as well as in the winter.

The manure pit should be sunk about two feet below the surface, and this should be kept filled with litter, as forest leaves, pine straw, swamp muck, etc., and it should be surrounded with a stone wall, or a log fence, four feet high, having a driveway at each end for the purpose of admitting a wagon for the removal of the manure. A drain, covered—without exception—should lead from the gutter in the stable to this pit, to convey the liquid manure. The solid manure and litter are wheeled out from the stable to the pit at each morning cleaning of the stable. If possible—and it should always be an object to do this—as much litter and waste matter as can be gathered should be spread over the manure, as an absorbent of the liquid, and to add to the bulk. Every week a liberal application of plaster should be scattered over the manure to absorb and combine with the odors of the decomposing mass. This completely prevents all offensive odor, and adds much to the value of the manure.

The pit should not be covered, as it will need all the rain which will fall upon it to keep it moist enough to prevent fire fanging or dry rot, which utterly destroys the value of manure. No water from the buildings should flow into this pit, but the yard should be graded so as to give easy drainage of the surface water into the manure pit, where it will be absorbed, and a few holes should be left in the wall to allow this water to drain in.

The yard will then be kept dry and free from mud. To add to the supply of manure, and to cover the droppings, the whole yard should be kept deeply littered. Green weeds from bottom lands and swamps, leaves, and any other coarse matter which can be procured in any way should be thus used. If this can not be done, the droppings should be gathered up with a shovel and a wheelbarrow and thrown into the manure pit, but in whatever way it is done, the yard *must* be kept clean. It will be a saving of labor in keeping the cows clean, and very much lighten the use of the card and the brush for this purpose. If the yard can not be located on high and dry ground, and there is any danger of mud in wet weather, it should be drained, and the drains made to discharge in some convenient way into a field, where the water can be spread over grass or some other crop, or be usefully employed in other ways.

The water troughs should be made tight so as to prevent leakage, which will make the ground muddy, and should be provided with some means to carry off the overflow. They should be provided with covers whereever snow will fall and choke them or chill the water, and these covers should always be let down when the cows are not in the yard. By providing cisterns to catch all the roof water, an ample supply will be procured, and rain water is the purest and best for the use of dairy cows. To keep the roof water pure, it is well to have the roofs painted, especially when oak or chestnut shingles are used, as these stain the water a dark color, and give it an objectionable taste, so that the cows will not take enough of it to supply their wants. When the cows are taken out of the yard, the trough should be emptied while the weather is cold, or there is danger of making ice in the troughs. Ice water is exceedingly hurtful to cows, and should never be used in a dairy.

An excellent way to make a trough is to procure white oak plank two inches thick, twelve or fourteen feet long, and twelve inches wide. For the bottom a plank sixteen inches wide is used. The edges of the bottom and end planks are evenly dressed and covered with two or three thicknesses of roofing paper dipped in tar. The sides are then drawn up close to the bottom and ends by means of screw-bolts, and this will make a strong, cheap, durable, water-tight trough. The troughs should be three feet above the ground, so as to avoid the gathering of filth in any way whatever. The yard should be well fenced with a strong plank fence, capped on the top, and should have several gates opening on hinges and closed with such fastenings as can not be loosened by any of the more experienced cows. The fence should be at least five feet high.

COW-SHEDS.—The practice of lodging valuable cows in a basement of a large barn filled with the most combustible matter, and provided with flues and air passages for the rapid spread of fire and passage of suffocating smoke, has frequently led to the entire and cruel destruction of fine herds of cattle, worth thousands of dollars each. The most valuable cattle are thus apt to be endangered. As the loss of a herd is a calamity equally serious to a working dairyman as to a wealthy amateur farmer, one of the first objects to secure should be safety from fire, without sacrificing other requisites, as cheapness, comfort, convenience and cleanliness.

An excellent cow shed, in every way desirable, may be built on the following plan (figure 11), which shows a complete arrangement, enclosing a square yard, and which will be isolated from other buildings. It consists of thirty-three loose stalls for cows and eight pens for calves and bull, in the front, on each side of the entrance gate. Each stall is six by eight feet, and separated by boarded partitions four feet high. The shed is nine feet high in the front, seven feet in the rear, is twelve feet wide, and ninety or 100 feet long. The roof is of boards. The frame is made of posts set in the ground, with a two

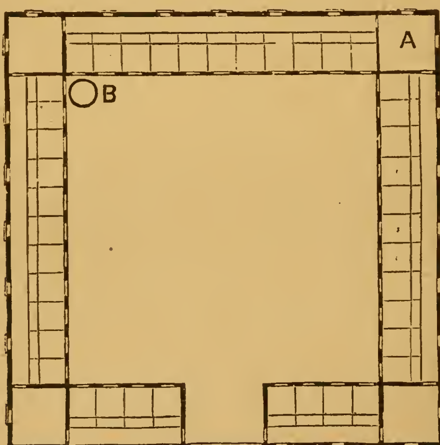

Fig. 11.—PLAN OF CATTLE SHED.

by four inch plate and girders of the same size where needed. There is a feed passage leading from a room in one end (*A*), for preparing the feed which traverses the whole length. There is a feed trough in each stall, and a bar or pole is fastened along the whole range of stalls, eighteen inches from the top of the front partition, by which the cattle are prevented from approaching the front too closely, and mounting the feed troughs, or putting their feet into them. The cows are kept loose in the stalls, unless otherwise desired; in which case they can be fastened to rings screwed to the sides of the stalls. A cistern, which collects the water from the roof, is made at *B*. The front of each stall has a double door, so made that the upper part may be left open for ventilation. Ventilating apertures may be made above each door, for use in cold weather. The sheds are arranged in a square, as shown, with a gate at one side for entrance into the interior yard. The yard will give room for exercise, and racks may be provided in it for feeding green fodder, hay or straw. The plan is admirably adapted for the soiling system of feeding, and the making of a large quantity of manure, while forty or fifty cows may be provided with comfortable room, at a cost of $600 to $750 only. In many cases, the value of the manure saved by soiling cattle in such a shed will repay its whole cost in one year. A section of the interior is shown

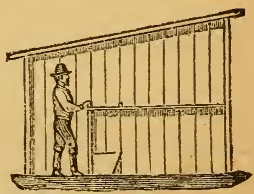

Fig. 12.

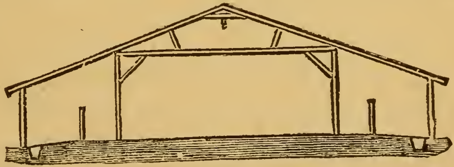

Fig. 13.—SECTION OF CHEAP BARN AND STABLES.

at figure 12. At figure 13 is a section of a cheap barn and stables connected. The building may even be brought lower at the eaves, and provide pens for pigs and calves, or sheep, or open sheds for tools, etc. In this way it is protected from sweeping winds, which can have but little effect upon it. The central space is used for storing hay or grain, or for threshing, and the side spaces for stabling cattle. Three and a half feet in length of floor space will accommodate two head, so that a seventy-foot barn will hold forty head, and provide abundant room for the crop of 100 acres, at a cost of about ten dollars per running foot. Light timber only is needed, and rough posts set in the ground will make the basis of the frame. The plan is arranged for a building to be seventy feet long, and fifty feet wide, with the central space twenty-six feet, and the wings each twelve feet wide; wide doors are made at each end, and also through the center; the stanchions or stalls in the center are movable, and may be easily taken down when it is necessary to use the central cross passage.

THE DISPOSAL OF MANURE is another important matter, and the construction of manure cellars should receive attention. Manure may be saved and made most easily in a cellar under the stable. By the use of trap-doors in the gutter on the floor, the manure and soiled litter can be drawn down and dropped into the cellar in five minutes. The stable is then clean and ready for a fresh littering of sawdust and leaves or short straw. To draw the manure along the gutter, I have used a large hoe made as wide as the gutter. This cleans the floor when necessary, as well as the gutter. A stiff broom is then used to sweep the gutter clean. The manure falls in a heap under each trap-door in the gutter, and is immediately spread and covered over with a coat of dry swamp muck kept in readiness in the cellar. A heap of the muck is then thrown under each trap-door to catch the drip of liquid which comes from the gutter. In this way there is no foul odor in the stable. If any should be noticed, the floor is dusted all over with plaster kept in a barrel in the stable for that purpose, and a half bushel of it is taken into the cellar and spread over the manure. In this way the stable is kept free from all disagreeable odor, and the most fastidious person could walk through it without the least disgust and witness the milking which follows this operation.

The cellar should be at least nine feet high in the clear, to permit the men who work in it to load the wagons. I have had my cellar four feet deep with manure, and as it was fifty by twenty-four feet, this gave 4,800 cubic feet, or about sixty tons. Manure made of swamp muck and leaves in large proportion, with the cow's droppings and urine, is not so heavy as the clear manure, and will weigh only about one and a half ton to the cord, but a ton of it is worth at least $5, if estimated in the way the value of artificial fertilizers is. I have used many hundred dollars' worth of fertilizers in addition to the large quantity of manure made in this way, and have often used $25 worth to the acre; but I have found that five tons of the stable manure, made as here described, from my high-fed cows, have shown more effect upon my light soil than the fertilizer. Being quite fine and pulverulent, it is spread from the manure-spreader quite evenly, and as a top dressing upon rye in the early spring, or grass or clover, it shows a conspicuous effect after the first rain. This is to be attributed to the fact that all the valuable urine is saved, and that plaster so liberally used preserves every atom of fertilizing matter, besides adding something of its own. At least fifty pounds of plaster are used to each ton of manure, as it is scattered in the horse-stable and pig-pens, as well as in the cow-stable and the cellar under it.

The bottom should be cemented, unless the greatest care is exercised to use an abundance of absorbents. I have never suspected any waste in my cellar, although the bottom is of sand. During many cleanings out the cellar bottom has become hollowed considerably, and any liquid free in it would soak into the sand. But I have never found the sand, even after some years' use, to be discolored more than an inch in depth. I would advise every man who makes a manure cellar to have it cemented; making the floor dishing to the center. The floor should be covered three inches deep with concrete, made of gravel, six parts; sand three parts; and hydraulic cement one part. These are well mixed into a thin mortar, which is evenly spread and well rammed down until it is firm and solid. It is advisable when it is dry to give it a coat of hot gas-tar, which makes it harder and more durable, and less liable to break under the weight of a load of manure, and it keeps vermin out. The cellar should have several windows to afford thorough ventilation. This is very important. The manure made by well-fed cows is rich and quickly ferments, throwing off a good deal of carbonic acid gas; more especially from the action of the plaster upon the ammonia which is formed, and which unites with the plaster, giving off carbonic acid. A good deal of hydrogen gas is also evolved, which, with the carbonic acid, will at times form carburretted hydrogen, and it is well to get rid of this gas as quickly as possible, as it is very deleterious. A thorough ventilation is therefore needed, and at least six windows should be provided in the cellar as near the upper part as may be. These windows should have sliding sash, and need not be larger than three feet by one and one-half, placed lengthwise horizontally.

The door should be at least twelve feet wide and made to run on hangers and a track, so as to slide easily each way. They are then in no way inconvenient, as hinged doors always are. My doors are open on the upper half, and are there barred, to admit air and to make them lighter. No animals are permitted in the manure cellar. There is nothing there for them to eat, and if there was, I object strongly to any animal consuming as food any part of the excrement of another; believing this to be a prevalent source of disease and loss, and to be avoided as unnatural, filthy, and unwholesome in the extreme. Moreover, pigs will do better with healthful exercise in a grass field or a wood lot, than in turning up the manure in a cellar; and poultry kept in manure are not fit food for a civilized being.

A cellar should be built firmly and neatly. If stone is used it should be well laid in lime mortar, and the spaces well filled with broken fragments. Care is to be taken to have no burrowing places for rats and mice, and one excellent feature of a good cellar is that it serves as an entire defence against the assaults of these vermin upon the stable and barn above it. The beams and joists are well hidden in the wall, and the floor above is laid close down upon the wall plate, which is a three-inch plank bedded in the mortar, and upon which the posts and studding of the frame of the stable rest and are spiked. The stable floor comes up snugly to this plate, and so leaves no crevice through which a mouse could force itself. As the barn above the stable has a tight floor, there is no chance for mice to get up there, and any one which by chance gets in the stable is soon captured by the well-fed cats, which have their home in the stable and get regular rations of milk twice a day. Lastly, it is advisable to make the corners of the cellar of dressed stone, and lay them up with care, as these are usually the first part of a cellar wall to give out, and are the most important.

Stable for a Family Cow.—Where but one cow is kept the stable may be located conveniently near the house if desired, because a well-kept stable will never be disagreeable in any way to the most fastidious house-keeper. Therefore I would have the stable for a family cow near the house, and not a hundred feet distant. It may be made to include a wood-house, a store-room, a dairy room and a garden tool house. It should be located upon rising ground, or so that water flows every way from it. The water from the roof should flow into a cistern, which will supply all the water needed.

The stable should have an upper loft for hay and a store-room below for feed. A building twenty-four by sixteen feet and sixteen feet high will be roomy and convenient. The cow stalls should be three and a half feet wide and twelve feet long in all. It is well to have two stalls : the extra one may be wanted for some other purpose, if not for a cow. To preserve cleanliness the floor should slope backwards a trifle, to a shallow ditch placed four and a half to five feet from the inside edge of the feed trough, in which ditch the droppings may fall. This will leave room behind for a broad passage from which a door leads into the barn. The manure gutter should drain into a manure tank outside. This is best made with a brick wall and covered with a tight trap-door to keep out flies in the summer. For this purpose, too, some powdered copperas may be liberally sprinkled over the manure and in the gutter. This will absorb all the smell and destroy the larvæ of house and dung flies which would otherwise gather by thousands in the manure. The feed trough should be two feet from the floor to the top, sixteen inches wide and twelve inches deep, which is sufficient to hold a full mess of cut grass or corn fodder. In front of the feed trough is a partition four feet high, and in this a falling door is made across the whole front of the stall, on a line with the top of the feed trough, by hanging one of the boards upon hinges and securing it by a cord, so that it can fall only to an angle of forty-five degrees and so make a slide by which to put the feed into the troughs. The feed passage will be three feet wide and in front of the stall or stalls. It should be provided with a neat, covered feed bin at the end.

The remainder of the building may be used for various purposes, for a carriage house if a horse is kept, or for wood, coal, storage, etc. A stairway may be made in one corner leading to the upper floor, and the pump and cistern may be conveniently placed under it. Where only one cow is kept, a very cheap shed with no upper floor will be sufficient, and forty dollars will be amply sufficient to supply a family cow with every comfort and convenience. The floor should be of cement or brick, or of hard-rammed clay. Wood is the least desirable floor. A cement floor is the best, and if well made it is vermin-proof. It should be made of one part of Rosendale cement and three parts clean sand, mixed dry and then with water into a thin mortar, to which add seven parts of coarse gravel. This should be laid three inches deep and have a top coat of half an inch of the clear mortar for a finish. A washing with a few pails of water occa-

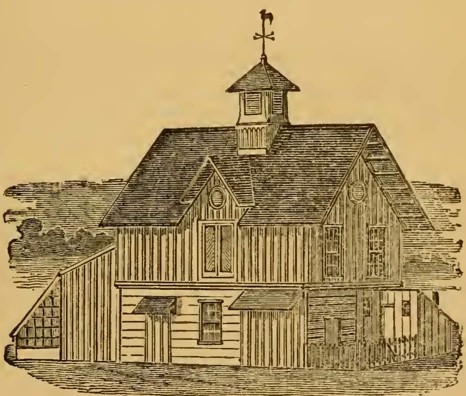

Fig. 14.—STABLE WITH POULTRY-HOUSE.

sionally will clean off such a floor and keep it sweet. The safest manner of fastening for a cow is a broad leather strap around the neck, with a ring in it, and a short rope tied into an auger-hole near the top of the front of the trough, having a snap-hook attached to the free end.

A plan for a stable to accommodate the family cow and one or two horses, with a poultry-house annexed, and suitable for a modest country residence, is given at figures 14 and 15. The central part comprises two horse stalls, five by ten feet, and a loose box for a cow, seven and a half by ten feet, with a passage, in which is a feed bin, room for a fodder cutter and feed box, and stairs to the hay loft. Over the feed box is a hay shute from the loft above. The poultry-house adjoins the passage, from which two doors open into it. This house is eighteen by twelve feet, and has a sloping front of glazed sash. The

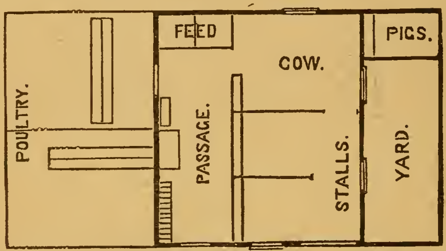

Fig. 15.—PLAN OF STABLE WITH POULTRY-HOUSE.

roosts are shown in the engraving by the three bars in each apartment. The poultry-house is divided into two parts, so that one can be appropriated for young chickens and brooding hens, which is a very convenient method, and avoids the loss of a single chick. At the other end is a yard for manure, with a pig-pen at the rear.

AN OPEN COW SHED.—A cheap and convenient open shed for feeding or milking may be built as follows.

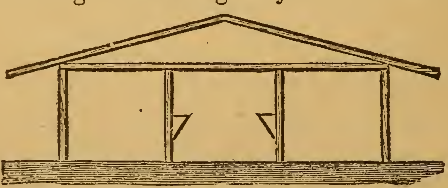

Fig. 16.—OPEN COW SHED.

Posts are set in the ground in four rows ten feet apart; the posts in the outer rows being ten feet apart and seven feet above the ground, and those in the inner rows being five feet apart and ten feet high. These posts are mortised and pinned at the top to plates upon which rafters are laid, and where necessary girders are spiked to the posts. A feed trough is fastened to each inner row of posts, and a hay rack is fixed above each trough; the passage between the rows of posts is used for the purpose of drawing fodder in a cart or wagon. The spaces between the inner posts form roomy stalls for the cattle, if desired, and if cows are kept the posts may be placed seven feet apart, and double stalls holding two cows each may be made. A tight roof is made overhead, and the gables and part of the sides and ends may be closed in; or the whole may be closed in and turned into a roomy

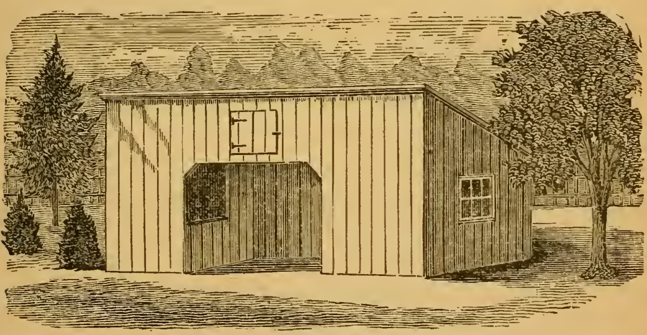

Fig. 17.—CHEAP COW STABLE.

and comfortable stable. The author has a shed of this kind on his farm in western North Carolina. It is found most convenient for the stock, and for storing hay and fodder in the upper part, which is four feet high at the eaves. The roof is made half pitch and consequently gives a large storage space on the upper floor. It is used for milking cows and feeding stock cattle in the winter. The cattle are tied by short ropes around the horns. In a timber country a shed of this kind may be built for about one dollar per running foot.

A VERY CHEAP COW STABLE for a rural cottage is shown at figures 17 and 18. The posts in front are twelve feet in hight, and the rear ones eight. The boards are put on vertically, and battened on the sides. The roof is made of rough boards laid double, and breaking joints, so that it will not leak. The box for

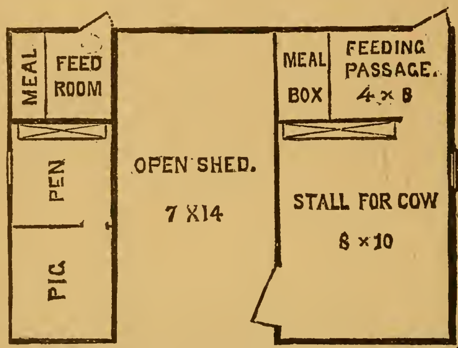

Fig. 18.—PLAN OF CHEAP COW STABLE.

the cow is eight by ten feet and six feet four inches high, and has a feed passage four by eight feet adjoining it. The middle portion of the building is an open shed, seven by fourteen feet, which is used for storing muck, protecting the manure heap from the rains, etc.

CHAPTER X.

WATER SUPPLY.

A COPIOUS supply of pure water is indispensable for a dairy. This is one point to which particular attention should be given in selecting a farm for this use. A clear, cool, running stream through the pasture, and near the barn, is the most convenient source for the supply of the cows; but unless the farm controls the springs from which the stream issues it is apt to be the worst of all. If the water is contaminated in any way, the quality of the milk will inevitably suffer; and many cases occur in which a dairyman, annoyed by a supposed mysterious trouble with the milk, and the butter or cheese made from it, has at last found the cause to be impurity in the water drank by the cows. Moreover, a large quantity of water is required in a dairy for cleansing the pans, and if this water is not pure the very source of the supposed cleansing brings impurity into the dairy. My own supply of water was procured from springs which were opened in the bottom of a slope below the house and barn, by digging three or four feet down to a bed of fine clean sand and gravel, when the water immediately flowed out over the brim and down to a small spring stream in the bottom, which was fed by a large number of bubbling springs in its bed. Such a source as this, conveniently close to the barn, and not so low but it can be brought up to it in pipes, by means of a pump, is the very best; as the water is pure, cool in summer and warm in winter, and in unlimited supply at all seasons of the year. The manner in which this supply of water was made available is as follows: A reservoir or tank was dug out near the foot of the slope, sufficiently deep to hold an abundant stock, and to secure an even temperature, which averaged from forty-eight to fifty degrees in midsummer, and forty-five to forty-eight degrees in midwinter. The pool was lined with a wall of stone laid closely and covered with a small building for protection. Other springs were opened and walled in the same way, and arched over with stone, after providing a safe outlet with drain tiles, and an air trap to prevent access of any small insects or animals. Pipes of galvanized iron were laid for these springs in trenches three feet deep, so as to be safe from frost, and to preserve coolness in the hot weather, and connected with pumps in the house, stable, barn, and barnyard.

Where the hight of the hillside was too great to permit of the use of a common suction pump, a dry well was dug to a sufficient depth, viz., eight feet, and the pipe was carried to the bottom of it and connected with a force pump, so that the water could be carried, by means of a hose, to any part of the yard or stables (see figure 19). A nozzle attached to this hose made it easy to throw a stream of water over any of the buildings; a most useful thing in case of fire, or for washing the

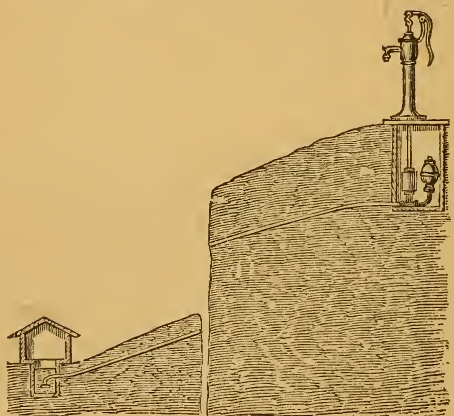

Fig. 19.—DRAWING WATER FROM A SPRING.

stable floor, wetting the manure heaps to prevent fire fanging, and other desirable purposes.

Where springs of this kind are not available, common wells are next in value. But as wells are quickly contaminated by drainage from the surface, when in or near barnyards or stables, it is advisable to have the well for use in a dairy at some safe distance from the stable and yard. It is only a question of time when the percolation of water fouled by the manure in a barnyard, constantly leaching by the rain, will reach the well; and although the water is filtered to some extent by its passage through the soil, yet in time a filter becomes fully charged with the impurities and cannot act any longer.

To be quite safe a well should be situated on the rising side of a bed of impervious clay, or gravel based on clay, so that any soil drainage should be carried *from* the well. To exclude surface water the upper part of the well should be curbed with brick laid in hydraulic cement, and the wall should be carried some inches above the surface and then covered with a flat flagstone with a small hole in it for the pipe of the pump to pass through. The flange of the pump should be cemented to the stone, so that nothing can gain access to the well. A mound of clay beaten firmly and sodded over with grass should be put around the well, to divert the rain water; or a large water-tight platform should be made around the pump.

Where there are neither springs nor wells, cisterns will be found useful. With some precautions cistern water is quite free from objection. The precautions to be observed are to have the cistern on high ground and safe from ingress of surface water, and to have an automatic arrangement for diverting the flow from the roof at the first part of the shower, which washes the filth from the gutters. A surprisingly large quantity of waste matter will gather on a roof in a short time. Atmospheric dust, pollen from trees and plants, droppings of birds, insects, small dead animals, and the wear of the roof covering, all these are washed into the cistern with the first part of the shower and make the water extremely filthy. A cistern becomes in many cases a collection of exceedingly injurious filth, which renders the water wholly unfit for drink, and dangerously infects the milk.

To avoid this, an arrangement is attached to the leading pipe from the roof, having two connecting pipes, one to receive the first flow from the roof, and one to take the clean water after the roof is washed off. These two pipes are pivoted upon a supporting arm which holds them in position to receive the water from the leader. When not in use the waste pipe is set under the leader and is a little over-balanced by the cistern pipe. A small metal box is fitted to the waste pipe and is connected with it by a small orifice, through which water enters slowly when the rain is pouring from the roof. This box becomes filled in a sufficient space of time for the rain to wash off the roof, and the weight of it then over-balances the cistern pipe, which is brought under the leader and conveys the flow into the cistern. This is a very simple arrangement, and has been found to work very well, needing no attention except to empty the water box after the rain is over and let the waste pipe return to its place.

Cisterns require careful construction. The best form is the oval or egg-shaped, as this best resists the pressure of the outer earth when it is empty. This form is shown at figure 20. The manner of construction is as follows. The surface soil is removed to a depth of eighteen inches to exclude frost in winter and heat in summer. The excavation is made as shown in the engraving, which is the shape of an egg with the upper third cut off. It should be eight to twelve feet deep, and seven to ten feet in diameter. The deeper the cistern the better and cheaper it is. If the soil is close and compact the cement may be laid directly upon it, and no brick lining is required. To do this, a large flat stone (*s*) is bedded in cement at the bottom for the workman to stand upon, and as a rest for the pump (*p*). The cement is made of water lime one part, and clean sharp sand three parts; mixed dry first, and wetted up in small quantities as required, and can be used before it sets hard. The cement is laid about an inch thick (*w*). When the bottom is covered, a layer is put around the wall about a foot high, and as it sets very quickly, as soon as one strip is laid another may be put on above it, until the whole is completed. In digging, a shoulder a foot in width is made on the top of the sub-soil eighteen inches deep, to rest the beams upon. This is also covered with cement, and the beams are laid on, and the spaces between them on the shoulder are filled in with stone, or brick, and cement, to the upper level, upon which the floor rests. A strong floor of four-inch plank, doubled, with the joints broken, is

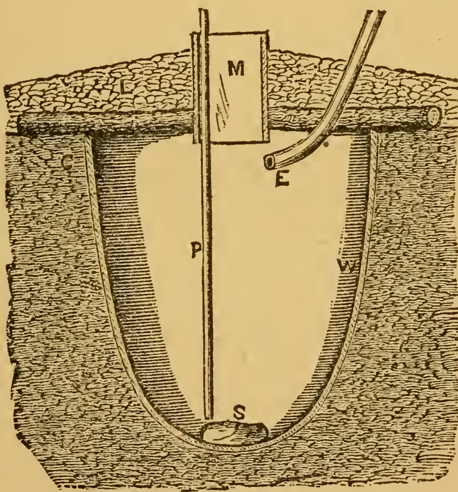

Fig. 20.—RAIN-WATER CISTERN.

laid upon the beams and covered with a coat of the cement to exclude surface water; and this floor is then covered with earth and sodded over, or a platform is built over it to stand upon. A manhole (*m*) should be made in the cover large enough for a person to go down when it is necessary to clean out the cistern, and this is brought up a little above the platform and fitted with a tight cover, kept locked, to avoid danger of children falling in. The pipe (*e*) conveys the water from the roof; but it is best to have it enter under the shoulder, where it is out of the way.

A force pump should always be chosen for the cistern, so that in case of need a hose may be attached and the water carried where it may be wanted, to a distant trough, or to any part of the yard or stables.

When the soil is sandy, or loose gravel, the cistern should be lined with hard bricks laid lengthwise so as to make a wall four inches thick. The floor should be of cement, and no bricks except a few in the center will be required. The bricks should be thoroughly wetted before they are used. The cement should be spread all over the surface of the brick so as to completely fill the spaces, and the outside of the wall should be plastered as it goes up. Earth should be packed firmly against the wall outside to give a backing which will resist the pressure of the water. This is an important point, and should not be forgotten. When the desired hight is reached the bricks are inclined gradually to form the shoulder for the arch, and the wall is then drawn in towards the middle; leaving a manhole in the center. This is covered with a large flagstone. The inside of the cistern is covered with a wash coat of clear cement.

The cost will depend upon its size and the material selected. The expense of excavation may be estimated at twenty-five cents for a cubic yard, or one cent per cubic foot. To ascertain the length of wall around a cistern multiply the diameter by three and one-fifth. Thus one eight feet in diameter will be over twenty-five feet around. Fourteen bricks will lay one square foot of wall, eight inches, or one brick thick; twenty-five will lay a square foot, twelve inches, or a brick and one-half thick. Thus for every foot in hight, an eight-foot cistern will require 350 bricks, if the wall is one brick lengthwise thick, or 180 if it is a half brick thick. For a small cistern the bricks may be laid in this manner, but those over six or eight feet in diameter should have an eight-inch wall to resist the outside pressure, especially if the soil is of gravel or sand. To lay 1,000 bricks two barrels of cement will be required, if used clear; but there may be one, or two, or even three barrels of sand used to one of cement, without danger of weakening the wall. Where expense is no object as compared with durability, we would use clear cement. Rosendale (American) cement is good enough for all purposes.

To ascertain the contents of a cistern the diameter is multiplied by itself, or squared, and this product is multiplied by .7854. It will be near enough to take three-quarters of the product in feet and multiply this by the depth in feet. This gives the number of cubic feet of water in the cistern. A cubic foot of water is equal to seven and a half gallons. Thus in figuring for a cistern the desired size may soon be ascertained. By doubling the diameter, the contents are increased fourfold. Thus a round cistern four feet in diameter will hold a little over three barrels for every foot in depth; if eight feet in diameter, it will hold twelve and one-half barrels for every foot; but if twelve feet in diameter, it will hold nine times as much; for if the diameter is enlarged three times, the contents are increased three times three, or nine times, and if enlarged four times, or to sixteen feet, the cistern will hold four times four, or sixteen times as much water for every foot in depth. Thus a great advantage is gained by making the cistern as wide as possible. The following table will be found useful for reference:

Contents of a round cistern for every foot in depth of

4	feet in	diameter	= 93	gallons	=	$3^1/_{10}$	bbls.
6	"	"	= 212	"	=	7	"
8	"	"	= 375	"	=	12½	"
10	"	"	= 588	"	=	19½	"
12	"	"	= 848	"	=	28	"
16	"	"	= 1500	"	=	50	"

A cistern lined with cement only, and finished completely, eight feet in diameter and ten feet deep, of the form shown in the engraving on page 123, will cost about forty dollars, and will hold 100 barrels.

In arranging for the water supply for the stock a sufficiency of water troughs should be provided, and as many as will give ample opportunities for all the cows to drink without molestation from the master cows of the herd. Four troughs are not too many for twelve or fifteen cows, and these should be scattered widely apart, or be so protected that one ill-natured animal may not keep guard over them all. An excellent arrangement is to have an octagonal frame with a trough on each side, or one trough all around it, so that every cow may have a chance to get to the water.

The water from the troughs should be carried off, to avoid ice around them in the winter, and some provision should be made to empty the troughs to prevent the accumulation of ice at that season. Where it is practicable, a constant flow of water in the troughs in the summer is desirable, and for this purpose, where there is a running stream, a water ram may be used, or a windmill with a reservoir of sufficient capacity to supply all the requirements both of the cattle and the dairy work.

The newly-introduced rustless iron pipe is a great convenience. Lead pipe is exceedingly objectionable on account of the danger of poisoning by solution of the lead by the carbonic acid almost always contained in water. Iron pipe rusts rapidly from the same cause, and is soon useless. The rustless pipe is the plain iron pipe subjected to a process by which the inner and outer surfaces are changed to magnetic oxide, which is not acted upon by water, or any acids or alkalies; not even boiling nitric acid affects it. This renders the pipe practically unchangeable and indestructible. A pipe which brings water several hundred feet from a spring, and which has been in use and partly exposed to the air near the surface of the soil for more than a year, is now as bright as when laid, and does not affect the taste of the water in the least.

CHAPTER XI.

FOODS FOR USE IN THE DAIRY.

THE subject of foods for use in the dairy is one of the highest importance to the dairyman. If the cow is a machine for manufacturing raw materials—the food—into finished products—milk, butter, and cheese—then it follows that while the character of the machine and its ability to do its work properly are of first importance, the character of the materials worked up is of but very little less importance; for no machine, however good it may be, can do good work with poor materials. "Out of nothing, nothing comes;" and if the food is deficient in the elements required to make the desired products—the nitrogenous elements to make up the caseine, the fat to make the butter, the carbo-hydrates to make the sugar, and the mineral matter to furnish the salts—the cow, no matter how excellent an animal she may be, cannot supply the deficiencies.

The dairyman should therefore be an expert on the subject of foods. He should know of what elements the animal itself consists, what are required to support the animal in a full condition of health and vigor, and of what elements milk of the best quality is composed. This furnishes the key to the most important problem, "How should a cow be fed to procure from her the largest quantity of the best product at the least cost?" Upon the proper solution of this problem the profits of the dairyman depend.

An animal requires a certain quantity of three elementary kinds of nutriment to support it in vigorous life, without loss of substance or gain in weight. This is called the normal maintenance ration, and consists of a class of substances: one known as nitrogenous or albuminoids; another known as carbonaceous or carbohydrates, including oils or fats (which are really carbohydrates); and, lastly, one consisting of mineral matters or salts, including phosphate of lime, chloride of sodium or salt, potash, magnesia, a little iron, and a very small quantity of other mineral matter. To supply the natural requirements of the animal for the restoration of worn-out tissue and for the support of the animal heat and of respiration, there are needed, for every 1,000 pounds of live weight of an animal, about three-quarters of a pound of nitrogenous substances, eight pounds of the carbonaceous substances, one-sixth of a pound of fat, and an insignificant quantity, more or less, of the various salts. These are contained in about twenty pounds of good hay. A certain quantity of these are digested and assimilated, and enter into the structure of the animal; the indigestible portion and the surplus unavoidably given, from the nature of the foods at our command, are ejected from the animal and form manure. This latter portion of the food and its disposal being of great importance will be more fully treated of further on, and after the subject of alimentation for support and production of milk has been disposed of.

After the natural wants of the animals are supplied, the dairyman's business is to furnish his cows with as much material as they can healthfully turn into milk and cream. Then the question occurs, Of what do these substances consist? This is simply answered by saying that milk has almost precisely the same composition as an animal has, and that milk contains every element required to support an animal. But the dairyman wants to put an excess of fat in the milk, of which he can make butter and rich cheese. Hence the feeding of a cow for dairy product requires an increased quantity of the very same elements that are needed for the support of an animal, with as much more fat as the cow can be possibly made to turn to profitable use healthfully.

The foods used in the dairy are classed, as regards their elements, as albuminoids, carbo-hydrates, fat and ash. Fiber or cellular tissue is also included, because this is in part digestible, and no doubt that part which is digested may go to help support the animal or form useful products. The following list includes all the foods used in the dairy, and to each one is appended the percentage of digestible matters of the above-mentioned classes contained in it. Hay and green fodder have already been enumerated in a previous chapter.

COMPOSITION OF SOME FOODS USED IN THE DAIRY. PER CENT OF DIGESTIBLE MATTER.

	Albuminoids	*Carbo-Hydrates.*	*Fat.*	*Money Value*
Oats ground	9.0	43.4	4.7	0.98
Corn ground	8.4	60.6	4.8	1.11
Pea meal	20.2	54.4	1.7	1.44
Cow peas	19.4	49.6	1.1	1.33
Sweet potatoes	0.9	28.0	0.3	0.30
Yams	2.1	25.9	0.2	0.33
Cotton seed (whole)	17.1	14.7	27.3	2.08
Acorns (fresh)	2.0	30.9	1.5	0.43
Chestnuts (fresh)	3.4	35.7	1.3	0.52
Pumpkins	0.4	7.1	0.1	0.08
Wheat bran	10.0	48.5	3.1	1.01
Wheat middlings	8.9	54.8	2.6	1.00
Rye bran	10.6	50.0	2.0	1.00
Pea meal bran	9.2	45.8	1.2	0.86
Hominy chop	10.13	50.20	7.6	1.17
Wheat starch waste	3.7	15.1	1.8	0.37
Corn starch or glucose meal	3.2	19.3	1 8	0.39
Brewers' grains (fresh)	4.8	11.3	1.2	0.36
Malt sprouts	20.8	43.7	0.9	1.33
Rice meal	8.6	47.2	8.8	1.16
Palm-nut cake	12.8	56.2	14.0	1.66
Palm-nut, extracted	17.6	60.4	3.1	1.44
Linseed oil meal, extracted	27.8	33.9	2.1	1.61
Cotton seed meal, without hulls	33.2	17.6	16.2	2.30
Corn cobs	0.6	41.7	0.4	0.41
Milk	3.2	5.0	4.5	0.34

The column of money values represents the food value of these substances as compared with ordinary meadow hay at sixty-four cents per 100 pounds, or $12.80 per ton, and with the very best hay at $1.00 per 100 pounds or $20.00 per ton.

It should be explained that these values are taken from the basis of the chemical composition of the substances; and, as a means of comparison, the analysis and comparative value of corn cobs are given, which on this basis would seem to show them to be worth forty-one cents per 100 pounds. Now no dairyman in his right mind and with any experience would purchase corn cobs for $8.20 per ton. Consequently, it is hardly necessary to say that the above figures are given for what they are worth only, as showing the actual composition of the substances mentioned, and to be used in the light of common sense, reason and experience, and as comparative only.

The experienced feeder of cattle will not need any suggestions in regard to the use of these foods; he will be able to select those which contain the elements he wants, and which are to be procured for the least money. For the benefit and use of other feeders and young dairymen the following remarks upon these foods may be made.

For the maintenance of an animal there is required, for each 1,000 pounds of live weight, a daily ration of twenty pounds of the best hay, which contains seventeen and a half pounds of dry substance, which should consist of 0.7 of a pound of albuminoids, eight pounds of carbohydrates, and 0.15 of a pound of fat, or 8.85 (eight and three-quarters pounds in round numbers) of digestible nutritive substance. This consists of nearly twelve parts of carbonaceous matters for the support of respiration and of the vital heat, to one part of nitrogenous matter for the repair of the muscular tissue worn out. For a cow in ordinary milk there is required twenty-four pounds of dry substance free from all moisture, or about thirty pounds of the best hay, containing two and a half pounds of albuminoids, sixty-two and a half pounds of carbo-hydrates, and 0.40 of a pound of fat; equaling 15.40 pounds of nutritive substance, giving the proportion of nearly five and a half pounds of carbonaceous matter to one pound of nitrogenous. This is precisely the ratio required for a young growing animal, and accords with the fact that milk is a perfect food in every respect for the maintenance of life and for vigorous growth. By reference to the last line in the above table it is seen that when the fat is multiplied by two and a half, to equalize it in estimated value with the carbo-hydrates, there are sixteen parts of these substances to 3.2 of nitrogenous; thus making the ratio of five of the former to one of the latter.

The twenty-four pounds of dry nutritive matter are contained in thirty pounds of the best young clover hay; and this quantity of hay, or an equivalent of grass, is taken as the standard food for a cow in full milk. Of this thirty pounds there are twenty-three digestible, consisting of 3.21 pounds of albuminoids, 11.28 pounds of carbo-hydrates, and 0.63 of a pound of fat. This subject is merely used in this chapter as preliminary to the following remarks and a fuller reference to it in the succeeding chapter. We now proceed to consider seriatim the list of foods mentioned in the table, in reference to their use and adaptability for the dairy, and especially in regard to their value for the production of milk and their healthfulness. In this consideration the author will give the results of his practical experience during many years' work in the dairy, helped by a large number of carefully-made experiments and a study of the literature of the subject.

Oats Ground are a costly food for the production of milk, because of the large proportion of husk they contain, but when they can be purchased cheaply, as compared with other foods, they are especially valuable for the manurial elements in them. A reference to the table given in the next chapter will show that 1,000 pounds of oats contain considerable potash and phosphoric acid, and hence may at times be used on this account. But as there are other foods which are much more valuable in this respect, oats have been discarded from the food list in use in the author's dairy. When they were used as a test in equal quantities with corn meal, the butter was of very light color and inferior quality.

CORN is the standard food grain of the United States, and fortunately is most excellent for feeding. It is most healthful in its effect when fed in a proper proportion with other foods; and, unless given in unusual and injudicious excess, never injuriously affects the milk glands. The greater part of the fat is in the husk and germ, and is retained in the waste product of the hominy mills which separate the starchy kernel from these parts of the grain. Consequently, the refuse of this manufacture, known as "hominy chop," would be worth more for feeding to cows than the corn itself, if the husk were all digestible. But in a long course of feeding corn meal we have found the fine bolted yellow meal to give better results than any other form in which corn has been used. This will be more fully explained hereafter.

PEAS have been found an exceedingly effective food for producing milk. In the feeding test of a noted Jersey cow, in which an average of seven pounds of butter daily was given for a week, sixteen pounds of pea meal were fed per day, with sixteen pounds of oat meal and twenty-four pounds of corn meal. Excellent pasture was also provided. This feed would supply an enormous excess of nutritive elements above those required for maintenance, giving four and a half times as much albuminoids, three times as much carbo-hydrates, and eight times as much fat as would be required for a cow in ordinary milk. No doubt, if a cow can digest sufficient food of the right kind, oil for instance, a kind of butter might be produced which would far exceed the enormous product above claimed for the Jersey cow. In such a case a cow would act as a filter, and merely separate the fats from the food and pass it through the udder. There could be no chemical change in the albuminoids or the carbo-hydrates into fat, as is effected in the ordinary feeding of dairy cows, for the system of the cow is unable to do so much work. The effect of the pea meal in this case was probably due to its effect in enabling the cow to digest the large quantity of corn and grass which was consumed. This effect of some foods is of great importance, and will be treated of at length in the next chapter. Pea meal seems to exert a greater effect in this direction than any other food.

Cow Peas, being a Southern product, as well as the three foods which follow in the list, and as Southern cows consume a large quantity of mast in the forest ranges, the value of all these substances are worthy of study and experiment in Southern dairies. Sweet potatoes and yams furnish most valuable foods for winter feeding in the South, where dairying offers exceedingly favorable opportunities to experienced and enterprising farmers.

Wheat Bran and the husks of grain generally are of great value for feeding, chiefly for their nitrogenous elements and the manurial value of their mineral constituents. Of these waste products, brewers' grains and starch or glucose meal are worth special note, because of the severe denunciations made against them by some persons. No doubt in some cases the objections were well founded, and there has been fault on the part of the dairymen who have used them in an improper manner. These moist and highly nitrogenous substances soon ferment and putrefy, and when putrefactive decomposition begins, the odor exhaled is exceedingly strong and offensive, chiefly on account of the sulphur compounds formed. If these foods are used in this condition in a dairy, this odor would almost certainly affect the milk, and would be found concentrated in condensed milk and in butter. But if used in a fresh and sweet condition, there is no reason whatever for objection to them. They are then wholesome, nutritious, clean, easily digested, and are usually cheap, and the milk produced from them is of the very best quality. It is not the use of these foods but the abuse of them which is objectionable. Hence, no dairyman need hesitate to use any of these foods if care is taken to keep them sweet. They may be preserved in a silo perfectly well during the winter, and for a short time in casks or tight boxes, if well rammed down.

Malt Sprouts are the roots and sprouts of barley germinated in the process of malting. The nitrogen is in the form of albumen and gluten, and the carbohydrates consist chiefly of sugar. They are seen to be exceedingly rich in albuminoids, and hence are a very valuable food for the production of milk. We have fed tons of them to cows kept for milk alone, but do not favor them for use in a butter dairy. The milk made from them has a rich sweet taste, and the sugar in it is in excess of the average. Hence it is apt to sour quickly, unless very carefully cooled and kept. The market price of them is much less than the actual feeding value. We have bought them for $8 per ton, while the estimated feeding value is $26.50. The practice while feeding them in the author's dairy was to steep them in water for twelve hours and pour the thick slop thus made upon the cut hay, and then mix the ration of meal with the feed. The sweetness of the sprouts makes this feed exceedingly palatable, and cows thus fed consumed considerably more, with a corresponding yield of milk of the best quality, than with the same food without this addition. As the sprouts are light and very dry—a bushel weighing only eight pounds—and are quite sweet, and consequently are greedily eaten, they should never be fed alone and dry, as they absorb a very large quantity of water and swell proportionately; hence may be injurious to cows eating them in this condition.

RICE MEAL appears by its analysis to be a very rich food, but either for milk or butter we never found it to be worth its exceedingly high cost, viz., thirty dollars per ton. We doubt very much the quantity of fat alleged by the analyses to be contained in this food. The high price of this waste of the rice mills is said to be due to the demand for it as an adulterant of cheap flour, and other similar purposes. It would be a useful food for horses if procured at twenty dollars per ton, but is not a desirable dairy food.

PALM NUT MEAL, in our experiments, proved to be the most productive food for butter. It costs thirty dollars per ton, which is not profitable to the dairyman, and it is difficult to procure. In an analysis of a lot purchased by the author, the oil was found to amount to eighteen per cent, and was of a very high yellow color. If, as there is reason to believe, oils in the food are assimilated and pass into the milk without change in the digestive process, the fine bland flavor and rich color of palm oil ought to make this meal an excellent food. The cows disliked it, and some wholly refused it. One cow in our herd which took it readily and ate six pounds per day, increased in the butter yield from nine pounds weekly to twelve and a half. It is an unusual article on the markets and not easy to procure, otherwise we should prefer it to cotton-seed meal at the same price.

Linseed Oil Meal is now made by what is known as the new process, that of extracting the oil by means of benzine or naphtha, by which the oil is practically all removed from the seed. The old process of pressure between heated plates left eleven to fourteen per cent of oil in the residue. As linseed oil has a laxative and most excellent effect upon the digestive organs, the old process meal was a useful food for fattening cattle, but was not a desirable food for dairy cows on account of the result on the butter, which was white, soft, greasy, and of a flat oily flavor. The new process meal is free from some of the objectionable features of the old process meal, and to some extent is useful in dairies, but after frequent attempts to use it with satisfaction we abandoned it in favor of cotton seed meal. At thirty dollars per ton—its present value—it is much dearer than several other foods in the above list which are preferable in other ways as well as for their cheapness.

Cotton Seed Meal, when used in moderation, is a very useful food for dairy cows. It is the reverse of laxative, and tends rather to costiveness. This, however, gives it an especial value when cows are upon grass, or when it is mixed with bran. When it was first introduced in the Northern States as a food for cows—and the author was the first to test it in his dairy, twelve years or more ago—it was sold at eighteen dollars per ton, and was an exceedingly cheap food. Since then it has become widely popular, and has advanced in value fifty per cent. Still, for the nutriment it contains, it is cheap, being valued for its nutritive elements at forty-six dollars per ton, as compared with the best clover hay at twenty dollars per ton. It is very rich in nitrogenous substances, and is consequently an unsafe food for cows if fed to excess. The cotton plant possesses some very powerful medicinal qualities. The root produces abortion, and the seed certainly has some of the same active effect upon the uterus.

The meal has a decidedly inflammatory effect on the milk glands, and therefore is to be used only in very moderate quantities. The author has fed it to cows from four pounds daily down to one pound, and while feeding two pounds a day, with twice as much bran and corn meal, the butter product of a cow experimented upon ran up to two pounds per day; when four pounds daily was fed, with the same quantity of corn meal and bran, the yield of butter was only 1.83 pounds per day for a few days, when an attack of garget was brought on, and for fourteen days afterwards the yield was less than a pound. (See chapter on Feeding.) As this result happened frequently with other cows in the dairy, while hired men could scarcely be restrained from using too much of it, and a fine litter of Berkshire pigs were sacrificed to this temptation to feed the meal to excess, its use was discarded. With one pound only, used with twice the quantity of corn meal and bran for a single ration, cotton seed meal may be used safely; but as any excess over that is apt to be injurious, it is advisable to mix the feed in bulk, so that the ration cannot be exceeded by any accident. This meal gives a high color, great solidity, a fine, waxy texture, and a rich nutty flavor to the butter. The latter fact seems to corroborate the belief that the oils of the food really go into the milk unchanged, through the digestive organs, in which they are emulsified.

As the digestibility of a food is really the measure of its value, and the analyses above given have no reference to this point, it is a most important part of the dairyman's business to make careful tests in his dairy of the effects of food in regard to the quantity and quality of the product. Animals differ very much in respect of their digestive ability. Some cows will make a very fair profit from the same food upon which other cows will make a serious loss; and these results, vital to the interests of the owner, can only be ascertained by most careful and repeated tests. While all the facts given in this work are vouched for by the author, when related as his own personal experience, and may, therefore, be taken as a guide by the reader, yet this guidance can only be general and not specific in its nature, and it may not answer in every case. A noted and most successful breeder of fine dairy cows was apt to say to an intending purchaser: "This cow has done, is doing, and will do, with me, thus and so; but I cannot guaranty that she will do the same with you or any other man. If she is managed as I have been in the habit of doing, she will probably do as she has done; but I cannot promise anything after she leaves my hands." The author feels much the same way in regard to the results obtained in his dairy. He has had twenty-five years' experience in feeding cows and in practical dairy work; obtained a scientific education, in which animal physiology and medicine bore the greater share; and has followed dairying in preference to any other pursuit, because it was a work of pleasure and a favorite object for study and experiment. The results which were reached have been carefully noted, after repeated observations and tests; and while, therefore, every confidence may be given to what is written in this work, yet every dairyman should make tests for himself as an important part of his business, lest difference in circumstances might mislead. This is for his own interests and conducive to his own profit.

Every cow eats, and there is not much difference in the consumptive ability of good and poor cows. To feed a cow costs at least twenty-five cents daily, and the labor costs ten cents more. If a cow then makes one pound of butter per day, and the butter is sold for thirty-five cents, the manure left and the calf are the only sources of profit. If a cow makes ten pounds of butter a week there is a gain of seventeen cents per day, a very satisfactory profit. But if the cow makes but half a pound there is a loss of this sum, which is ruinous. It is therefore indispensable that the dairyman should test his cows very carefully, and know the actual product of each. The tests made are—first, for milk and cream; second, for butter; third, for quality of the butter; and, fourth, for feeding. It is clear that all these must be included in any test to determine the value of the animal. Even if no more than ten cows are kept, such tests should be made. A test is wholly useless unless it is based on certainties and made with precise accuracy. Such tests are as fully scientific as if made by a professor in an experiment station, for science is no more than exact truth of which the reasons and results are ascertained, and which can, therefore, be made the basis for establishing principles upon. Any intelligent farmer can do this for himself in his dairy. Indeed no one else can do it for him, for milk varies in character, and cream even is equally various; while the cows and the results of feeding differ so much that no certain rule can be laid down from the results reached in any one case to determine another. First, then, the milk of each cow is to be weighed. This is very little trouble. A spring balance hung in the stable is used to weigh the pail with each cow's milk in it separately. That the person who does the weighing, if the master is not there, shall make no mistake, the gross weight is taken and marked down by each milker, on a paper pad hung in the stable with a pencil attached to it. If the owner is there—and he should be to look after his business, which otherwise will not look after him—he should do the weighing and marking down, and then he may take down the net weight of the milk, deducting the known weight of the pail. In our dairy every milk pail used was of precisely the same weight, and made so purposely by the addition of solder on the bottom inside. A twelve-quart pail of good tin, with a cover over half of it, and a ring of zinc plate around the bottom to prevent wearing, will weigh three pounds, or can be made to do so by the addition of some solder. Then it is quite a simple matter to get the exact weight of the milk of each cow every day. And it is best to do this constantly as a rule, for it will be very useful in discovering anything that may have gone wrong with a cow, and gives an immediate opportunity of rectifying it. The weights of the milk are set down in this way, a separate pad being hung behind each cow and having its name written upon it. In our experience the yields of milk given by the cows, when regularly fed and systematically managed, differ so little from day to day, even in unusual changes of weather, that each pad easily distinguishes the particular cow to which it belongs. The weights are taken to half pounds, which is near enough for all purposes.

At stated times, say on a special day in the week, a portion of the cow's milk is dipped up from the pail into a cream gauge and left to stand for the cream to rise. The cream gauges are ranged in a frame made like a narrow box having no sides and a handle upon the top to carry it by. The gauges are set in this box so that they can be carried easily to the milk-house when they are filled, and each cow's name is written over the place in the frame where the gauge is set. The proportion of cream is then seen under precisely the same circumstances, and, of course, is an accurate test of the relative cream value of each cow's milk.

The butter test is made in a small churn, that used in our dairy being the smallest sized Blanchard churn, easily making as little as a pound of butter at one time. The particular cow's milk is kept separate and set by itself, and the cream is skimmed precisely the same as from the other milk, and is kept the same as the other cream, except that more milk is mixed with it to help in the churning. The churning is done under the same conditions as the general churning, and this test determines not only the quality of the milk and the butter, but the time occupied in the churning, which is quite important. The butter made is accurately weighed, and compared with the quality of the milk, and that of the cream known from the test in the per cent glass. The buttermilk is also tested by the ether test, which is by using a long test-tube marked with equal spaces—tenths of an inch—and putting into it a certain quantity of buttermilk, then a small quantity of ether, and shaking the tube for a few minutes, after which it is set to rest, and any butter in it appears on the top dissolved in the ether. The tube is set in a warm place and the ether evaporates quite quickly, leaving a film of butter on the buttermilk. This test is not of much practical importance, because a small quantity of butter will remain in the buttermilk in spite of the best churning; but it serves to show that some milk leaves more butter in the buttermilk than others. But when all the different milks are mixed, the butter which escapes from one milk may be caught and gathered by the other milk, and while the butter globules of one cow's milk are so small that some will be lost when her cream is churned alone, they are picked up by the larger globules of other milks. This fact is proved by the use of a microscope, which shows clearly how the milk of various cows differs in this respect. The quality of the butter is learned by taste and by the melting point, which indicates its hardness and firmness. This is an important test, because at times the cream of some cows varies in character, and especially as the cow approaches a new calving the flavor becomes quite distinct and will affect the butter of other cows.

The feeding test is the most interesting and soon gives the dairyman a very clear idea of the value of his cows. The food is changed in quantity—decreased or increased—and the result is noted by the previously described tests. In our dairy we have found an increase of food at times to reduce the yield of milk and a decrease to have the opposite result. One specially determined fact, however, was clearly proved by some hundreds of tests, and this was that the food had a most important result upon the product of butter. This was denied by the Director of the New York State Experiment Station at the time, but his later tests fully corroborated the accuracy of our statement, which has been fully accepted by practical dairymen. Hence, foods rich in fatty matter are the best for the product of butter, and the choice of those foods which are proved by careful tests made in this manner, in each particular dairy, is one of the most important parts of the business of dairying.

Condimental Foods are those substances which are used to supply certain requirements of the system, but are supposed to be only supplementary to the ordinary foods. The term food includes any substance used for the nutrition of animals, and we must also include water, for seventy-five per cent of the body of an animal consists of this fluid, and salt as well, for this substance enters largely into the composition of an animal. The following table gives the quantity of salt (sodium chloride) contained in the various parts and secretions of an animal:

SALT CONTAINED IN AN ANIMAL.

In 150 pounds of live weight 4 pounds 163 grains.

In the blood	3.29 parts in 1,000
In the female blood	3.90 parts in 1,000
In the ash of blood	54.76 parts in 100
In the liquor sanguinis	6.98 parts in 1,000
In the pulmonary mucous	5.82 parts in 1,000
In the sebaceous matter of the skin (oily secretion)	37.00 parts in 1,000
In the perspiration	2.23 parts in 1,000
In the secretion of the eye (tears)	13.00 parts in 1,000
In the saliva of the mouth	.84 parts in 1,000
In the saliva of parotid glands	3.06 parts in 1,000
In the gastric fluid	1.70 parts in 1,000
In the pancreatic fluid	7.36 parts in 1,000
In the bile (of the ox)	15.00 parts in 1,000
In the lymph	5.00 parts in 1,000
In the bones of an ox	3.45 parts in 100
In the bones of a man	1.20 parts in 100

The quantity of the above-named fluids secreted every twenty-four hours is very large; in a man of 140 pounds' weight the amount is as follows :

	Pounds.		Pounds.
Saliva	2.88	Pancreatic fluid	1.87
Gastric fluid	14.00	Lymph	3.86
Bile	2.42		
Total			25.03

The quantity secreted by a cow is even larger in proportion to its greater weight.

These figures indicate and even prove that salt is a most indispensable article of food. The quantity secreted by a horse or an ox, in which animals these fluids are produced more copiously than in any others, has not been determined, for obvious reasons, but it must be several times larger than the human secretions. All this goes to show the absolute and indispensable necessity for an adequate supply of salt as food—not as a condiment or a relish to the food, but as necessary aliment, without which animals cannot perform their functions of digestion and nutrition, and make a healthful and satisfactory growth.

But it is also proper to make some computation of the discharge of this substance from the system in the waste matter excreted. The animal system is in constant course of destruction and renewal. A man of one hundred and forty pounds' weight discharges in all the excreted matter seven and one-quarter pounds every twenty-four hours, that is, the whole body requires complete renewal every twenty days, and an absorption of seven and one-quarter pounds daily of various matters. An ox or a horse performing the same vital functions requires a proportionate supply to make up its proportionate waste. So that as a large quantity of salt is thrown off in this waste every day, an equal amount must be supplied to restore the loss. It has been calculated that an ox or a cow requires two ounces of salt daily to replenish the system; a horse needs one and one-half ounces, and a sheep one dram. This is in addition to that which is naturally contained in the food.

How seldom does any farmer provide his animals with this indispensable article of food? How much disorder of the digestive functions may be and is due to this neglect? Nearly all the ailments of farm animals are produced by disturbances of the digestive organs. Is it not just and reasonable to assume that the absence of this indispensable salt is the cause of much of this disease and the loss of thousands of animals for want of a necessary part of their nutriment.

But salt given in excess is an acrid poison, producing corrosion of the gastric membranes and quick death. It is therefore to be given with the food in regular and safe proportion; or if given alone should be given daily in the needed quantity, as above mentioned.

The salt barrel should be kept adjacent to the feeding box, and to avoid accidents by any animal trespassing and taking too much, the barrel should have a safe, close-fitting cover, or a well made bin should be used. The regular ration, given with each feed, should be measured out accurately. One ounce for each cow at each feed, or half a pint for fifteen cows, is the proper allowance. This will be equal to one pound or sixteen ounces for the fifteen cows.

There are times when the appetite of the cows will fail from repletion, sameness of food, or other causes, which are removed by a change of feeding. The addition to the food of some agreeable flavoring will at once have a good effect. We once procured a barrel of molasses for use in the dairy, and once a week gave at first a quart of it to our herd of fifteen cows, mixed with the dry meal, a little water being added to make the mixture even. The zest thus given to the food was conspicuous by this small quantity, and it was given in larger quantities, a gallon to the fifteen cows, or about twelve ounces to a cow, in two feeds once a week. While the effect on the milk was not apparently worth noting, the result upon the cows was quite marked; and had the molasses been given in the first small quantity every day it is probable that it would have been repaid with profit.

A useful condimental food for use when the appetite appears weak may be made as follows: linseed meal, pure, fifty pounds, brown sugar ten pounds, corn meal one hundred pounds, ground gentian one pound, ground turmeric one pound, ground ginger one-half a pound, caraway, anise and coriander seed one-quarter of a pound each, finely ground, sulphur two pounds, salt two pounds, cream of tartar one-half a pound, all well mixed. Two pounds of this is given in place of as much corn meal once or twice in a week. This subject should not be dismissed without some remark upon improper foods, or more correctly, injurious substances taken with the foods. Much injury is sometimes done by these unwelcome additions to the food.

In some investigations for the purpose of testing the effects of various foods upon animals, and the peculiarities of the functions of nutrition, it was found that the red color of madder roots, which were cut and mingled with the food, appeared after a time in the bones, which became of a pink color. Fowls, pigs, and rabbits were experimented upon with similar results. In the pigs, after a continued feeding, the fat became tinged with pink, while no effect was found upon the flesh, probably from the difficulty of noting any change of tint, by reason of the sameness of the color.

Such an experiment is not needed to add proof to the fact that food has a very great effect upon the character of the flesh of any animal, and necessarily upon the milk. The flesh and fat of pigs fed upon beech mast is well known to be soft and oily, while peas-fed pork is firm and hard, and even more so than that made by feeding corn. The flesh of sheep fed upon the short sweet herbage of mountain pastures, and which consists in part of resinous plants, as heather and various other species of the heath family, is remarkable for its peculiar and agreeable flavor. The hunter easily recognizes the flavor of hemlock in the flesh of the northern hares, which feed upon it in the winter; while the spruce or swamp partridge indicates by the flavor of its flesh the various foods which it has subsisted upon for some time before it has been killed. It is the same with trout, the flesh of which is of a bright red when it has been taken in cold, clear, gravelly, or rocky streams, and of a muddy white when it has lived in water flowing from swamps. The law is general ; and it is to the differences of food in a great measure that the differences in the flavors of meats of various kinds are due. If we feed domestic fowls upon the food of the prairie hen, and let them roost out of doors in the pure air, the flesh will be vastly superior in flavor to that of a fowl cooped up in a confined and filthy yard, or fattened in a poulterer's cellar upon cheap and damaged grain. And if these differences are so noticeable in other animals, they cannot fail to exist in regard to cows.

Indeed, every one knows how quickly strong-flavored weeds will scent and flavor butter, and it has happened in our own dairy that the milk of cows, in whose stable a heap of half-decayed frozen turnips were kept but one day and night, smelled so strongly as to be detected in the milk room immediately upon entering it, and the pans could be distinguished by the scent with the greatest ease. And yet none of the turnips had been fed ; it was merely the air of the stable impregnated with the odor which conveyed the scent to the milk through the animals' lungs and blood.

If all this is true—and we think none will question it, for it is unquestionable—then with what justice can a dairyman insist that to devour the dung from a horse stable will not harm a dairy cow, or to keep cows in stables reeking with filth will not infect the milk? A well-known dairyman once observed of milk from such a stable, that "it was hardly strong enough for good manure, but it might do for that purpose better than for food."

CHAPTER XII.

FEEDING RATIONS.

When the dairyman feeds his cows he is beginning his work of manufacturing. He is supplying his machines with the raw material. We have seen what these materials are, and the purpose for which they are to be used; let us now study the character of the machines used, and the manner in which they may best be supplied.

Food is given to the cow to be digested. Digestion consists of the mastication or grinding of the food in the mouth; the maceration of it in the paunch or large stomach—the first and second compartments of the quadruple organ possessed by all ruminants; the return of it in small portions—the cud—into the mouth for a second grinding; the further maceration and pulping of it in the third stomach or maniples between the rubbing plates or leaves with which this part of the organ is furnished, and its partial solution in the true digestive stomach where it is subjected to the action of the gastric fluid. The food then passes into the intestines. It is in the form of a semi-fluid grayish mass, containing still some undissolved food.

The undissolved portions of the food are chiefly the nitrogenous matters or albuminoids; the starch has been dissolved and changed to sugar, and the oily part of the food has been worked up by the mastication and trituration in the stomachs into an emulsion with the other constituents of the food. In the bowels, the food is subjected to the action of the bile which is poured out from the liver, and the fluid of the pancreas, the office of which is not yet clearly established. The changes which are effected in the intestines are the complete conversion of any remaining starch into sugar; the albuminoid substances are brought into the condition of soluble albumen, and the fats are still further divided and made into a more perfect emulsion.

Digestion is then completed. The food is brought into contact with the absorbent vessels of the mucous membrane of the intestines, and the process of assimilation begins. The dissolved food and the emulsified fat are then absorbed by the very small capillary blood vessels of the mucous membrane of the stomach and intestines, and pass on with the venous blood into the liver and lungs, where it is purified by the combustion of the excess of carbon by which the animal heat is sustained, and the purified fluid is poured into the heart and mixed with the arterial blood; thence carried to every extremity of the system it repairs the waste and adds new matter to the growing animal.

The fat, in the form of an emulsion or exceedingly intimate mixture, in particles so fine as to be invisible, is absorbed directly into the circulation and is carried on with the blood to be deposited where the exigencies of the system require it. It is deposited in the tissues, or in masses in various parts of the body, and in females, at and after the birth of their young, is carried in large part to the udder, where it is first deposited in the glandular cells of the udder, and is then mingled with the copious secretion known as milk.

Thus the milk of the cow is a direct product of the food, and it is probable that the fatty part of it is carried without change directly from the absorbent vessels of the intestines to the milk glands, where it is separated from the blood and poured into the milk ducts. This, however, will be fully discussed hereafter. Such is the machinery and function of the cow in the disposal of the food.

It should be obvious to the intelligent reader that the provision of suitable food for the cow is most important, both to guard against waste and to furnish a sufficient supply for the full and profitable employment of the digestive organs. For whatever there is in the food that cannot be assimilated is discharged from the bowels, and whatever is assimilated that is not required and cannot be healthfully disposed of by the animal, becomes a source of mischief and causes disease.

Food is given to animals for three distinct purposes: first, for the growth of a young animal; second, for the fattening of a mature animal; third, for the production of milk and butter. The last of these is more particularly to our purpose. The practice of feeding for the dairy is a truly scientific process. The foods given must be chosen particularly for the end in view.

The results of experience, properly arranged and reduced to rules for practice, are as truly scientific as if they were evolved from the most abstruse theories. In the practice of feeding we are guided by two principles, viz., that certain products are composed of certain elements, and that if these elements are supplied to an animal we may secure the desired products.

No dairy can be profitably worked on grass alone. The object of feeding any animals, especially cows, is to use cheap feed and make more valuable meat, milk, butter or cheese out of it. In this lies the skill and the profit of the dairyman's work. It is indispensable, then, that he should fully understand the nature of the feeding substances he works with. The principles of feeding are these: an animal digests its food and a process of assimilation follows; assimilation is the conversion of the digested food into blood, and then into flesh, milk, fat or butter. None of these products can come into existence unless the elements of them are given in the food. No food can be changed into these products unless it is digestible. Therefore, to produce milk and butter most profitably, the dairyman must choose such food as is the most easily digested—that contains the most of the elements that are required—and he must give them in such quantity that the cow can digest them most perfectly and up to the largest quantity possible.

A large variety of food substances are at the service of the dairyman, all differing in market value as well as feeding value, some being cheap and some dear. A comparison of these foods will show how some may be procured for less money than others, and perhaps produce cheaper milk and butter.

But in choosing foods the experimental tests and chemical investigations of the German agricultural schools will be of much value. While animals differ individually, yet on the whole there is a universal law of Nature which controls natural operations, and the general causes being the same, and bound by these universal laws, the results are very similar. So that what happens in one herd or in many, as the result of feeding certain foods to cows, is most likely to happen to all, when the circumstances of the feeding are similar. Hence the method of feeding is of much importance.

In considering this question we will assume, as the majority of dairymen are apt to believe, that practical experience is worth much more than chemical analysis and scientific theory, and the following results of some careful tests made by the writer with a Jersey cow which had been fed and kept as a test cow for three years, may be relied upon as giving an accurate value to the feeds mentioned; the more so, as they have been confirmed by actual feeding in a dairy of fifteen cows for a still longer time. It is easy to trace in these figures the difference between the feeds given, which is really the test of the values. The cow was twenty-two months old when record began, and had calved two months previously. She was a pure-bred Jersey, of a noted butter family. The feed through all the winters included five pounds of clover hay cut and wetted and mixed with the feed morning and noon, and five pounds of loose hay at noon. Every part of the management was the same every day, excepting that when there was grass, pasture was used instead of the hay, and the meal was given dry with a little fine grass:

PRODUCT OF BUTTER, FIRST CALVING.

Feed.	1880.	*Lbs. butter.*	*Av. per day.*
2 lbs. bran; 3 lbs. corn meal	February	33 3/4	1.25 lbs.
	March	35 1/2	1.45
6 lbs. bran and midlings	April	28 1/2	.95
	May	26	.84
2 lbs. bran; 3 lbs. palm nut meal	June	38 3/4	1.39
	July	36 1/2	1.18
2 lbs. bran; 2 lbs. corn meal; 2 lbs. cotton-seed meal	August	38 1/2	1.22
	September	44	1.45
	October	39 3/4	1.28
SECOND CALVING.			
	1881.		
2 lbs. bran; 2 lbs. malt sprouts; 2 lbs. cotton-seed meal	April, 15 days	23 1/4	1.53
	May	52	1.70
	June	49 1/4	1.60
4 lbs. corn meal; 2 lbs. cotton-seed meal	July, 12 days	22	1.83
	5 days sick with garget.		
	July, 14 days	11 1/2	.80
2 lbs. bran and 3 lbs. oats and corn meal	August	45	1.45
	September	37	1.20
2 lbs. bran and 3 lbs. fine bolted yellow corn meal	October	51 1/2	1.66
	November	46	1.54
	December	47 1/2	1.55
	1882.		
2 lbs. bran; 2 lbs. fine meal; 1 lb. cotton-seed meal	January	49 1/4	1.59
	February	48	1.81
	March	34	1.01
	April, 2 days	3 1/4	1.62

PRODUCT OF BUTTER—*Continued.*

THIRD CALVING

Same feed	May, 16 days	32	2.00
	June	51	.66
	July	53½	1.72
	August	61	2.00
2 lbs. bran and 3 lbs. yellow meal	September	48¾	1.60
	October	40¼	1.30
	November	42	1.40
	December	40	1.30
1883.			
5 lbs. buckwheat bran	January	24	.79
	February	22	.76
2 lbs. bran and 3 lbs. fine yellow corn meal	March	23	.76
	April	38¼	1.23
	May	41	1.33
	June	34	1.01

The same feeding was continued until December 6th, when the cow was dried off, giving in the twenty months from her last coming-in, 675½ pounds of butter.

A few points in the above should be specially noticed. Every time cotton-seed meal was used the butter increased in quantity, but what was gained in this way was nearly all lost by the attack of garget, brought on by this feed. This result has been so frequent with other cows that the use of cotton-seed meal has been abandoned, excepting in quantities of not over one pound at one feed, and never without bran in the mixture. The great falling off when buckwheat bran was used is also worth noting. The mixture of two pounds bran and three pounds of fine yellow corn meal, bolted, in every case turned out the best and cheapest feed, and made the finest quality of butter. It has since then been a standard feed, and there is no desire to change it. The bran used is the fine bran made at the country mill, and has some coarse middlings with it, and weighs eighty pounds to the two-bushel sack.

The forcing of cows to a large yield by excessive feeding is a very unprofitable business. Garget is almost sure to come on, and this not only loses milk and butter, but it wastes time and gives a great deal of trouble and care. The standard feed mentioned above, viz., two pounds of wheat bran and three pounds of fine yellow meal, twice a day, with fifteen pounds of hay, is quite sufficient for an ordinary cow, and as much as any such cow can digest healthfully and profitably. There are "phenomenal" cows, as there are other animals, whose digestive power and appetite seem to be unlimited. Any good cow ought to pay well for such feeding, and it is not giving any cow a chance to show what she can do if she is not furnished with at least this supply of food regularly.

We will now test the above practical experience by a comparison with the standard of feeding given by scientific investigations. It has been stated that a cow in full milk should be supplied with a certain quantity of digestible food elements, viz., $2^1/_2$ pounds of nitrogenous matter or albuminoids, $12^1/_2$ pounds of carbonaceous matter or carbo-hydrates, and four-tenths (0.40) of a pound of fat. These quantities are theoretical, but have been proved by thousands of tests to be practically justified. Now the ration fixed upon in our dairy contains the following nutritive elements:

	Albuminoids.	*Carbo-Hydrates.*	*Fat.*
15 lbs. of clover hay	1.60	5.64	0.31
4 lbs. of bran	.40	1.94	0.12
6 lbs. of corn meal	.50	3.60	0.28
	2.50	11.18	0.71
Theoretical ration	2.50	12.50	0.40
Difference		−1.32	+0.31

There is seen to be a deficiency of 1.32 pounds of carbo-hydrates and a surplus of 0.31 of a pound of fat. This excess of fat will very nearly make up the deficiency of carbo-hydrates. But the actual value of the foods above given, on account of the extra quality—the very best of each being used—would raise the total feeding value to 3.12 pounds of albuminoids, 13.98

pounds of carbo-hydrates, and 0.89 of a pound of fat; making an ample supply of materials for the quantity of butter produced. In calculating these rations it is only necessary to multiply the figures given in the table of analyses by the weight of food given, and divide decimally by 100, by placing 00 before the sum. Thus the nutritive elements in fifteen pounds of the best clover hay is calculated as follows: $10.7 \times 15 = 160 \div 100 = 1.60$; showing the quantity of albuminoids contained in this quantity of hay. In this manner the reader may easily make up a table of rations of whatever feed he may find convenient to use, or calculate the feeding value of what he may be using.

Concentrated foods are useful, but at the same time require extreme caution in their use. It is a physical necessity of animals that some indigestible fiber shall be consumed with the nutritious part of the food, and that concentrated aliment, wholly soluble and digestible, cannot support life healthfully. Animal life is, to a large extent, analogous with vegetable life, and as we cannot feed a plant with carbon, nitrogen, phosphorus, potash, and other of its elementary constituents, in solutions in water, but must supply our crops with the raw materials from which the plants can select and procure for themselves what they require, and analyze and reconstruct these elements in their own way, so animals require to be fed, not upon the ultimate elements of which they are formed, but upon certain substances containing these in various combinations from which the alimentary organs can select what are wanted and with these build up the new tissue with which the wear and tear of the system are repaired.

We feed, for instance, some substances containing albumen, gluten, sugar, starch and oil, and these, being digested and absorbed by the alimentary organs, are changed into the fibrin and albumen of the flesh and the fat of the tissues, a large portion of the last three and perhaps some of the first two being changed into carbonic acid by the combustion of the carbon, or, to speak more strictly, by the union of their carbon with oxygen inhaled by the lungs, and affording by this consumption of carbon the heat necessary for the performance of the vital functions of the animals. It is believed that the oil is directly absorbed into the blood and changed into the fat which is deposited in the tissues, or is gathered in masses in various parts of the body, or is secreted in the milk and forms butter. But by some mysterious process this fat is wholly changed in appearance, flavor and character in its passage through the animal, and although the various oils and fats of the food affect to some small extent the taste and color of these animal fats, yet on the whole there is little or no chemical difference between them, and they all partake very much of the same general character. It is true that an expert can detect, for instance, the flavor of the oil of cotton-seed or of linseed meal in the butter made from them when used as food for the cows, and also the difference in the fat of pigs made by feeding peas, corn, acorns, chestnuts, and beech nuts; also the flavor and color of the fat of oxen are affected by the various fatty foods used; but so far as we know the differences are only apparent to the taste and cannot be detected by chemical analysis.

Nevertheless the alchemy of the palate being more sensitive than that of the chemist's laboratory, it behooves the feeder of meat and the maker of butter—and cheese, too, beyond a doubt—to make use of concentrated foods with care and judgment, because of their effect upon the character of the products as well as upon the health of his animals. This latter, however, affects the dairyman more than the feeder of meat, for as fattening is a morbid process it is only necessary to stop at a certain stage at the obesity of an animal to save it from death by disease, and substituting the butcher's knife for it; but the dairyman cannot sacrifice his cows, except perhaps an occasional victim to serve as a medium for a test of ability to consume food and change it to butter in excessive quantities. He must therefore watch, not only the results, both ways, of feeding such rich substances as oil meals, and as a safeguard he must know the character of what he is feeding. These remarks refer chiefly to cottonseed meal, which, from several writers' experience, we have found to be well worth the closest scrutiny and most careful use in respect to its effect upon the animal's system. Its effect upon the butter is excellent, giving good texture, fine color, sweet, nutty flavor, much like its own, and great firmness, so much so as to render it difficult to work up in the winter at less than seventy degrees of temperature and to give it a desirable hardness in the summer. Two pounds per day, however, we believe is the extreme quantity that is safe to give a cow whose proclivity for converting rich food into butter makes her subject to attacks of garget by over-pressure in this direction. As regards the effect of cotton-seed meal upon the circulatory system of an animal it is only necessary to refer to its composition. A recent analysis of the oil meal of the crop of 1886—a very favorable year for quality—gives its composition as follows:

Water	6.90	
Oil	15.13	
Albuminous compounds	42.40	(nitrogen, 6.77)
Gum, sugar, and digestible fiber	26.96	(carbo-hydrates)
Indigestible fiber	2.53	
Ash	6.08	
Total	100.00	

As the ash consists mostly of potash and phosphoric acid, which are useful alimentary substances, it appears that there is only two and one-half per cent of this food that is indigestible. Hence it is almost as highly concentrated a food as sugar or butter, and therefore equally injurious and disturbing to the system as these, when fed in excess. But as forty-two and one-half per cent of this meal consists of nitrogenous substances, and six and three-fourths per cent of nitrogen, an excess of it is even more disastrous to the animal than an excess of carbonaceous food, because of its serious effect upon the blood and also upon the kidneys, through which the excess of nitrogen must escape. Hence the use of this food especially, and all other concentrated foods generally, requires care and caution to avoid any excess beyond the quantity that the animal can dispose of safely.

The healthful proportion of the protein (albuminoids) to the carbo-hydrates of the food, for the maintenance of an animal in good health and thrift, is one of the former to five and one-half of the latter, or, as the figures are put, 1:5.5. Of these foods mentioned wheat bran is seen to be the nearest to this ratio. Fat is always taken as two and one-half times as much as the other carbo-hydrates, hence the richer a food is in fat the more the relative value of the carbo-hydrates is, and the ratio is made out accordingly. As wheat bran contains three and one-half per cent of oil or fat, the carbo-hydrates are increased by 8.75 instead of 3.50, and the ratio is thus 12.9 to nearly 68, or 1:5.3 nearly. This is a close approximation to the normal ratio, hence wheat bran should be, and is, practically, the best basis for a food for cows and other animals kept for milk or flesh. Then we have to consider what is wanted after the animal itself is supplied with every healthful requisite for its maintenance. Clearly, if one desires butter, he should feed some substances rich in fat; if milk, those which are rich in protein, to supply the nitrogenous matter of the caseine, and others rich in carbon, to supply the sugar and the fat. Malt sprouts and cotton-seed meal are typical foods of these kinds, and in our dairy practice have been found most excellent when given in such moderation as their richness in nitrogen demands of the feeder.

A few words in explanation of this moderation may be useful. Nitrogenous matter in the food, if given in excess, must be expelled from the system, or if retained in the blood will quickly render this vital fluid poisonous and cause serious disorder. The waste nitrogen of the food in the vital functions is discharged chiefly through the kidneys, and these organs are exceedingly delicate and easily disturbed. Hence, food rich in nitrogen is to be given with caution, lest the system may be unbalanced and disease produced. Cows suffer very quickly from inflammatory diseases, as garget, milk fever, and lung fever, when an excess of food of either a nitrogenous or carbonaceous character is given; but there is far more danger from an excess of the former than of the latter. Young animals which are growing and making flesh may easily dispose of food rich in nitrogen, while old cows kept for butter-making or animals kept for fattening will turn to good account an excess of food that is rich in sugar, starch, and fat. It is to be taken as a rule in feeding that no food should be given when in a state of fermentation. The use of such food is not only unwholesome, but dangerous. The warmth of the stomach very quickly accelerates the process of fermentation, and produces a rapid change to acid. A small quantity of lactic acid—which is formed in brewers' grains, green clover and other rich fodder, by moderate fermentation—is not injurious, but assists digestion, hence fresh brewers' grains are a most excellent food for the production of milk of the best quality; but if the grains are used in an advanced state of acidity, acetic acid is formed, which is an acrid poisonous substance and necessarily injurious when in excess. It should go without saying to any intelligent man that this food is utterly unfit for cows producing milk when it is decomposing and offensively putrid, although it is so used sometimes in districts where milk for market is the chief product. As brewers' grains are seen to be too rich in protein they are best used with twice their dry weight of cornmeal. When fed in this manner, as is common in some of the largest and best of the milk dairies of Westchester and other adjacent counties in New York, the milk is unsurpassed in quality.

Mixing the food is a matter of economy in two ways; viz., to secure complete consumption and the desired results of it, and so both get all its possible products and avoid waste. In our practice, every kind of fodder is cut up finely in the winter feeding, and in the summer, when soiling is practiced, the coarser kind of the green fodder is cut up in the same way. The cut fodder is wetted sufficiently to make the finely ground meal adhere to it, and the usual ration of salt (one ounce per head) is added and the whole evenly mixed and given to the cows.

During all our experience in the dairy the observance of the Sabbath day as a rest for man and beast has been strictly kept up, and as some dairymen think that the work cannot be suspended, even in part, on this rest day, the method practiced for several years is here described. In the summer, field work is left at 4 P. M. on Saturday, and preparations are made for the next day's feeding. The fodder is cut and brought in from the field to the barn for all day Sunday and for Monday morning, and a supply is also cut and put under hay caps for a reserve in case of bad weather on Monday. The feed for Sunday morning is wetted and mixed and left in the feed box, and that for the noon and evening is cut and put in a heap on the floor near the box. Everything that can be done is made ready for the next day, and by seven in the evening the milking is all finished and everything prepared for immediate use the next morning. An extra supply of pails and pans are kept for use on Sunday, and no pan washing is needed. The pails and pans used are well rinsed and filled with cold water and left in the outer room of the dairy until Monday. An hour's extra work on that day makes all things even. The cows are kept in the yard and not turned out, and an extra large mess of fodder is given at noon as a compensation. The cows seem to enjoy the change, and lie around in the shade and act in every way with the general quietness and stillness one so often observes on a Sunday in the country. The milking is an hour later on Sunday morning, and this slight irregularity is the only thing which has any appreciable effect, for, as a rule, the milk falls off to a small extent on Monday morning.

Cutting the fodder has the effect of reducing the muscular work of the cow. Every movement of the cow's muscles, every motion of the lungs as the animal breathes, consumes some of the muscular tissue and requires some food to repair the waste. Every digestive function is also carried on at some cost of substance for the repair of which food is required. The proper preparation of the food, then, is a saving of labor for the cow, and a saving of food for the owner. The grain food thus should be ground as finely as possible, and being mixed with the cut and moistened fodder is eaten with less exertion, and is digested with the greatest ease. It is also more thoroughly digested because of its fine condition, subjecting it more completely to the action of the solvent fluids of the mouth (the saliva), stomach and intestines. As the fat and oil of the food exist in exceedingly fine particles distributed in the cellular tissue, the thorough grinding and the perfect mastication of it tend to its most economical disposition in the body of the animal.

A valuable experience in feeding is given by Professor

Muncy of the Iowa Agricultural College in the following paragraph:

"The question often asked me is, 'How do you mix your feed?' Suppose it is desired to feed corn, oats, and bran. According to the best authority we have, the nutritive ratio should be 1 to 5.4. By nutritive ratio is meant that the digestive albuminoids should be mixed with the starch, sugar, and fat of the food in the proportion of 1 of the former to 5.4 of the latter. Suppose now I take the average analyses of corn, oats and bran, and determine how much digestible ingredients are contained in two bushels oats, one bushel corn, and fifty pounds bran. It is as follows :

	Digestible.		
	Protein. *Pounds.*	*Carbo-Hydrates.* *Pounds.*	*Fat.* *Pounds.*
64 pounds oats	6.22	31.04	2.49
56 pounds corn	5.10	37.56	2.32
50 pounds bran	6.01	22.01	1.52

Nutritive ratio of above is 1 to 6.1, which shows that I should add more flesh-forming food. To be brief: If you mix sixty-four pounds oats, twenty pounds corn, and fifty pounds bran you will have a nutritive ratio of 1 to 5.6, which is approximately the one recommended ; 112 pounds corn, 100 of shorts, and fifty of bran gives a nutritive ratio of 1 to 5.4, and with corn at twenty-five cents, shorts at twelve dollars, bran nine dollars, and oats twenty-two cents, is cheaper ration for me than corn, oats, and bran ; the difference is about five cents per 100 pounds; 100 pounds of oats, twenty-five of wheat, and fifty of bran will do as well for cows as any given at a cost to me of seven cents per hundred more. Bran itself is not the best feed for cows. It should be mixed with some feed richer in starch, sugar and fat, if you desire to feed economically and for profit. Feeding bran increases the per cent of cream. By feeding ten pounds of bran per day two cows at the Texas Agricultural College increased three and four and a half per cent, respectively, in a twenty days' trial. At first they received bran and ran on good pasture. Next they were made to depend on grass exclusively. The Iowa dairyman should remember that the manure from a well-fed cow is worth probably twice as much as the manure from a grass-fed cow."

It has already been stated that the results of feeding vary with circumstances. The character and quality of the herbage vary; and necessarily, as grass is the basis of a cow's feed, any variation in this will affect the results of the grain feeding and make some modification necessary. Iowa is a leading dairy State, and this experience of Professor Muncy, a most capable and enthusiastic dairy expert, will be valuable for Western dairymen.

To observe the effect of feeding, some tests will be found useful. A dairyman should be very inquisitive and observant, for his profit depends upon it. He should count, measure and weigh everything; and the quantity of food given, its cost and its results, should all be carefully noted. The manner of testing cows described in the previous chapter has been constantly practiced in the author's dairy, and has been found of the greatest use.

In practice in the dairy there are times when it is impossible to feed hay and other rich foods, on account of scarcity in adverse seasons. Farmers have a large quantity of rough material to dispose of. Corn fodder, straw, coarse hay, and even marsh hay at times, are the sole dependence for feeding. In such cases these inferior fodders may be made up by the addition of the richer foods which can be purchased and used at such a profit as will be satisfactory to the dairyman. And in feeding these coarser fodders, the use of roots with them will be found exceedingly valuable. The succulent roots, being almost wholly digestible, aid very much in the digestion of the coarser fodder, and for winter feeding a supply of mangels or sugar beets will be indispensable for the most profit. In a similar way the use of malt sprouts steeped in water—which makes a sweet semi-liquid pulp of an agreeable odor and taste—mixed with cut straw and corn fodder, has been found to keep up the yield of milk, and, with a slight increase in the mixed meal or ground grain food, to prevent any deficiency in the yield of butter. Well-cured corn fodder, or the stalks of the corn crop, cut before frost, or as soon as the grain has been glazed, and stacked so as to preserve the greenness and sweetness of the leaves, has yielded, with the addition of a peck of sliced roots, as much and as good butter as that made from the best clover hay.

The effect of certain foods rich in nitrogenous elements, which has been referred to, renders such foods injurious at times to cows soon to calve. The author's practice has been to wholly suspend feeding grain food of any kind to cows as soon as the milking ceases, and to feed only roots with hay or corn fodder or straw, or a mixture of all, as the case may be, in the winter, and only grass or green fodder in the summer. Grain food, too, should not be given until the milk has acquired its normal character, the fourth day after calving, and is then given only in small rations at first and increased gradually during a week or ten days, until the full milk yield is reached. Feeding for manure as well as milk yield is a subject of much interest in the dairy. Large crops enable the dairyman to keep a large herd, and large crops are grown only upon rich land. A large herd makes a large quantity of manure, and it will pay a dairyman to expend money, borrowed even for the purpose, in the purchase of cows and their food, that he may produce manure to improve his land, repaying the cost of the food through the milk and butter made.

Having practically experienced this fact, during a few years upon a very poor farm, the former owners of which had starved and had been sold out by the sheriff, we here relate the methods by which a bed of mere shifting sand was brought into a condition of fertility, the soil changed to a dark loam and made capable of producing 100 bushels of corn and 1,200 bushels of mangels per acre, with a slight surplus of profit the first year, and a very satisfactory balance after, which kept increasing up to the end of the eighth year, when the farm was disposed of at twice its cost. The farm consisted of seventy acres, of which nearly one-half was unreclaimed swamp meadow, too wet and springy to be safely pastured by cows, but which afforded a large quantity of coarse hay and a small amount of better grass along the borders of the low ground. There was a piece of open beech wood which afforded a little pasture, and an old mossy upland meadow which gave about 300 pounds of hay to the acre from a few grass spots. The rest of the land had been cultivated in rye and corn, until the crops had quite run out and the whole product could be drawn off in a one-horse wagon. Consistently with this condition of things there was a stable and barn in one, about sixteen by eighteen feet, which was empty and not one ounce of manure about the premises. The one poor horse and cow were running in the swamp or on the roadsides to pick up a starvation living. Possibly there never was a much more unpromising case, nor one which offered a better opportunity for making an experimental farm, and testing the question whether a poor farm could be restored to fertility by a judicious course of improvement out of its own product and without an extravagant outlay of money.

The first thing done was to purchase fifteen cows in October, and sufficient hay and grain to winter them. The cows were Ayrshires and Jerseys, and some cross-bred ones of these kinds. A commodious stable was built, with a capacious manure cellar under it. A description of the stable has been given in a previous chapter. The swamp was drained and a large quantity of the best of muck was dug out and drawn into the manure cellar and the barnyard, and also stored as litter for the cows and absorbents to take up the liquids in the manure gutter. Everything went into the cellar, and by spring 300 loads of the very best manure was put on fifteen acres of the land. About as many acres of fall rye were sown and manured with 300 pounds per acre of the artificial complete manure. At first milk was sold on a neighboring route at eight cents per quart, which paid a good profit; but the difficulty of finding a man who could withstand the temptation of handling another person's money caused this business to be abandoned, and butter-making was substituted. There was another reason. Milk contains many valuable elements of plant food. Ten cans of forty quarts (1,000 pounds) of milk carried off from the land three and a half pounds of phosphate of lime, one-half pound of phosphate of magnesia, and some other combined phosphoric acid and other mineral matter equivalent in all to about six and a half pounds, and an equal quantity of nitrogen. Every month, then, there is lost to the land from fifteen fair average cows about seventy-five pounds each of nitrogen and as much essential mineral plant food, and in a year about 900 pounds of each. To replace this would cost about $250. In making and selling butter, nothing but carbon and water are carried off, and these cost very little to replace, and the loss of carbon is so small that it can be safely ignored, although it may be taken from the soil. This saving of all the valuable elements of the milk is sufficient to throw the balance in favor of butter-making when the improvement of the land is a considerable object.

In the spring the manured land was planted with sweet corn for fodder, and the rye was cut green and fed to the cows. The rye stubble was partly sown with clover and orchard grass and clover mixed, and partly plowed and planted with mangels, peas, oats and corn. The drained swamp was grubbed, thoroughly harrowed up, and sown with various grasses, viz., timothy, fowl meadow grass, red top and meadow fescue, all of which are adapted to moist peaty land. The next year this meadow afforded a large quantity of the best hay and constantly improved each year afterward.

These methods of management were continued with a gradual improvement of the land, which in time changed from a loose sand, which filled the eyes and ears when a strong wind blew across the bare stubble in winter, to a dark-brown loam which produced profitable market crops, as early potatoes, sweet corn, peas, cabbages, melons, etc., all of which sold well and left more or less fodder for the cows. No corn (grain) was grown after the second year, as other crops were found more profitable. A constant succession of crops occupied the land. As soon as a strip of rye was cut off in the spring the ground was manured, plowed, and planted with corn, and this corn was at once followed by a second planting or with millet. The clover was fed after the rye, and with the orchard grass and the grass from the meadow gave abundance of green food until the sweet corn fodder was ready, after which there was a large surplus to be cured for winter feeding. The clover was cut a second time, and made a heavy crop of hay with a top dressing of the fine manure made from the swamp muck used in the stables, yards, and pens.

After seven years of this method of work the farm became highly profitable and not only repaid the whole cost of the improvements and stock, but left a considerable profit. The butter made brought an average of sixty-five cents a pound from private families, and the market crops helped considerably in increasing the income as well as in providing excellent fodder for the cows in the refuse.

There are many cases in which farms which have been badly managed near towns and cities may be purchased cheaply, stocked with cows, and worked in this way with great advantage; for the needed foods can be easily procured. Manure may be purchased cheaply and the products sold at the best market prices. The purchase of manure, however, is not best when food can be bought and made into butter at a profit, and the manure left.

The following remarks by Sir J. B. Lawes, the first authority in the world upon this subject, may be read most profitably:

"The only constituents of food which are of importance as ingredients of manure are the nitrogenous substances and the ash constituents. If the live weight of an animal remains unchanged, and there is no production of milk, the quantity of nitrogen and ash constituents voided in the manure will be the same as that contained in the food consumed; the albuminoids and ash constituents of the food used for the renovation of tissue being in this case equivalent to the quantity yielded by the degradation of tissue. In cases where the body weight is increasing, or milk being formed, the amount of nitrogen and ash constituents in the manure will be less than that in the food, in direct proportion to the quantity of these converted into animal produce.

"A part of the albuminoids and ash constituents are left undigested during the passage of the food through the alimentary canal; these are voided in the solid excrement. The digested nitrogenous matter and ash constituents pass into the blood; a part of them may be converted into animal increase if the animal is gaining in weight or producing milk, and the remainder is finally separated from the blood by the kidneys, and is voided in the form of urine. The albuminoids are oxidized into urea before being expelled from the system. In the case of herbivorous animals hippuric acid is also formed in variable quantities, and is found as an ingredient of the urine.

"The proportion of the nitrogen in the food which will appear in the solid excrement is determined by the digestion co-efficient of the albuminoids. Thus, seventy-nine has been given as the digestion co-efficient of the albuminoids of barley-meal when consumed by a pig; it follows that in this case for 100 of albuminoids consumed twenty-one will be voided in the solid excrement and seventy-nine pass into the blood. It has been stated that 500 pounds of barley-meal, containing about fifty-three pounds of albuminoids, will in the case of the pig produce 100 pounds of animal increase, containing 7.8 pounds of albuminoids. Its follows from these data that for 100 pounds of albuminoids consumed 14.7 are stored up as carcase, twenty-one appear in the solid excrement, and 64.3 as urea, etc., in the urine. In the same way, by deducting the ash constituents stored up from those present in the food, we arrive at the quantity of ash constituents voided in the manure. Calculating in this manner the relation of food to manure in the case of the fattening ox, milking cow, sheep and pig, we arrive at the following conclusions:

NITROGEN STORED UP AND VOIDED FOR 100 CONSUMED.

	Stored up as Increase.	*Voided as Solid Excrement.**	*Voided as Liquid Excrement.*	*In Total Excrement.*
Oxen	3.9	22.6	73.5	96.1
Sheep	4.3	16.7	79.0	95 7
Pigs	14.7	21.0	64.3	85.3

* The quantities of nitrogen given in this column are a little below the truth, as besides the undigested albuminoids some nitrogenous biliary matter is present in the solid excrement. With oxen and sheep the amount of biliary matter in the excrement is very small, with pigs it is more considerable. In the case of the pig the nitrogen in the solid excrement should probably stand as 25, and that in the liquid as 59.3.

ASH CONSTITUENTS STORED UP AND VOIDED FOR 100 CONSUMED.

	Stored up as Increase.	*Voided in Total Excrements.*
Oxen	2.3	97.7
Sheep	3.8	96.2
Pigs	4.5	95.5

"The proportion of the nitrogen and ash constituents of the food which is retained by a fattening animal is in all cases very small; in each instance mentioned above, save one, more than ninety-five per cent of both nitrogen and ash constituents find their way into the manure. The pig is seen to retain the largest proportion of the nitrogen of the food ; this is clearly owing to the greater proportion of increase which the pig produces from a given weight of food.

"The amount of nitrogen voided in the urine is seen to be three or four times the quantity contained in the solid excrement. This relation will vary greatly according to the character of the diet. If the food is nitrogenous and easily digested, the nitrogen in the urine will greatly preponderate; if, on the other hand, the food is one imperfectly digested, the nitrogen in the solid excrement may form the larger quantity. When ordinary hay is the diet, the nitrogen in the solid excrement will generally somewhat exceed that contained in the urine ; with a straw diet the excess in the solid excrement will be still greater. On the other hand, corn and oil cake, and especially roots, yield a large excess of nitrogen in the urine.

"The ash constituents are very differently distributed in the solid excrement and urine; in the former, lime, magnesia, and phosphoric acid preponderate, while the latter contains nearly all the potash. With sheep fed on hay about ninety-five per cent of the lime contained in the food, seventy per cent of the magnesia, and eighty-three per cent of the phosphoric acid were found in the solid excrement, but only three per cent of the potash.

"A fair idea of the general composition both of the solid excrement and of the urine is given by the following table:

PERCENTAGE COMPOSITION OF SOLID AND LIQUID EXCREMENT—SHEEP FED ON HAY.

	Solid Excrement.		*Urine.*	
	Fresh.	*Dry.*	*Fresh.*	*Dry.*
Water	66.2	----	85.7	----
Organic matter	30.3	89.6	8.7	61.0
Ash	3.5	10.4	5.6	39.0
Nitrogen	0.7	2.0	1.4	9.6

OXEN WITH NITROGENOUS DIET.

	Solid Excrement.		*Urine.*	
	Fresh.	*Dry.*	*Fresh.*	*Dry.*
Water	86.3	----	94.1	----
Organic matter	12.3	89.7	3.7	63.0
Ash	1.4	10.3	2.2	37.0
Nitrogen	0.3	1.9	1.2	20.6

"The extreme richness of the urine, both in ash constituents and nitrogen, is very evident. In the case of highly-fed oxen (and cows) the dry matter of the urine is seen to contain over twenty per cent of nitrogen. Urine readily undergoes fermentation, the urea being transformed into carbonate of ammonium. As this is a volatile substance, a loss of a part of the nitrogen voided may easily occur, especially if an insufficient amount of litter is employed.

"The relative value of the manure produced by different foods is determined by the relative richness of the foods in nitrogen and ash constituents, but chiefly by the amount of nitrogen, this being the most costly ingredient of purchased manure. The average amount of nitrogen and of the two most important ash constituents contained in the ordinary foods is shown in the following table:

MANURIAL CONSTITUENTS IN 1,000 PARTS OF ORDINARY FOODS.

	Dry Matter.	*Nitrogen.*	*Potash.*	*Phosphoric Acid.*
Cotton cake (decorticated)	900	66.0	15.7?	31.2
Rape cake	900	48.0	13.2	24.6
Linseed cake	880	45.0	14.7	19.6
Cotton cake (undecorticated)	885	39.0	20.1	22.9
Linseed	905	36.0	12.3	15.4
Palm-kernel meal (English)	930	25.0	5.5	12.2
Beans	855	41.0	12.0	11.6
Peas	857	36.0	9.8	8.8
Malt dust	905	38.0	19.5	17.2
Bran	865	22.0	14.8	32.3
Oats	870	20.6	4.5	6.2
Wheat	856	18.8	5.4	8.0
Barley	860	17.0	4.9	7.3
Maize	886	16.6	3.6	6.1
Clover hay	840	19.7	19.5	5.6
Meadow hay	857	15.5	16.8	3.8
Bean straw	840	10.0	25.9	4.1
Wheat straw	857	4.8	5.8	2.6
Barley straw	850	5 0	9.7	2.0
Oat straw	830	5.0	10.4	2.5
Potatoes	250	3.4	5.6	1.8
Mangels	115	1.9	3.9	.7
Swedes	107	2.4	2.0	.6
Carrots	142	1.6	3.2	1.0
Turnips	83	1.8	2.9	.6

"The oil cakes yield the richest manure, as they contain a large amount both of nitrogen and phosphoric acid, with a considerable amount of potash. Next to these come the leguminous seeds, malt-dust and bran. Clover hay yields a richer manure than the cereal grains, but meadow hay stands below them. The cereal grains and the roots contain about the same proportion of nitrogen in their dry substance; the roots, however, supply much more potash. Potatoes stand below roots in their manurial value. Straw takes the lowest place as a manure-yielding food; bean and pea straw are more valuable for this purpose than the straw of the cereals.

"The ash constituents present in animal manure have probably the full money value of the same constituents in artificial manure, but the nitrogen has apparently a lower value than the nitrogen of ammonium salts or nitrate of sodium, from the slowness with which it becomes available for the plant's use."—The greater permanence in the soil of this element of the manure, however, is a point worthy of high consideration.

As giving some practical results of actual dairy practice, the following instances of successful feeding of dairy cows by some prominent dairymen in New York State may be usefully mentioned here. They were given by Mr. Scoville of New Hartford, N. Y., at a meeting of the New York State Dairymen's Association.

Mr. Scoville visited a few farms in the vicinity of Syracuse, among which were the Avery farms, conducted by the Skiff Brothers. They had at that time sixty cows in milk. The cows were fed morning and evening, two quarts of middlings, three quarts of shorts, with a half-bushel of corn ensilage. The shorts and middlings were thrown upon the ensilage when the latter was given to the cows. About eight pounds of cut hay is fed to each cow at noon. About a half-acre of pasture range is apportioned to each cow in summer, with one feed at evening of green clover, green oats and corn to follow as the season advances. The milking is regular at five o'clock in the morning and five at night. In summer there is no grain feed. In winter the cows are bedded with cut straw and watered once a day at about ten o'clock in the morning, usually in the yard, but in stormy weather in the stable. The yield of milk from this dairy, as gathered from the books of the Onondaga Milk Association, for the twelve months ending December, 1886, was 188,070 quarts, an average to each cow of 2,756 quarts, or about 5,900 pounds average.

The George Crouse farm has forty-three cows in milk. Steaming the fodder was formerly practiced on this farm, but has been abandoned. The feed now used is all cut. Ensilage forms the base of winter feeding. The ration to each cow twice a day is a half-bushel of ensilage, morning and night, and about six quarts of brewers' grains with cut hay at noon. The cows stand in stanchions and the feeding is in a trough in front of them, six inches in depth and two feet wide. The cows are watered from these feeding troughs from a stop-cock at one end. The cows are kept in the stable and let out only on very pleasant days, and not left out over half an hour at a time. When exposed to the cold for any length of time, there is a perceptible falling off of the milk yield. In very cold weather the chill is taken from the water in the tank by steam pipes. The grinding of the grain and cutting of the feed are done by steam power. In summer about three-fourths of an acre of pasture is allowed to each cow, with green feed once a day at night. The yield of milk from thirty-six cows kept on this farm during the year ending 1886 equaled 5,500 pounds to a cow.

Another farm visited was that of B. Chaffee, who feeds about one bushel of ensilage to each full-grown cow twice a day, with a peck of brewers' grains and three quarts of bran and hay at noon and evening. Mr. Chaffee has a silo which cost complete $750. The silo is thirty-two by twenty-one feet, divided by inside wall into two equal silos, twenty-four feet high from the bottom of silo to top of the plate. The bottom of the silo is about nine feet below the surface of the ground, and sixteen feet of wall is concrete, eighteen inches thick at the bottom and one foot on top, and perfectly plumb on the inside. The inside walls of the silo are finished with round corners, and it takes eighteen planks, one foot wide and fourteen feet long, to cover each silo. The walls of the silo are made with waterlime concrete and cobble-stone, excepting that the corners are laid with quarried stone. The larger proportion of corn used for ensilage was the Southern White, and field and sweet corn. The sweet corn ears were sent to the canning factory. Mr. Chaffee's milk record of thirteen cows for the last year showed an average of 6,300 pounds to each cow.

The Demming farm, near the city of Auburn, has been managed for many years by A. D. Murdock. It contains something over three hundred acres. There are usually fifty or sixty acres in wheat and about forty acres field corn, besides other grain. About sixty cows in milk are usually kept on this farm. Mr. Murdock uses no ensilage, but, with steam power on the farm, cuts and grinds all his own feed. The winter feed of his cows is in substance as follows: A bushel of cut corn-stalks night and morning, with about seven quarts of the mixture of two bushels barley sprouts, six bushels bran, two bushels middlings or corn meal, all thoroughly mixed together. In winter the cows are out from one to two hours, when the day is pleasant, for exercise. The cows are sometimes kept in the stable for three weeks at a time in stormy weather without apparent injury. They are watered in the stable from a trough conveniently arranged in front of them. In summer they are pastured, and when the pastures become dry and the feed scanty they receive a supplement of some green-cut fodder. The stock of cattle on this farm is replenished by raising the calves.

On the farm of Charles E. Benton, near Utica, containing 130 acres, forty cows are kept, which in winter are fed hay, brewers' grains, shorts and meal, in the proportion of one-third bushel of grains to four quarts of shorts and two quarts of corn meal mixed, with a little salt added. When grains are not obtainable, roots are fed. In summer they are kept in pasture, and fed twice each day brewers' grains and green-cut clover or corn.

On the farm of Dr. L. L. Wight, of Whitesboro, are kept about fifty cows. A specialty of this farm is to supply milk in winter, the cows dropping their calves late in the autumn. The food is a bushel of corn ensilage three times a day, and in the morning and at night about five pounds of shorts during the winter. In summer the cows are kept to pasture. The cows are watered in winter by turning them out in squads of about fifteen. While fed this amount of ensilage, the cows require but little water. While the cows go dry before calving, no shorts or grain is fed. By long experiment in feeding on this farm, it is found that the best and largest flow of milk is obtained when shorts alone are fed with ensilage. About thirty acres of corn are planted, ten acres of which are used for soiling and the balance made in ensilage. About two-thirds of this was sweet corn, which was allowed to ear, and the corn was used for canning, the stalks being made into ensilage. The corn is drilled in rows four feet apart, and harrowed with a smoothing harrow till six inches high, when the cultivator is used. The corn is cut with the reaper and left in bundles to be loaded upon the wagon, hauled to the silo and cut. The cutting is done with a six-horse power engine. Fifty tons are cut and put in the silo in a day.

CHAPTER XIII.

MANAGEMENT OF COWS IN THE STABLE.

MILK is one of the most actively absorbent of all substances. It acquires most easily the odors which escape from adjacent objects. When the author was in Europe some years ago and visited a noted French dairy at Isegny, he found the stable windows filled with pots of growing roses, and a portion of the yard in front of the stable fenced off from the rest was occupied by beds of the standard roses peculiar to French gardens, which bear large heads of profuse bloom at the top of a single stem four or five feet high. The stable and yard were redolent with the perfume of these roses, and of heliotropes and other sweet-scented flowers. The dairy-house was embowered with roses and other flowers. The butter sent to the Paris market every day was packed in boxes with fresh green leaves and a quantity of roses spread upon the linen cover over the butter. Without going quite so far as this French dairyman, whose butter is sent to Paris, London and Vienna, and, packed in casks of brine, to the East Indies, the American dairyman should at least preserve his stable free from the ill odors so common to these buildings. It has been said in regard to scents that the best odor is the absence of scent, and this certainly applies to a butter dairy from the beginning to the ending. For as "good wine needs no bush" so good butter needs no perfume more than its own natural sweetness and pure agreeable aroma.

Nevertheless, the presence of a green lawn and flowers about a stable would certainly tend to the preservation of that perfect cleanliness which is the great secret of success in the dairy. And it might be a most valuable addition to the cow stable as an inducement to keep all other things consistent with it. A lady visitor to the author's dairy, placing her hand upon one of the well-brushed and clean-skinned cows, remarked: "Why, everything is as clean and neat as a parlor; it seems so strange and unlike a cow stable." It was certainly our wish and effort to keep the stable always so, but it must be admitted that this visit was made at the time when the daily cleaning had just been completed, the floor neatly littered with cut straw and leaves, the gutter filled with fresh dry swamp muck and dusted over with plaster, and the cows brushed and carded for the evening milking. A glass of fresh milk newly drawn from a cow under such circumstances is a delicacy, while it would be wholly repugnant under the too common circumstances prevalent in cow stables. But the dairyman who would excel in his business and stand at the top, MUST practice this thorough cleanliness in every detail. Pure, fragrant milk, sound, well-flavored cheese, and the finest and sweetest butter are procured only under these conditions. The cows themselves, too, are as absorbent of impurities as the milk. The air breathed into the lungs, and carried through all the intricate cellular passages and chambers of the lung tissue, is brought into contact with an infinite number of capillary blood vessels, which absorb the air and discharge the load of impurities brought from every part of the animal's body. If the air is not pure the offensive matter is taken into the blood, and some of the impurities in this fluid are retained, thus poisoning the very source from which the whole animal system is nourished. A stream is never purer than its source, and thus the animal is polluted by this absorbed impurity which is forced to escape in some way. As the milk is a direct product from the blood, the blood discharges its offensive load in part with this secretion, and impure blood cannot make pure milk. Besides, the self-preserving instincts, or rather laws, of animal life tend to force the blood to throw off impure matter in the easiest way, and as a large quantity of milk is secreted daily and the milk glands are exceedingly active, any impure matter in the blood is rapidly discharged through the milk glands. An instance of this was afforded when a quantity of frozen turnip leaves left in the stable, which was filled with the odor of them, caused the milk to smell disagreeably by the absorption of the odor through the cows. Physicians are well acquainted with the fact that the perspiration and urine of painters who use turpentine always have an odor, more or less, of the turpentine. Disease is most prevalent where impure air prevails, and if disease and death are produced by the absorption of impurities we cannot expect pure milk from foul stables, Thus the careful management of the cows becomes an important part of the business of a dairyman. The stable should be clean, or the cows cannot be clean; it should be well aired and ventilated, or the air in it will be impure; it should be made comfortable, or the cows will be worried and yield less milk; it should be cool in summer and warm in winter. There should be a convenient way to dispose of the manure, and a convenient and safe mode of entrance and exit. The fastenings should be safe. The cows should be separated so that they cannot hook or punch each other when fastened, and yet be so close together that space is economized; they should be thoroughly carded and brushed twice a day, and immediately before milking, and in every way they should be preserved from uncleanliness and annoyance, and kept contented and happy.

The following system of management has been adopted and practiced in the author's dairy:

The stable has been described in a preceding chapter. The cows are stabled every night through the year; in the winter for warmth and shelter, and in the summer for coolness and for safety from flies, also for the saving of manure. The manure made is an item of importance and is an object of solicitude; the management is therefore to some extent made consistent with the saving of all the manure possible.

At five o'clock in the morning the stable is cleaned by opening the trap doors in the gutter and drawing out the manure into the cellar by means of a large hoe, fourteen inches wide to fit the gutter, the gutter is then washed out with a few pailfuls of water from the pump, and brushed out with a stiff broom, after which the trap doors are closed. The standing floors and passage-way behind the cows are previously swept. The floor and gutter are then sprinkled liberally with gypsum (plaster), and are littered down with leaves, cut straw, or hardwood sawdust, as the case may be, and two or three wheelbarrows of dry swamp muck are scattered along the gutter. The cows are then well carded and brushed, and a little hay or green fodder is given them, by which time breakfast is ready. After breakfast the cows are fed in the manner previously described and while eating they are milked. This plan has been adopted as the best in every way, and it certainly tends much to the largest yield of milk. As each cow is milked the pail and milk are weighed on a spring balance hanging in the stable, and the weight is marked down on a slate or a tablet hanging on the wall at the back of the cows. The milk is then strained from the pail, which has a lip strainer, through a separate double strainer of wire gauze with a fine linen muslin stretched over it, into a deep pail. The milk is thus passed through four strainers at one operation, and perfect cleanliness is secured. After milking, if any cow evinces a desire for more feed, an additional supply is given to satisfy her. The system is to give to each cow all she can be persuaded to eat. If any cow's food is not all eaten the fact is noted and the reason ascertained. If the milk of any cow has fallen off or has increased more than the usual small variance from day to day, this is made a matter for inquiry and note.

In the summer the cows are then let out and taken to the pasture or a grass lot, or kept in the yard, as the case may be, and have as much water as they desire. The yard is always kept clean, the manure being taken up and thrown upon the heap in the center of the yard. In the winter the cows are kept in the stable and remain there until noon, when they are watered. In the hot weather, when flies are troublesome, great care is taken to preserve the cows from annoyance. This plague of flies is very detrimental to the cows, and should be avoided in every possible way.

The liberal use of plaster (finely powdered gypsum), or a solution of two pounds of copperas in a barrel of water, in the stables is at once a cheap, simple, and effective relief. It sweetens the air of the stables, which is equivalent to increased ventilation, and thus permits the windows to be protected with fine wire gauze or mosquito netting, which to some extent obstructs the free passage of air. A peck of plaster, at the cost of a few cents—all returned, of course, in the manure afterward—is sprinkled over a floor fifty by twenty-four feet, and more freely in the manure gutter than elsewhere; or a pailful of the solution of copperas is spread from a garden watering-can over the floor, and these applications are made after clearing off the floor and sweeping it. Occasionally the floor is washed off with a hose attached to a force-pump in the yard, or to one on the cistern close by, and the floor is then freely sprinkled with sand brought from the root cellar under a portion of the cow stable. A bushel basket of the sand is sufficient for one day's use. This avoids the certain danger of the cows slipping upon the damp floor, dries it, and also absorbs some of the odor.

To darken the windows is a great relief, and this is done by having green blinds, which afford free ventilation while excluding the light. The same result may be reached by covering the windows with whitewash of Spanish white, in which some indigo or Prussian blue is mixed, or a little lampblack may be used, but the tinge is then dark and somber, and the blue is the best. If the windows are on the north side of the stable so much the better, as the flies gather mostly upon the south and west sides. The stable may be quite freed from flies in the afternoon, when they are unusually abundant, by stirring a pot of coal-tar with a hot poker so as to fill the building with a dense smoke, but the iron should not be so hot as to cause the tar to take fire. This smoke is healthful, and with a little care there need be no risk in making it. Then there are some applications that may be made to the animals themselves. Wormwood, tansy, tomato leaves, and, best of all, carbolic acid in water (one dram to a pailful), may be applied to their skins, and chiefly the legs, the last thing in the evening, and left on to dry. The last two years we have used Persian insect powder with the best results. A small quantity of this dusted freely through the stable and blown through a tube on to the ceiling, stanchions, and stalls, will kill every fly in the stable, and, if the entrance of others is prevented, a quiet night will be enjoyed. Unfortunately, this is a costly substance, selling at fifty cents a pound; but a little goes a long way, as it is very fine and light and floats in the air. For rooms in houses, and especially kitchens, it is indispensable once it has been used, as the flies may all be destroyed in the evening and more kept out at least for a few hours in the morning; and a house may be freed from flies by keeping it dark through the day, for the pests always make for the light. A tame bat, which we first found hanging in its usual way to the cord behind a picture, and which now stays with us, clears the rooms at night of every fly. During the night it goes from room to room, the doors being left open for it. It will be found better to encourage these harmless creatures in this way to enter the house and stable than to attack them with brooms and kill them, to the eminent risk of destroying glassware and mantel ornaments.

But all the flies cannot be got rid of; some will remain in spite of all endeavors. For these, when milking, we keep a sheet, which is thrown over the back of the cow, and that prevents the lashing of the tail and the kicking which is so disagreeable and risky for the milk pail. A little bundle of horse-hair, tied to the end of a light handle, is a part of the milking utensils, and lies handy to be picked up to brush the flies from the forelegs when they become troublesome there.

In the summer the cows are brought in at five o'clock in the afternoon and put into their places in the clean stable. They are very eager to come in, and are usually standing at the gate waiting for an hour or more before the time comes. If not, they come at the call of a whistle which they have learned is the summons to their evening meal. The same routine as to brushing, feeding and milking is gone through, and when all is finished it is supper time. After supper, and the last thing before retiring for the night, the stable is visited and the cows looked over, the fastenings being especially examined to be sure every cow is safely secured. This is quite important and an instance of this may be noted. Once when visiting a well-known breeder of valuable Jersey cows and a noted maker of fine butter, about nine o'clock in the evening we suggested that a walk be taken and the cows looked at, remarking that this was never neglected in our dairy. Our friend laughed at our overcarefulness, but went out and passed through the stables. On coming to the loose stalls where the most valuable cows were kept, one was found down with her head under the manger and the tie rope tangled around one foreleg and her neck. It was a fatal predicament had the cow not been quickly released, for the rope was pressing on the cow's throat. "That idea of yours has saved me $1500," said my friend as we returned to the house, "for that cow is sold to go to Canada at that price as soon as she has calved, and she could not have lived in that way until morning."

For the sake of safety, all the inner doors in the stables are made to open and shut from the inside next the cows, and to shut themselves by coiled springs and fasten with a spring latch, so that no animals can get from their own place to the others or out of doors, or to the feed rooms or the feed on the floor, should they get unfastened. The ground feed is kept on the floor over the stable, and in every possible way precautions are taken for entire safety. No matches are kept about the buildings; no smoking has been permitted, and no light is used excepting the safety kerosene oil lanterns, in which the safest and best oil is burned. The lanterns are hung, when in use, upon bracket hooks over the passage-way, above the reach of a man's head. The outer door of the stable is then locked and the day's business is ended. Similar practice prevails with the calves, bull, and horses, and all the farm management is brought to a systematic routine, through which one never needs to stop and ask what is next to be done.

The chief business of this dairy has been winter butter making, and the cows have been brought in from September until December. The course of breeding has been such as to bring each cow into milking at about the same time in each year, and the heifers about September or October, so as to give them as long a milking season as possible with the first calf. Some particular care is taken with the incoming cows. If not naturally dried off two months before the calf is due, milking is gradually suspended so as to have six weeks at least of rest. When the cow shows indications of early calving, she is moved to the stall in the further end of the open shed and nearest to the house, where she is under careful supervision until the calf is born. As soon as the milking is suspended, all grain feeding is stopped, and only dry long hay is fed. The cow is left loose in the stall, which is well littered and is kept clean. When the calf is dropped, the cow is tied up and is fed a meal of warm bran mash. The calf is removed at once to the pen at the further end of the yard. In six hours the cow is milked, and the milk is given to the calf, which is taught to drink. The cow is never troubled about the calf after this, and comes to her milk without any of the common difficulties of holding up the milk, sore teats, etc., which appertain to cows suckling calves. The food given is dry hay with the usual warm bran mash, until the fourth day, after which the cow goes back to her place in the stable and is gradually brought up to her full feeding. Large milking cows very often have the udder hard, and milk very little for the first and second days. This is the natural condition of the udder of a newly calved cow, the glandular substance of which is excited but has not yet come into action. In a short time the glands get to work and begin to secrete milk copiously, and then the udder softens down and comes into a natural condition again. There is no reason to fuss over the hard udder the first or second day and to apprehend trouble, and as long as the udder is free from inflammation and extreme tenderness there need be no anxiety. When the chapter on milk is reached, this condition of the udder will be explained, and it will be seen that it is naturally to be expected from the necessities of the case. To attempt by unnecessary fomentation, or the use of exciting applications, to remove this supposed trouble in the udder, is to most likely cause the very result one is apprehending and trying to avoid.

CHAPTER XIV.

REARING CALVES FOR THE DAIRY.

The calves are the means for the improvement of the dairy. By a gradual course of breeding, rearing, and development the calves become the basis for all the skill of the dairyman's work in improving his stock and in increasing their valuable product. Breed is made up of feed and the most skillful care, and by judicious management the calves are developed into more useful and productive animals than their dams, until in course of time the improvement becomes fixed and is inherited by the progeny. It is in this way that the improved breeds have been made up. The Shorthorn cattle have been thus trained and educated—this word means literally "lead out" or brought out—for over a hundred years, until they have become the finest beef cattle in existence. The Ayrshires have thus been made a most excellent dairy breed, and the defects of the original race have been bred out by selection and care in the breeding of the young stock. The Jerseys have been brought up in size, productiveness and beauty during the past thirty years by the same process, until they have become greatly increased in value; and so it has been and is with other races. A herd of our common native cattle has been improved during the short space of seven years until their product has been doubled and their appearance greatly changed. The produce of one cow in this time will number about sixteen animals in five generations, and a great deal can be done in these repeated breedings. The choice of a pure bred bull of some acknowledged dairy breed and of good character should however be made, and in three or four years the progeny, if well selected, will then partake of the good qualities of the pure breed. Half bred Jersey, Guernsey or Ayrshire calves have been found equally valuable for product with the pure bred ones, and, as a rule, these half bred calves, from well selected sires and the best native cows, will be found on an average to be superior for product to an average of the pure bred cows. Such has been the experience of dairymen who have thus started on a course of improvement of their common stock.

The calf thus well bred must be well fed and trained. It is by no means necessary that the calf should be fed upon fresh milk from the cow. Cream a: l fat are not required by a calf intended for the dairy, but a good frame of bones covered with healthful muscular tissue. These are abundantly supplied by skimmed milk, and the milk is well and fully digested when given warm and at a temperature almost equal to that of the stomach. Eighty degrees is a very good temperature for the milk for a young calf. An excellent method of feeding a calf intended for the dairy is as follows. Heifers only should be reared, as the cost of fattening a male calf is greater than its value for veal, and males should only be reared when their value for breeding purposes offers a chance for profit.

The calf, removed to a dry comfortable pen away from the cow, is given the whole milk warm from the cow, twice a day, for four days; the ninth meal is made up of half the fresh milk and half sweet skimmed milk, warmed to the same temperature as the new milk. Three quarts are a sufficient meal for a calf at this age, if two meals a day are given; if three meals are given two quarts at each will be sufficient. Overfeeding at this stage is to be avoided, and it should be remembered that the young calf, if sucking the cow, will get only a small meal at a time, and its digestive functions are not as yet prepared to dispose of several quarts of milk at once. The quantity should be gradually increased as the calf can digest it, until three meals of three quarts each are disposed of, or two meals daily of four or five quarts each, at the end of a month. The milk should be given sweet and always at the same temperature. If by any accident diarrhœa should occur, a quart only of new milk warm from the cow, or heated to ninety degrees, will stop it, if no other food is given. In nearly every case this disorder is caused by an excess of food and consequent indigestion, or the use of sour milk. When a month old the calf may be taught to lick a little finely ground corn, bran and linseed mixed in equal parts. A teaspoonful is enough to begin with, gradually increased up to a table-spoonful daily at two months, four ounces daily at three months, eight ounces daily at five months, and a pound at six months. From three months up, six quarts of milk twice a day may be given, and at a month old the calves should have a run in a grass pasture of a quarter of an acre or so, enclosed purposely with portable fence, which is moved to give fresh grass as may be required. At two months the calf will begin to drink a little water, which should thereafter be provided. In winter some fresh, sweet, early cut clover hay should be given after the first month, and the quantity increased gradually as the calf learns to consume it. The gradual increase of the food should be carefully watched; but there is no danger from an excess of hay; it is the grain food which is more apt to be given to excess and do harm.

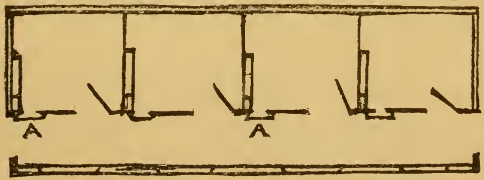

Fig. 21.—PLAN OF CALF PENS.

There is a temptation when a calf is doing well to give a little more food, in the hope of making it do a little better, but it is a mistake to try to force a young animal ahead of its ability to digest.

The young calf should be tied up from the first. A small halter or a leather strap around the neck, with a ring, and a light rope with a swivel snap hook in it, may be used to fasten it in the pen. Calves should never run together loose in a pen, or they will learn to suck each other, and thus contract habits which will be trouble-some afterwards. In our dairy the calf pens are divided into separate stalls, as shown at figure 21. These are five by seven feet, and are separated by barred partitions, so that the calves can see each other. The partitions are four feet high. A rack for hay is made on one side and a small box near it is for meal. A slide door is made in the front (*a*, *a*) large enough for the calf to put its head through easily, and in front of it is a shelf with a receptacle for a pail, in which milk is given to the calf. The calves are thus fed very easily and quickly, the milk being brought to the pens in a deep pail holding fourteen quarts, and enough for four or five calves is poured into the feeding pails and each pail is set in its place. The slide door is then opened and the calf drinks its milk without any trouble, and cannot upset the pail. A few days' training is required before the calf learns all this, but with patience the lesson is soon taught. Calves are phenomenally stupid, and much patience is required to manage them ; but it is far easier to train a calf kindly than with force and by beating it. When a calf learns not to fear its owner, and experiences only kindness, it is a most affectionate animal, and this trait is exhibited ever afterwards as long as the same kind treatment is given to it. For the comfort and profit in managing a dairy this general system of management is indispensable. At times it is certainly trying to one's patience to worry along with self-willed and stupid calves, but it should not be forgotten that our training is contrary to their instincts, and we are teaching them to acquire new habits and unnatural ways. Rightly considered, it is amazing that a kind and gentle owner may so soon reduce a young creature to submission to his will and wholly change its natural inclinations. The dairyman, however, should be able to control his own instincts and passions, and then will be better able to train his calves to become docile, patient, gentle and useful cows.

When six months old and done with milk-feeding the young heifers are moved into the cow stable, where they are fastened, fed and treated as the cows are, being handled, brushed and cleaned daily. This they submit to without trouble, having been used to it in the calf pens. At from nine to twelve months old they are bred, and come in when from eighteen to twenty months old.

The feeding of a heifer should be liberal. She should have regular rations of the feed prepared and given to the cows, and about half as much of it will be eaten profitably. Liberal feeding of good food develops the digestive functions, and the training of a heifer for the dairy should be such as to encourage the healthful disposal of as much food as possible. It does not matter if the heifer should get fat, if the growth is not stunted by it. The gradual development of the normal figure of the model cow should be watched, and as long as this development is going on satisfactorily the feeding may be persevered in. Excessive fatness, however, is a bar to usefulness in the dairy, and when heifers with this tendency to fat come in there is usually some defect which spoils the animal for a cow. One such instance occurred in the author's dairy. It was a pure bred Ayrshire, which as a calf and up to twelve months old gave every promise of making an excellent cow. But she became very fat, and up to her coming in grew rapidly in size and rotundity. On calving the milk was blood and nothing else, and the calf would not touch it. She was kept for four months in the hope that the milk organs would become free from their unusual condition, but the secretion of blood instead of milk continued. The secretion was not milk at all, but an albuminous fluid highly charged with the red corpuscles of the blood. Cream or a fatty substance separated from the fluid, but it was reddish yellow in color, and made almost red butter. It was a remarkable instance of abnormal action of the milk glands, which had no power to secrete milk from the blood passing through them, but merely discharged the blood in an almost pure state. The cow was finally slaughtered as an incurable. If a heifer becomes fat on liberal feeding, instead of enlarging her general growth and retaining the most desirable form, she should be discarded from the herd. It is one of the valuable uses of the method of training heifers, that as they develop by age and growth their future character becomes indicated. When the heifer approaches the period of calving, the udder and teats are frequently handled, and she is made familiar with the milk pail and the operation of milking. When she comes into the stable a cow there is no trouble with her.

The training of heifers for their duties in the dairy should be a constant care of the dairyman. Vicious animals, which kick, hold up their milk, suck themselves, and practice the other usual vices of disorderly cows; are all made so by want of, or misdirected, training. The first lesson the calf learns should be affection for its owner, fearlessness, and docility. Having never been maltreated it has no sense of fear and accepts the attentions of its owner without alarm. Receiving nothing but kindness and its food from him, it is always ready to meet him with eagerness, and soon learns to come at his call. Its natural instincts are even readily controllable, because its acquired docility accustoms it to give way to the management of its owner, and it never practices those troublesome vices which are intolerable in a dairy. It becomes in every respect a domesticated animal, and to attain this result, with all the comfort and advantages it involves, should be the constant care of the dairyman whose crop of calves is being harvested. Kindness and gentleness in the owner are indispensable to these virtues in his cattle.

CHAPTER XV.

MILK.

MILK is an exceedingly complex compound liquid. It is a saccharine and caseous solution, having a slightly alkaline reaction caused by the presence in it of a small quantity of free soda. It also contains some little albumen, which varies, sometimes considerably, and this albumen gives to it a more or less viscous character. It has the following average composition, as given by Becquerel and Vernois.

COMPOSITION OF MILK OF VARIOUS ANIMALS.

1,000 *parts.*	*Human.*	*Cow.*	*Goat.*	*Sheep.*	*Mare.*	*Ass.*	*Sow.*	*Dog.*
Specific gravity	1032.67	1033.38	1033.5	1041.0	1033.74	1034.6	-----	1041.6
Water	889.08	864.06	844.9	832.3	904.3	890.1	854.9	772.1
Solids	110.92	135.94	155.1	167.7	95.7	109.9	145.1	227.9
Fat	26.66	36.12	56.87	51.31	24.36	18.53	19.50	87.95
Caseine & albumen	39.24	55.15	55.14	69.78	33.35	35.65	84.5	116.88
Sugar	43.64	38.03	36.91	39.43	32.76	50.46	30.3	15.29
Salts (ash)	1.38	6.64	6.18	7.16	5.23	5.24	10.9	7.80

As milk is seen to vary considerably in different races of animals, so it varies quite as much in different individuals of the same race. Thus Dr. Sharpless of Massachusetts, in a paper presented to the American Academy of Arts and Sciences, gives the following analyses of different samples of cow's milk :

ANALYSES OF COW'S MILK.

	No. 1.	No. 2.	No. 3.	No. 4.
Sugar	3.96	3.94	4.19	4.82
Caseine	3.64	4.81	5.23	3.54
Ash	.45	.65	.72	.57
Fat	3.30	2.47	4.39	2.71
Water	88.65	88.13	85.57	88.36

In my own dairy I have found the fat in the milk to vary from 2.15 to 6.38 per cent in different cows. The wide variations show how easily a dairyman may lose money by keeping inferior cows in his herd, and, by the neglect of testing each cow's milk separately, cause the good ones to support the inferior ones. Moreover, it is by no means the handsomest cow or the largest milker that produces the most butter. It is a curious fact, as showing a physiological anomaly, that not only do cows differ in this respect, but that the different glands of a cow vary in the quality of the milk yielded. Thus one quarter, or separate gland, of the udder will, in the same cow, most always yield milk richer in fat than another. The following figures, given in the paper of Dr. Sharpless above referred to, show this. The milk was drawn from each teat separately, and separately examined. The cow was a pure Ayrshire.

Per cent of	*Right forward teat.*	*Left forward teat.*	*Right rear teat.*	*Left rear teat.*
Cream	25.	42.	29.	24.
Specific gravity	1.025	1.024	1.026	1.028
Sugar	4.09	2.18	3.44	4.20
Caseine	4.48	6.58	5.00	5.59
Ash	.68	.61	.66	.67
Fat	5.59	4.43	4.39	3.84
Water	85.16	86.20	86.51	85.70

To affirm these unexpected results the milk of another cow was examined and determined as follows:

Per cent of	*Right forward teat.*	*Left forward teat.*	*Right rear teat.*	*Left rear teat.*
Cream	14.	11.	13.	10.
Specific gravity	1.032	1.031	1.030	1.031
Sugar	4.90	5.0	4.72	4.87
Caseine	3.53	3.42	3.61	3.48
Ash	.59	.57	.61	.64
Fat	3.32	3.0	2.73	2.13
Water	87.66	88.01	88.33	88.87

The coincidence in both cases as regards the left rear teat, in which the fat product was nearly fifty per cent less than that of the right forward teat, is very interesting. While this is not a really practical matter, yet, as a scientific fact, it is well worthy of remark here. To prove the truth of the well-founded popular impression that the first drawn milk is poorer in fat than the last drawn, or "the strippings," Dr. Sharpless tested another pure Ayrshire cow with the following result:

	First third.	*Second third.*	*Last third.*
Specific gravity	1.029	1.032	1.027
Cream	6 per cent.	9 per cent.	11 per cent.
Sugar	4.49	4.80	4.50
Caseine	3.06	4.25	3.90
Ash	.54	.58	.54
Fat	1.78	3.03	4.03
Water	90.13	87.34	87.03

Dr. Sharpless' conclusion, after making a large number of tests, was that no one cow's milk is as uniform in composition as the whole milk of a herd, for as the cows will vary either way a general average of remarkable consistency is procured. This will no doubt accord with the general experience of dairymen. But then there are some cows, especially among the Jerseys—as was the case with the selected test cow Nellie, referred to in Chapter XII., and which was chosen for her uniformity in product—which vary little in the quality of the milk under the same feeding and other conditions.

Milk is the final result of gestation and is coincident with parturition. For some days previous to calving, preparations are being made in the mammary glands, which is commonly called the udder, for the secretion of the milk; which Nature intends as a provision for the support of the calf. This preparation of the glands consists in an œdematous tumefaction, or a soft pulpy swelling by which the udder is largely increased in size. A thin serum can often be expressed from the teats during this preparatory period, which begins from a month to two months before the calf is born. This preparatory period is much longer with a heifer with its first calf, and usually begins a short time after the beginning of gestation. After the first calf, a considerable falling off in the milk, and a stoppage of the secretion, accompany the beginning of this period with some cows, but with others the milk flow continues for a much longer time. The character of the milk, however, changes considerably, and the salts in it are much increased in quantity, so much so as to considerably affect its taste.

When the calf is born a sudden change occurs in the milk glands. They become hard and tense, and very sensitive from the large accession of blood which they receive. The formation of cell matter is now at its maximum, and a sudden breaking down of it into a strongly albuminous fluid containing a large quantity of salts takes place. With some cows this is accompanied by a serious disturbance of the nervous system and active febrile conditions, which produce the generally fatal disorder known as milk fever. This disturbance approaches its maximum during the change which is occurring in the character of this first milk, or, as it is called, "colostrum," and which lasts about four days. In fatal cases death occurs on the third or fourth day after calving.

The colostrum is a viscid, yellowish, sweetish fluid, disagreeable to the taste, and of greater density than ordinary milk, having a specific gravity 1.063. It coagulates on heating, and on this account is often used in England for making custards, which need no eggs and are extremely firm and of a high yellow color, inclining to a reddish tinge. Butter made from it is a deep reddish orange color and soft, and soon becomes rancid. The fat globules of colostrum are smaller than those in ordinary milk and are fewer in number; but there are large numbers of disc-shaped corpuscles (figure 22, *a*, *a*) generally agglomerated in masses in a tenacious viscid matter, some having nuclei (figure 22, *b*), and among these are to be observed many peculiar bodies

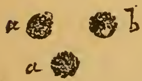

Fig. 22.

called "leucocytes," which are endowed with a power of motion. The composition of colostrum is given by Boussingault as follows:

Water	75.8
Albumen and caseine	15.0
Fat	2.6
Sugar	3.6
Salts	3.0
Total	100.0

Dumas gives the composition of colostrum of the various animals mentioned as below, viz.:

In 1,000 *parts.*	*Cow.*	*Ass.*	*Goat*
Water	80.33	82.84	64.10
Fat	2.60	0.56	5.20
Albumen	15.07	11.60	24.5
Mucus	2.0	0.70	3.0
Sugar	——	4.30	3.20

Milk, it is admitted by all physiologists, is produced by a fatty degeneration of the epithelial cells of the gland follicles, in which the cells are very greatly multiplied and developed during lactation. The cells rupture and set free the fat globules. This theory is rendered highly probable by the similarity between milk and other animal products of the glandular follicles, or the breaking down of cellular tissue, as mucous and true pus, the composition of which are very much like that of colostrum. Thus pus from a mammary abscess in a cow has been found to consist of the following, viz.:

Water	87.94
Fatty matter	2.65
Albumen	8.36
Lactates of soda, potassa, lime and phosphates	0.90
Loss	0.15
	100.00

The frequent production of pus in the cow's udder, which often goes under the name of ropy milk, is a very easy transformation of the products of the gland follicles due to disturbance of the function of lactation. In colostrum the epithelial cells have not undergone this destructive change, the walls are still intact and contain their oil granules, and thus constitute the corpuscles of this fluid. In the colostrum albumen takes the place of caseine in the perfect milk, but a reverse change is slowly made and completed about the fourth day. At the end of lactation, when the animal is again pregnant, the milk again loses its caseine and gains albumen, and is consequently easily coagulable by heat and causes many serious difficulties in the dairy which are not easily understood by the dairyman who is unfamiliar with these facts. The sugar also disappears in part or wholly, and the leucocytes increase as in the colostrum.

About the fourth or fifth day after parturition the milk becomes normal in character and is fitted for general use. It however always contains more or less albumen, and this is a common source of trouble in the dairy, especially in winter, when heat is used to effect the necessary acidity or ripening of the cream. The albumen is thus solidified and causes the troublesome white specks in the butter.

Fig. 23.

When the milk glands first assume their tumefied or swollen condition, just previous to parturition, the lobules of the glands become filled with a largely increased number of cells (figure 23, *b*), and these greatly increase the size of the udder. Previous to this condition the lobules are shrunken (figure 23, *a*) and the formation and constant destruction of cells, as they are formed, are occurring continuously, and it is only when the udder is charged and filled with milk that it is distended. But when the active development of cells is in progress, the lobules of the glands are enlarged and do not break down immediately, but retaining their increased size they cause the udder to become hard and much extended in size. This hardness of the udder is often supposed to be caused by some disorder, and much unnecessary trouble is often borrowed on this account. When, however, the process of lactation is under way, and the glandular follicles begin to break down copiously and the secretion of milk increases, and especially when the colustrum period has passed, the udder becomes less hard and tense, excepting when full of milk, and loose and soft as soon as the milk is drawn.

The udder of the cow consists of four distinct and separate glands commonly called quarters, each one consisting of a mass of lobules, among which are a large number of ducts small at the extremities, but gradually connecting and forming large ducts, which in their turn form sinuses or reservoirs in which the milk gathers as it is secreted. The largest of these reservoirs is immediately above the base of the teats. The teats form the outlets for the principal lactiferous ducts or milk channels, and these connect with an orifice at the extremity of the teat through which the milk is drawn.

In structure each of the glands of the udder consist of: first, an envelope of yellow elastic fibrous tissue ; second, the glandular tissue formed into lobules ; third, the lactiferous ducts or milk channels ; fourth, the milk reservoirs or the sinuses ; and fifth, the excretory canal or orifice of the teat.

The elastic envelope is extremely strong and is formed of wide bands detached from the abdominal muscles ; it has numerous prolongations which cross each other in the mass of glandular tissue, forming partitions which divide this into lobes and lobules, which are thus somewhat independent of each other, and are firmly supported without pressing upon each other. This separation and partial isolation of these parts of the udder are such that one or more of the parts may become diseased or deranged in function without involving the other parts. Thus one or more of the lobules may for some cause or other become deranged, and secrete blood from the numerous capillary vessels which pass through it and form the connecting links between the arterial and venous circulation; or the cellular tissue may break down into albuminous serum or pus, which being discharged with the milk causes it to become ropy or forms adherent strings which are ejected with the milk; at the same time all the other parts of the gland may be acting normally.

The glandular tissue consists of vesicles clustered like grapes on a stalk around the finest lactiferous tubes or smaller ducts, which are the ultimate terminations of the lactiferous ducts. Each of these tubes forms a *cul-de-sac* or a channel closed at one end, which opens into others to form enlarged tubes which converge together, and so on to form the lactiferous ducts. The vesicles (*acini*) of the lobules as well as the tubes are lined with epithelium or membranous tissue, which become infiltrated with fat during lactation (figure 23, *b*).

The lactiferous ducts are at first exceedingly numerous but gradually converging, like the branches of a tree, unite to form larger channels which flow into the sinuses or milk reservoirs.

The sinuses or reservoirs are situated just above the base of the teat, and are usually two in number, one in front and one behind, but sometimes in cows with highly developed udder and milking capacity there are three or four. They communicate with each other and are prolonged into the teat by separate and distinct excretory terminal canals whose orifices are quite small and gather at the end of the teat forming an outlet (figure 24).

The excretory canals are larger at the upper part than at the extremity; the orifices are usually behind one another and about a tenth of an inch apart. They are lined with a fine and highly sensitive membrane which is continuous with the skin. The teat varies in form with use and is subject to considerable alteration by manipulation; it is composed of longitudinal fibers which at the end are capable of a sort of erection under the influence of stimulus, and thus act as a sphincter to close the orifice and prevent the constant and passive flow of milk.

The udder (or udders, there being really four of them in the cow) is made up, in addition to the organs described above, of connective tissue, arteries, veins, capillary vessels, nerves and absorbents. It is supplied with blood by the external pudic artery and requires two sets of veins to complete the circulation, one deep, which follows the arteries, and one superficial, which converges into the great abdominal vein which passes from the udder near the skin and enters the abdomen behind the umbillical region. This large vein is commonly called the milk vein, and is rightly supposed to indicate by its prominence the larger milking capacity of the cow.

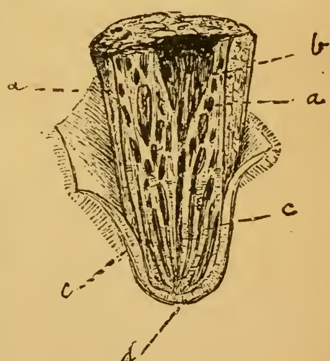

Fig. 24.

When gestation is not going on the above described glandular *culs-des-sacs* and tissue connected with them are shrunken and contracted (figure 23, *a*), the lining membrane is shriveled and folded upon itself and covered only by contracted epithelium. When gestation has progressed to a certain stage the vesicles are enlarged and new ones are developed, the epithelium expands, becomes globular in shape, and is charged with fat granules, filling the vesicles ; thus the entire gland becomes enlarged in size (figure 23, *b*) and firm to the touch, and as parturition approaches this increased size and firmness are intensified, until delivery takes place, when the vesicles break down, the albuminous serum with the fat globules escape, gather into the lactiferous tubes, and collect in the sinuses or reservoirs. This process goes on more or less actively in proportion to the natural ability and the liberal nutrition of the cow to supply the materials for the enormous loss of tissue.

Milk is easily analyzed and its constituents separated, and every dairyman should be able to perform this operation for himself. The separation of the fat is the matter of greatest moment, although it is quite as often desirable to know the quantity of caseine contained in it. It is necessary to procure a pair of delicate scales with weights and measures of the metric or decimal system, grams for weighing, and a one hundred centimeter rule for measuring. One hundred cubic centimeters of the milk at sixty degrees of temperature are measured and weighed, and the weights noted ; this milk is set apart for the cream. Five centimeters are then weighed, evaporated to dryness, and weighed again ; the difference is the water and the weight the total solids. The fat is then dissolved out by benzine and the loss after the benzine has been wholly evaporated is the quantity of fats. There are then left the caseine, sugar and salts. The residue left by the benzine is weighed and is then burned completely. The last result, the ash, is then weighed. The caseine and sugar are then to be determined. Twenty-five centimeters of the skimmed milk are curdled by the addition of acetic acid, and the curd separated, dried and weighed. The whey may be then evaporated, washed in benzine, and then weighed and burned ; the loss is the sugar. In this way every constituent may be easily calculated. But the character of milk is as yet far from having been fully explained, for when the summer heats produce a most active chemical action in all organic matter, this unstable substance, milk, becomes very troublesome to the dairyman. Milk consists of a solution of caseine in a sweet liquid, which is somewhat alkaline. The average four per cent of sugar and the four per cent of caseine are both held in solution in the milk, which also contains a sufficient quantity of free soda to make it distinctly alkaline. This free soda enables the caseine to remain in solution, and when it is taken up by any acid in the milk, and rendered inert, or neutral, the caseine is at once precipitated, and the milk curdles, because of this precipitation or separation of the caseine. The mineral matter of milk consists of the following substances :

IN 1,000 POUNDS OF MILK THERE ARE OF

	Pounds.		*Pounds.*
Phosphate of lime	2.31	to	3.44
Phosphate of magnesia	.42	to	.64
Phosphate of oxide of iron	.07	to	.07
Chloride of potassium	1.44	to	1.83
Chloride of sodium	.24	to	.34
Free soda	.42	to	.45
Total	4.90	to	6.77

All this matter is neutral or chemically inert or inactive excepting the free soda, which is at all times ready and eager to combine with any acid which may exist in the milk.

Sugar is a very unstable substance, and is liable to change under very little persuasion. A saccharine solution very easily oxidizes and changes to acid at the expense of the carbon which is combined with the oxygen, and produces carbonic acid, which escapes, leaving an acid liquid instead of a sweet one. Really, the sugars and some acids derived from them are compounds of carbon and water. Thus common sugar consists of twelve atoms of carbon and eleven atoms of water, and milk sugar of twelve atoms of carbon and twelve of water, while acetic acid, made by the fermentation of cane sugar, consists of two atoms of carbon and two of water, and lactic acid, made by the fermentation of milk, is composed of three atoms of carbon and three of water. To put these in a table will show the character of these substances more clearly, thus:

One atom of cane sugar consists of $C_{12}H_{22}O_{11}$.
One atom of milk sugar consists of $C_{12}H_{24}O_{12}$.
Six atoms of acetic acid consists of $C_{12}H_{24}O_{12}$.
Four atoms of lactic acid consists of $C_{12}H_{24}O_{12}$.
One atom of water consists of H_2O.

Thus chemically the addition of one atom of water to cane sugar changes it to milk sugar, which is much less sweet than cane sugar, and by breaking up one atom of milk sugar into six parts the result is acetic acid or vinegar, and by breaking it up into four parts lactic acid is produced.

The last-mentioned fact is of the most interest to us in the present consideration, for it shows how very easily milk is changed from an alkaline to an acid condition and how the difficulties inherent to his business are precipitated upon the dairyman.

When by reason of some controlling influence, it may be the heat of the weather, the condition of the atmosphere produced by heat, the condition of the cows caused by food, heat, or any other accident, there occurs a chemical breaking up or separation of the atoms of the sugar in the milk, lactic acid is produced. This acid is neutralized by the free soda as fast as it is produced, and lactate of soda is formed until the soda is all taken up, when the acid accumulates in the milk, and then serious difficulties arise. But just here it may be worth while to notice that this same acid (lactic) is produced in various substances which are fed to cows, and very freely in the warm weather. The acid of sauerkraut or cabbage is lactic; it is also formed in the fermentation of moist corn-meal, cotton-seed meal, bran, middlings and oatmeal, and of green clover, grass, wet straw and hay, and other vegetable matters which are fed to cows. And this acid may very easily be taken into the system of the cow and directly affect the condition of the milk, causing it to be distinctly acid instead of alkaline, as it should be naturally. Moreover, as this acid may be very easily, and is no doubt often, produced in the course of the digestion of the food in the cow's stomach, it is readily seen how most unexpected difficulties may arise in the dairy in the summer to vex and discomfit the dairyman.

Acid is the most treacherous and effective agent of change in milk, cream, and butter. It should be watched for at every turn and neutralized by every possible means. The addition to the milk of a small quantity of soda will take up the acid as fast as it is formed, and will remain as lactate of soda in the milk in an inert and harmless condition; but to avoid the presence of this acid the food and every utensil used in the stable, feeding process, and in the care of the milk should be kept most rigidly free from acidity.

But another fact still remains to illustrate the excessive instability of milk. Caseine, of which about four per cent is dissolved in the milk, is itself able to change milk sugar into this milk (lactic) acid. Many nitrogenous substances possess this peculiar power. Gluten of wheat, animal membranes, as a piece of bladder or of the gut or stomach of an animal, as well as the legumin of peas and beans and the caseine of milk, exert this effect. Some time or enabling effect, however, is required to develop this property in caseine, and exposure to air and warmth for a certain period are sufficient to develop it.

And upon this fact another most important one bears, viz., that caseine in this active condition has the effect of changing milk sugar first into lactic acid, and then the lactic acid into butyric acid, which is the active agent of rancidity in butter, and is the cause of the greatest difficulties which the dairyman meets with in the warm season. This acid is also produced by the direct action of caseine upon the fats of the butter themselves, changing the harder fats into the more oily ones, and thus causing the butter to be soft and of inferior quality. The oxygen of the atmosphere has also the same result. These facts show how necessary it is to preserve the utmost freedom from any remains of stale milk or cream upon the utensils, to preserve the milk from excess of heat and from currents of air, as well as from the entrance of any injurious matter into the cow.

Milk is thus a serous or albuminous fluid, in which a varying quantity of sugar, caseine, and mineral salts are dissolved and in which a varying quantity of fat or oil in the form of very minute globules are mechanically suspended in the manner of an emulsion (figure 25, *d*).

Fig. 25.

The sugar, caseine and fat are each of them the basis of a profitable manufacture; the sugar is separated and used in various ways as milk sugar; the caseine and fat are made into cheese, and the fat is gathered and made into butter. When left at rest for a time the fatty globules rise to the surface, together with some of adherent milk, by virtue of their lighter specific gravity, and controlled as to time by various conditions of the milk and the temperature, they form what we know as cream (figure 25, *e*). These fat globules were supposed to consist of a pellicle or film of caseine enclosing a granule of fat, as it is set free by the breaking down of the vesicles or *acini* of the glandular lobules of the udder. This supposition was held to be unreasonable and erroneous by the author, who opposed this view of it as supported by Professor Arnold, the eminent authority upon the science and practice of dairying, at a meeting of the American Dairymen's Association in 1872. Since then the inherent simplicity of the fat globule floating free in the milk as an emulsion, and without any coating or pellicle whatever, has been demonstrated by patient and painstaking investigation, microscopical and chemical, by the author, and by others, notably by the New York State Agricultural Experiment Station, and this view of it is now accepted by all American dairy experts. This true and reasonable view greatly simplifies the management of milk and the churning of cream, and clears up some difficulties and mistakes in regard to the behavior of cream in the churn.

The peculiar character of milk, being a direct product of the cellular substance and fat in the animal, gives much importance to the consideration of its uses as food, and of the proper treatment of the cow. Any disorder arising from bad food or water, or disease, directly affects the quality of the milk. This is conspicuously shown by the prevalent disease, so frequently fatal, known as milk sickness, which is induced in persons by the use of milk, cheese or butter from cows which have been exposed to the peculiar infection which produces this disorder. The common disease known as "aphtha," or "foot and mouth" disease, is communicated to persons by the milk of cows suffering from it; so is tuberculosis, anthrax, and other diseases of the blood. Milk even absorbs the germs of febrile diseases which are prevalent near the dairy, or to the infection of which it has been exposed; scarlet fever and typhoid fever have thus been spread widely through localities by the use of milk from a farm upon which cases of these diseases have occurred. This characteristic of milk is serious and so prevailing that the greatest caution in respect of it should be observed, both by dairymen and those persons who purchase milk.

The importance of the subject renders it desirable here to say a few words in regard to the common use of the lactometer for testing the quality of milk. The use of the lactometer, or rather the hydrometer or water measure, for testing milk is a delusion and a snare. This instrument is constructed for measuring the relative specific gravity of liquids, pure or distilled water, water at a temperature of sixty degrees being taken as the standard. The so-called lactometer or milk measure is in its very name a fraud and a delusion, because it does not in reality measure milk, but merely the water in it and the specific gravity of the fluid which shows the quantity of solids in solution or suspension in it. Milk is a complex fluid containing a certain proportion of water, mixed with an uncertain proportion of various salts, some caseine and some sugar which are heavier than water, and some fat and volatile oils which are lighter than water. Now, it is an utter impossibility for any measurer of specific gravity to ascertain what the true relative gravity or weight of a liquid should be when it contains every time a different quantity or proportion of each one of these added substances and each one differing somewhat in its own specific gravity. For instance, we take the milk of a poor cow, that will not show more than three or four per cent of cream, and "measure" it—as the term "lactometer" really means—and find that this instrument marks 1.030, which is considered to indicate an excellent quality of milk, and this because the milk contains the normal amount of other solids besides fat, and these are all heavier or of a greater specific gravity than the fat. Hence this poor milk would pass muster with the inspector. But if we take the milk of a Jersey or Guernsey cow with fifteen or twenty per cent of cream in it, and subject it to the lactometer, it may mark only 1.028, and it is an understood rule with milk inspectors that milk of so low a specific gravity as 1.028 is suspicious and subjects the seller to the pains and penalties of arrest, and, on conviction, fine and disgrace. A painful case occurred in the author's experience. A milk seller, misled by the popularity of Jersey cows, purchased some for use in his dairy, which was kept to supply milk for consumers in a large town. An inspector one day demanded a test of his milk and on finding it to mark only 1.028 he arrested the milkman and led him to the magistrate. The author was summoned to give testimony in regard to the quality of the milk and proved by actual test that some of it contained $16^1/_2$ per cent of cream, and that the mixture of this rich milk with the other milk reduced the gravity of the whole to this low average; but that the milk was actually richer than other kinds of a higher gravity. The court adjudged that the milk was not up to standard, as the inspector—a very ignorant man—swore that the lactometer was a reliable test of the quality. The justice (?), no better informed, convicted the innocent man, who was so affected by the injustice and the imputed crime, and the disgrace of it, that he gave up his business and in a few days after committed suicide. This is but one of several cases known to the author of convictions by the evidence of this unworthy, fraudulent, and false test and witness. The only reliable test of milk is a chemical analysis or such an examination as has been previously described.

CHAPTER XVI.

CREAM.

Cream is the fatty portion of the milk, which rises to the top when the milk stands at rest. The difference in the specific gravity of cream and milk necessarily causes this separation; indeed to some extent this separation is partially made in the reservoirs of the udder, for it is a well established fact that the first drawn milk is less rich in cream, or fat, than that drawn at the end of the milking. This has been shown in the previous chapter. The specific gravity of cream is about 1.020, that of milk with the cream about 1.030, that of milk without the cream 1.035, so that the difference in weight of an equal bulk of cream and milk is one and one-half per cent. This is sufficient to cause a very rapid rising or floating of the cream, were it not for some obstacles which prevent this separation. Milk is a viscous or adherent fluid, and consequently any lighter body immersed in it would have to resist this adhesive force in the act of rising to the surface. Again, the globules of fat in milk are extremely small, varying in size from $^1/_{4500}$ to $^1/_{2500}$ part of an inch in diameter, hence the force of gravity is very slight and is not sufficient to force them through an adhesive fluid except quite slowly.

The cream rises more rapidly under certain circumstances, as when the milk is set in deep pails in cold water at a temperature of forty-five degrees, when all the cream is raised through eighteen or twenty inches of milk in twelve hours; while at sixty degrees it will require thirty-six hours to rise completely through three inches of milk set in shallow pans. Also when the milk is diluted with water the cream rises more quickly, because the milk becomes less adherent. The low temperature of forty-five degrees reduces the milk to almost its maximum density, which is at thirty-nine degrees, hence the cream is comparatively lighter than at a higher temperature. This fact is taken advantage of in the use of the deep pails and low temperature for setting milk for cream, an innovation which has been of the greatest value in butter-making. The cream raised in this manner is, however, more fluid and has more milk mixed with it than that raised in shallow pans; but this is also an advantage, because it is then in the best condition in respect of fluidity for the churn.

Cream is simply the butter globules of the milk gathered into adherent masses (figure 52, Chapter XX.), together with a small quantity of the milk held by molecular attraction among and between the fat globules. Milk consists really of a colorless liquid in which are suspended an enormous number of minute globules. As has been stated in the previous chapter, some erroneous views have been held in regard to the character of these globules which constitute the fatty portion of the milk, and some discussion is still made by misinformed persons in support of the now exploded theory, that these globules are enclosed in a thin membrane of albuminous matter. It may be interesting to readers to know by what experiments the true nature of these globules may be demonstrated.

As milk is a serous viscous fluid, and adherent and adhesive, when air is forced into it it forms and produces a cohesive froth, consisting of small and large air bubbles. This is precisely the character of beer, or a solution of soap, gum, syrup, or any other mucilaginous or saccharine fluid. If a quantity of any of these fluids is warmed to the temperature of new milk, or 100°, and a small quantity of butter oil is added and thoroughly mixed with it, and the mixture is agitated, the oil soon separates into small globules, which, when viewed under a microscope, appear in every respect precisely similar to the butter globules in milk. This mixture is known as an emulsion, and similar mixtures are commonly used in medicine for the purpose of administering oils in a convenient and desirable form.

When such an emulsion is permitted to remain at rest the globules rise to the surface slowly and form a cream. The appearance of these globules under the microscope gives precisely the refractive rings around them which have been supposed by inexpert observers to be surrounding films, pellicles, coverings, or envelopes of caseous matter, enclosing the fat.

When these emulsions are churned at a temperature at which the fat is soft and non-adherent, the globules are beaten finer and finer as with cream in the churn under those conditions—to be explained hereafter—in which the butter will not come. When churned at the ordinary temperature of the dairy, the fat globules are gradually gathered into granules, then into small masses or grains, and finally form butter.

These results happen alike with milk and with artificial emulsions, of which the author has experimented with several kinds, viz., made with butter, oleomargarine, lard, cotton-seed oil and olive oil, and the behavior of each was precisely the same as that of the others. Moreover, the most patient and careful tests and examinations have all utterly failed to discover one of these envelopes, pellicles, shells, or whatever name has been given to the imaginary substance, isolated and separated from the globules.

The number of these globules contained in milk of average richness in butter is enormous, and they differ in this respect considerably with various cows, and as much in the size of the globules. Moreover, they differ in the same cow as regards size and number when any disturbing influence occurs to affect the nervous condition of the cow, or to excite or to tranquilize her. Thus in a cubic millimeter, or about the one-hundredth part of a quart, there are nearly 3,000,000 of these globules, thus giving about 300,000,000 of them in a quart of milk, or 5,000,000 in every cubic inch.

Cream varies greatly in character, and this variation has a most important bearing upon the business of a creamery, in which, necessarily, there are many kinds of cream gathered from the large number of patrons. The following analyses of creams gathered by Professor

Wanklyn from different cows show a most remarkable and important variation.

Per Cent of	*Water.*	*Sugar, Ash, and Caseine*	*Fat.*
Sample 1	72.20	8.80	19.0
Sample 2	71.20	14.70	14.1
Sample 3	66.36	14.77	18.87
Sample 4	60.17	6.81	23.02
Sample 5	53 62	8.21	38.17
Sample 6	50.00	5.63	43.91

The result of such a difference as this, and it is by no means an uncommon occurrence, is of the highest interest to dairymen selling cream to the creameries by the inch or quart. For if one inch of No. 2 gives a pound of butter an inch of No. 4 would give two to five ounces, and an inch of No. 6 would give over three pounds. If No. 6 gives a pound of butter per inch, No. 2 would give less than six ounces. Either the patron would lose or gain as his cream might be richer or poorer, and the creamery would be subject to the same risk in an inverse ratio. In any case there would be great loss and injustice to some persons concerned. This uncertainty is to some extent avoided by the use of what is known as the "oil test," to be explained hereafter (Chapter XIX).

The methods of separating the cream from the milk are three in number, viz., the deep pail system, the shallow pan system, and the centrifugal creamer. The deep pail system is derived from the method which has been common in Sweden for many years, and which is there known as the Schwartz method. It is based on the fact that the rapid cooling of the milk to a low temperature and the maintenance of this temperature causes the entire separation of the cream in a few hours; the lower the temperature the more rapid being the separation. There are several kinds of apparatus in use adapted for this system which will be described more fully in a succeeding chapter. The use of water from a permanently cold spring or of ice is necessary under this system. The use of this method of raising cream is rapidly extending and is indispensable in the management of a public creamery.

The shallow pan system is the most used, and is practically universal in private farm dairies; it has the advantages of convenience and simplicity, and under the best conditions of practice is quite as effective in every way as the deep pail system. No water or cooling is required, but some method of heating is desirable in the winter. An airy, dry, deep cellar with thick walls, and well-constructed, as hereafter explained, furnishes every desirable or requisite condition for raising the cream under this simple system.

The centrifuge is a comparatively new introduction in the business of dairying, but its value and adaptation for the economical and effective working of dairies large or small are boundless. This useful machine operates on the principle that centrifugal force in a confined vessel, properly constructed, will throw the denser and heavier particles of a fluid to the outer circumference, and thus compel the lighter particles to seek the center. It is really the adaptation of the principle of gravity to a horizontal position, compelling the lighter particles to rise to the top and the heavier ones to sink to the bottom, so to speak, by the exercise of this force exerted horizontally instead of perpendicularly. Like all other operations of natural dynamic laws it is exceedingly simple—when it is understood.

In considering the nature of cream the cause of its varying yellow color is worthy of some thought. Why is cream yellow, and more deeply yellow in some cows than in others? The author has given much study to this interesting question, and with the following result. Yellow is a diluted red, or at least red is a concentrated yellow. Yellow pigments, when concentrated, always appear to be red. Annatto in its solid state is red, but its weak solution is yellow; the common gamboge is another instance of this. All butter-coloring preparations, whether prepared from annatto, gamboge, or the petals of various flowers, are red, but give a yellow color to the butter. The fat globules are derived directly from the blood, which is red, and in some conditions of the cow the milk is distinctly red. The color of the cream from colostrum is a deep reddish orange, and some butter from Guernsey cows has quite as deep an orange color under normal circumstances as the colostrum of other cows. Some butter made from the cream of colostrum of a Jersey cow in the author's dairy, whose butter has been always of a deep yellow color, was distinctly reddish. Is not this reddish tinge, and the deep yellow approaching the red, then directly derived from the coloring matter of the blood, the hematine from which the blood derives its red corpuscles? As this appears to be the case, it explains why the color of cream or the fat in the milk is a special attribute of each particular cow, and why some cows always produce deep yellow butter upon the same food which yields in other cows butter which is almost free from color and is nearly white.

CHAPTER XVII.

MILKING AND MILKING APPARATUS.

The operation of milking is necessarily based upon the peculiar construction of the udder and teats. It is intended to draw the milk from the udder by the force of pressure rightly directed, and compel the natural flow of the milk from the secreting lobules into the ducts and reservoirs to refill the reservoirs after the pressure has been removed. In the act of suction the calf exerts this required pressure to force the milk from the teat and intermits this pressure by intervals of rest. Thus the milk is drawn by a series of pulsations in much the same mechanical way as a water-ram forces water through pipes. A study of the structure of the udder and teat, with the various reservoirs and ducts leading to these, will easily enable the intelligent dairyman to perform this operation in the required manner.

The milk reservoir at the base of the teat is first to be emptied by forcing the milk from it downwards through the orifice of the teat. This is done by clasping the teat close up to the udder in the hand, between the folded forefinger and thumb. These are then drawn tightly together, and the pressure of these upon the upper part of the teat is followed by that from the other fingers in succession, so as to make a following pressure from above downwards. The motion of the fingers is consecutive and not simultaneous; acting in effect as if a set of rollers or cams pressed upon the teat from base to extremity. This method is indispensable for emptying the teat, for if all the fingers are closed at one time the ducts in the teat and the orifice from it are closed and the milk will be forced upwards into the udder. It is also the most rapid and effective way to empty the udder, for it forces the milk from the largest reservoir at one act and movement, and when the pressure is released the expansion of this reservoir by the elasticity of its fibrous walls produces a vacuum, into which the milk is forced instantly by the pressure of air upon the udder. Thus the action is similar to that of a force-pump, which alternately forces out and draws in a stream, the first by mechanical pressure upon the water and the second by creating a vacuum which is immediately filled by atmospheric pressure, and the motion by which the stream is forced out produces the vacuum and sets in action the pressure of the air. This rapid milking is very important, as it affects the yield of milk considerably. It has been shown that the milk is produced by a breaking down and decomposition of the cells of the glandular tissue, which are in a condition of engorgement by reason of the excited circulation of blood, and the formation of tissue for this large accession of blood through the arteries and capillary vessels. Whatever will tend to excite this activity of the glandular substance will necessarily increase the flow of milk. The rapid pressure, gently and pleasantly performed upon the udder in the act of milking, and the continuous pulsations following each movement of the hands, tend to excite the circulation in the udder and increase the formation of cells with the fat granules contained in them, and as these must necessarily break down as fast as they are formed, to prevent tumefaction of the glands, the production of milk is the most rapid at this time and during the act of milking. There can be little doubt that the milk is thus made very rapidly while the milking is going on, and the more rapidly the milking is performed the more the glands are excited to action and the consequent secretion of milk is effected. In fact, a cow which yields from twenty-four to forty pounds of milk, as some do, at one milking, must necessarily secrete a large portion of this during the process of milking. The "giving down" of the milk, as the popular expression has it, is a physiological and actual fact, and if so the converse of it, the "holding up of the milk," must be equally a fact.

Hence the milking must be performed in the most effective and gentle manner; in such a way as to avoid nervous resistance on the part of the cow and secure the necessary excitation of the udder. When the milker seizes upon the lower part of the teat and simply presses the milk out of this, without exerting any pressure upon the milk reservoir, shown in the engraving (figure 25) in Chapter XV., the milking must be much slower and the excitation of the glands much less active. Thus the rapid milker will always get the most milk.

Not every cow has teats of the most convenient size and shape for this purpose, consequently there must be different methods of milking. By taking hold of part of the udder above the teat and where the large sinus—or milk reservoir—is situated, a person with a small hand may milk a cow with very short teats, at least two inches in length, without difficulty. With cows of this kind—and many of the best Ayrshire cows have this defect—some practice is necessary to make one an adept in milking. But from practice the author knows it to be not only possible but easily acquired with a little patience, except by persons with large broad hands. Even then it is easy to milk such cows by using the upper joint of the thumb bent down, as a support for the teat, instead of the palm of the hand, and then clasping the fingers around the teat and pressing it against the bent thumb, the very same kind of pressure can be exerted upon the teat and udder. This method also rests the hand, when, in milking cows with short teats, the wrist becomes wearied. The common method of stripping by means of the forefinger and thumb, drawn down the teat, is also a rest for the wrist, and may be used for milking short teats; but in this manner of milking cows the teat should be stripped from the extreme top to the bottom, and the part of the udder where the largest milk reservoir is situated should be taken in and stripped. The milk is then drawn from this part and the perfect operation is performed. The condition of the cow's nervous system is a large element in the effective milking, for the product of milk is greatly dependent upon nervous action, and no doubt the abundant nerves with which all parts of the udder are furnished must have an important effect in controlling the action of the glandular tissue. Every dairyman knows how much those disturbing conditions of the cow which result from changes in the regular course of management, in any irritation, act of fear or fright, worry, pain, anger, and unusual exercise, affect the yield of milk and also of cream. This decrease of yield is unquestionably due to the effect of these changes upon the nervous system of the cow, and this is very great at times. In the author's dairy the cows have been always apportioned regularly to the different milkers, and the variations in the yield of milk have been very slight, except when some changes have occurred to disturb the cow. When an unfamiliar attendant fed and handled the cows, or a stranger did the milking, or the feeding was late and the cows—excellent timekeepers—were bawling for their morning meal, and especially when a fresh hand, unaccustomed to the cows and they to him, beat an animal (this should be an unpardonable offence in every dairy) to compel it to obey unusual orders, then there was always more or less falling off in the milk of that day and part of the next. Therefore the dairyman must take this fact into account and avoid every disturbance of the cow in the manner or time of milking as well as in other respects.

The periods of milking should be at intervals of twelve hours as nearly as may be. This is most convenient, as it gives ample time for all those accessory operations which come in between. It has been stated by some rather visionary, and certainly impracticable and inexperienced, writers upon dairy subjects, that a larger quantity of milk, and especially of cream, can be procured from cows by making more frequent milkings, at eight or six hour intervals for instance. As the matter of convenience is always subject to a question of profit, if this statement were true it would be important. But it is wholly untrue and misleading, being based no doubt, theoretically, upon the fact above mentioned, viz., that the production of milk is excited during the act of milking. But if this excitation of the glands by the act of milking could be made continuous, and one should be always milking, it might be supposed more milk would be procured than by separate milkings. But this would be a wholly mistaken calculation, for the too frequent milking of a cow will tend to lessen the product of milk and a cow may be dried off in this way, the too copious secretion tending to exhaust the action of the glands by injurious reaction. The glands need a period of rest, as all active and nervous tissue does, to recuperate and gain resources for renewed action. Some persons think this is a new thing altogether; but there is nothing new under the sun, and this is as old as a century at least. For in the old magazine entitled "Annals of Agriculture," for 1789, the following statement was given of a trial of this kind with two, three, and four milkings in the day:

MAY 21, 1789.	*Pints.*	OCTOBER 22, 1789.	*Pints.*
First milking	9½	First milking	11
Second milking	13	Second milking	6
Total	22½	Total	17
MAY 22.		OCTOBER 23.	
First milking	13	First milking	11
Second milking	8	Second milking	3
Third milking	5	Third milking	3
Total	26	Total	17
MAY 28.		OCTOBER 24.	
First milking	12	First milking	10
Second milking	7	Second milking	1½
Third milking	6	Third milking	1½
Fourth milking	1	Fourth milking	3
Total	26	Total	16

Certainly this proves nothing, or, if anything, that there was a loss as well as a gain, and the long night's interval is never taken into account. If a little more milk was thus gained from the cow, more feed must be given, and the labor required would make the practice too costly or wholly impossible in a business dairy.

True, there are some cows of such phenomenal productiveness that more frequent milking than twice a day is necessary. But the above remarks apply to such average cows as are found in most dairies.

In regard to another delusion, skimming the cream at short intervals, which has been claimed to increase the yield, the author has spent six months at one time consecutively in his dairy in making all these experiments, but never got more butter out of the milk by many skimmings than was in it, and with the usual skimming at the end of thirty-six hours in shallow pans, or twenty-four hours in deep pails, the skimmed milk never showed a trace of cream which would have repaid the labor of collecting it.

The manner of milking should be systematic. It should be cleanly, rapid and complete. A good system

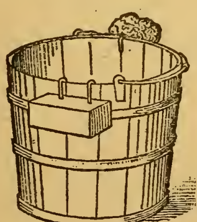

Fig. 26.—A DAIRY PAIL.

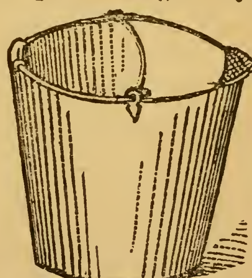

Fig. 27.—MILKING PAIL.

of milking is as follows. The cows should be kept in a contented and quiet condition during the milking. Previously, they should have been thoroughly cleaned by carding and brushing, and the stable floor should be made clean for the milkers. The milkers should be clean and their clothes free from dust. A quick brush with a broom-corn whisk will quickly remove any adhering matter from the clothing. The milking furniture should include a hand wash-basin, water, soap and towel, always to be used by the milker before he begins his work. A pail of water with a box hooked on to one side for cloths and a towel, and a sponge on the other (figure 26), has been found very convenient for cleansing and wiping off the udders and teats, which is absolutely indispensable for getting clean milk. The milker is provided with a small low three-legged stool, with a hand hole in the seat to lift it by. The best pail is a tin one, made of heavy double plate, and having a zinc or galvanized iron ring around the bottom. The top of the pail is about half covered with a slightly rounded cover, to exclude dust, and has a strainer lip on the top. This is covered by a hinged lid not shown in the engraving (figure 27), but very useful to prevent dust or hairs, at the shedding season, from falling upon the strainer. A strainer of this kind is easily reached by a sponge or cloth on a stiff brush, which is the best thing to clean dairy utensils with. Thus provided, the milker begins his work.

The process is as follows: The milk secreted by the glands gradually fills the ducts from the smallest to the largest, the latter being situated at the lower part of the udder and having for their outlets the teats. The duct of the teat, when filled, has considerable capacity. When the teat is gently squeezed from the top to the bottom, the contents are forced out in a stream, and when the pressure is relieved the duct is instantly filled again, not only by the force of gravity, but also by the pressure of the distended membranes of the udder and by the atmospheric pressure as well, because when the teat is emptied and released from the squeezing of the milker's hand, the elastic tube takes its original form, and an air vacuum is formed in the passage, or would be, if the milk were kept back; this, however, rushes in and fills the space. The pressure should be from top to bottom of the teat, and should be made without dragging on it. To pull down the teat, as in stripping, so-called, between the fingers, is to be avoided, unless as a rest for a short time, or for a good reason. The teat should be taken in the hand from the top and squeezed with a firm, even motion. One may force the milk in a contrary direction, and from the teat to the udder by bad milking, and many cows are injured by this faulty action in careless or ignorant milkers. When the udder is completely filled, the pressure of the distended membrane is very great. Sometimes this pressure overcomes the elasticity of the annular or ring-like membrane which closes the opening of the teat, and the cow leaks milk.

If it were not for this outlet the cow would suffer; because when the distension of the udder is at a maximum, the pressure then affects the ultimate gland cells, which are highly nervous, and causes pain; it further affects the circulatory apparatus, and causes engorgement; the blood in these fine vessels cannot then unload its burden of milk, and this is returned into the circulation, with the effect to load the blood with abnormal and therefore diseased matter. From this it will be readily seen that some cows should be relieved of their milk more than once in twelve hours, and that once in eight hours would be better and safer, and would be more productive of milk; and further, it will be seen how much mischief may result from leaving in the udder a portion of the milk not drawn off, or of drawing it in an improper manner. The udder should be completely emptied of milk at each milking. The cow should not be disturbed during milking, and no person but the milkers should be present.

The best time for milking is either immediately before or after feeding. To milk while feeding is troublesome and annoying. No singing or droning should be permitted, but to speak to the cow in a gentle, petting manner would not be objectionable. Constant watch should be kept against any movement of the cow's leg or foot which might upset the pail, and if such should happen accidentally, the cow should not be punished for it. Milking should be made a business; there should be no fuss, no noise; it should be done quietly and quickly. If a cow is vicious, she should be punished. A cut with a raw-hide, kept purposely, will be the most effective, and if but one blow is given the cow will be disciplined and not enraged, as by repeated brutal beatings for revenge. Punishment for cause only, and that prompt, sharp, decisive and summary, is needed at times, especially with some young cows, but a cow should never be beaten and never kicked, or struck about the head or face.

Sometimes it is necessary to draw the milk artificially; this is done by means of a silver tube (figure 28) inserted

Fig. 28.—MILKING TUBE.

into the udder. The tub is shown its exact size. It is oiled and carefully inserted in the teat, and in case of garget or wounded udder or teat, it is left in continuously, so that the milk runs off as it is secreted. The slide regulates the depth to which the tube is inserted. But these tubes should only be used when thus required. They cannot safely be used for regular milking as a substitute for the hand. Efforts to introduce them for that purpose have been costly failures; but for use under special circumstances, as when the teats and udder are affected by cow-pox and covered with pustules which must not be broken, or in cases of injury to the teat, they are indispensable, and a set should always be kept in reserve.

As the milk is drawn from each cow it should be weighed, and the weight of the pail being deducted, the quantity of milk should be marked on a tablet hung up on the wall behind the cow. This is greatly to be advised in every business dairy, as it gives an indication that everything is going on right, or that something is wrong which requires attention. This method should commend itself to every business dairyman. There are sometimes troubles occurring even in the best regulated dairy.

The principal difficulties in milking consist of holding up the milk, hard milking, leaking of the milk, and spattering of the milk. The first is the most troublesome, because it is a sort of intangible matter, arising out of the wilfulness of the cow, which is very difficult to deal with. It is usually first noticed at the time when the calf has been taken from the cow after having been permitted to suck. In the author's dairy not a single calf has ever been allowed to suck its dam, and the cows that have been thus trained from birth have never exhibited any desire to let their calves suck. The cow is removed, a few days before her time is expired, to a secluded building, where there are all the necessary conveniences provided for her safety and comfort, in a roomy, loose stall. Here she is closely watched, and when the calf is soon expected, attention is given so that, as soon as the cow has dried it, the calf is picked up and carried away to a pen out of sight and hearing of the cow. The cow is then fastened up by her neck-strap to a ring in the trough, in the usual manner, for reasons that need not be particularized. A slop of scalded bran is then given warm to the cow and she is left alone for several hours. By that time she has become quiet and her nervousness has gone. The pail is then brought in, and she is milked. If she should try to hold up her milk for the calf no harm is done at this time, because the flow of milk has not come; but it has never occurred to the writer, in many years' experience with cows, that a heifer with her first calf, and that has not herself sucked her dam, has ever refused to let her milk down at the first milking, so that it is pretty certain that a habit of holding up the milk, which some cows occasionally have, is due at first to want of proper training. But it is easier to point out a reason for any thing than to give a remedy; and a remedy for this difficulty is not always to be found, although many have been suggested by persons who have found them effective in their own cases.

The most popular remedy is to lay a weight across the loins, such as a heavy chain or a bag with sand in it. There is some rational plausibility in the remedy, for the following reasons :—The nerves which control the whole muscular system of the hind-quarters, and the digestive, urinary, generative and lacteal organs and their functions, proceed from the spinal marrow near the lumbar regions. A pressure, then, upon the loins will necessarily have some effect upon this portion of the nervous system, and may quite possibly interfere with the ability of the cow to control the voluntary muscles of the udder. If one will carefully note the action of a cow holding up her milk, he will be able to observe how she will draw up the udder in such a way as to contract the outlets of the milk ducts. If, then, by any means the cow can be prevented from exercising the power to interfere with the flow of milk, her attempt can be counteracted.

Another remedy is to distract the attention of the cow from her milking by some enticing food, and it is frequently found that to give her a pailful of warm bran or meal slop when she is to be milked will induce her to let the milk flow. But the most effective method of overcoming the cow is to use the milking tubes. These, when inserted into the teats, pass into the large milk reservoir above the base of the teat and draw off the milk in spite of the cow's efforts to retain it. It has also been found effective to refrain from milking the cow until the udder has become painful from the retention of the milk, when she is very willing to be relieved.

Patience is also a virtue in this respect, and if the milker will stay and tire out the cow, waiting and continuing to rub the udder and draw upon the teats for a considerable time, the milk will come in the end. But one should never lose his temper or become impatient in such a case as this. To irritate the cow will make matters worse. A cow that exhibits affection and regard for her owner will rarely give any trouble in this or any other way, and it is a case in which it will be found very convenient to be on friendly terms with the animal, as, indeed, every owner of a cow ought to be.

A hard milker is usually a good cow, and should be treated patiently. This difficulty arises from a stricture of the sphincter muscle or a want of capacity of the duct of the teat. Either of these can only be remedied by mechanical means. The insertion of a silver milking tube into the teat after milking, the tube being closed at the bottom by a piece of cork or India rubber, will have the

Fig. 29.—PLUG FOR CONTRACTED TEAT.

effect of stretching the membrane and enlarging the orifice, by giving a new set to the muscles of the teat or to the sphincter muscle at the base of the teat; or a piece of whalebone may be filed into a proper shape, as shown in the illustration, both to enlarge the duct and to be retained in its place, without danger at the same time of penetrating too far so that it cannot be withdrawn. The form shown in the illustration (figure 29) provides for all these. Whalebone is to be preferred because it is hard, smooth, elastic and cannot be broken. It should be well oiled with sweet oil before it is inserted into the teat.

Leaking of the milk is caused by the exact reverse of that which produces hard milking. It is doubtful if any permanent remedy can be found for it. A temporary preventive, and one not at all difficult of application, is to smear the teats of a leaking cow with photographers' collodion as soon as she is milked. A bottle of collodion may be kept in the barn (always well corked or it will evaporate very soon), and a small quantity may be rubbed over the teat and on the end of it with the finger. The collodion contracts considerably as the chloroform evaporates from it and practically forms a tight bandage around the teat, which compresses the duct. When, as is sometimes the case, a cow will lose two or three quarts of milk a day, it may pay to use this remedy. A rubber band around the teat has been suggested, but it is not to be recommended, as it would obstruct the circulation and cause trouble.

Spattering of the milk is produced by a ragged edge of the skin at the extremity of the duct of the teat. When it is permanent it will require for its removal the insertion of a short plug having the form shown at figure 29, by which the extremity of the orifice will be brought into more even shape. But generally the use of a piece of smooth pumice-stone, rubbed gently upon the edge of the teat before and after milking, will remove the loose scales of the skin which cause the trouble. When the stream of milk is diverted from its course and broken in the manner referred to, it may often remedy the trouble to clear the end of the teat with the finger-nail, by which any loose scale of skin will be removed. The skin is changed in its natural manner by the flaking off of minute scales or shreds, and as these are worn off or fall off new skin appears under them. It is this continual reparation of the skin tissue which is the cause of the spattering, and when the cause is known the remedy becomes very simple. If the pumice-stone or finger-nail does not effect a remedy, the difficulty may be removed by applying a little wet carbonate of soda or saleratus to the end of the teat and rubbing it a minute ; this will dissolve the scale and cause its removal.

Kicking cows make serious trouble in a dairy, but a good cow should never be discarded on this account, for the trouble may be cured. Kindness and patience, by which the confidence and affection of the cow are secured, often effect

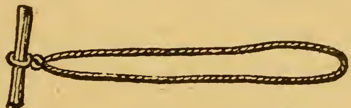

Fig. 30.—TIE FOR KICKING COW.

a permanent cure in cases where the fault has been produced by cruelty and bad management. Sometimes kindness is not effective, as where a cow is suffering from sore teats, when she cannot be blamed for kicking. Then it is necessary to tie the leg in a very simple manner. It is done by the use of a fastening common in Irish and Scotch dairies, and known as a spancel. It consists of a loop of cord about as thick as a common clothes-line, and about twenty inches in length, having a cross stick fastened at one end. This is shown at figure 30. It is used as follows : One end is looped around one of the

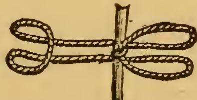

Fig. 31.—TIE FOR KICKING COW, AS USED.

cow's legs just above the ankle, and the end with the cross stick is carried around the other leg and the cross stick is passed through the doubled cord, as shown at figure 31. The cow cannot lift her leg to kick, and the band is very quickly and easily applied and taken off. Such a fastening should be kept in every cow stable to be ready in case of accident, for the quietest cow may kick and upset a pail of milk when the teats are cracked and sore in cold weather, or scratched by briers when at pasture, or when they are tender after calving. Under such circumstances, and with young heifers having tender udders at the first milking, the author has used this fastening with the most satisfactory effect.

The principal troubles with milk are, loss of quantity, ropiness, mixture with blood, a bitter flavor, foaming in the churn, difficulty of churning, and white specks in the butter. Most of these come from without the cow and are avoidable. One cow may be constitutionally delicate and more subject to ailments than another more robust, and if she is very defective in this respect, she is poor property and should be got rid of as soon as possible. There are some cows that are constitutionally scrofulous and subject to tuberculosis and other similar diseases, such as softening of the bones and suppuration of the milk glands. Cows so diseased are easily distinguished by their thin, white skin, the bloodless appearance of the membranes of the eyes, and the occurrence of nodules and swellings about the udder, the joints and the head. The milk of such cows is usually thin, bluish in color and frequently mixed with strings of ropy or tenacious fibrous matter which comes from the teats without any other appearance of disorder, and may not be detected in the milk until this comes to be strained. But healthy cows need never cause any trouble in regard to the milk if they are properly cared for. If anything is wrong, the cause may always be found in the manner in which the cow is treated—either the food is suddenly changed; or it is deficient in quantity or quality; or it is not rightly prepared; or the cow's health is suffering from some accidental cause, as exposure to heat or cold, or storms, or some sudden change which interferes with the circulatory system; or she has been chased by dogs, or roughly handled by her companions or her keeper. Something that might have been avoided has happened to produce the trouble.

For instance, when the milk falls off in quantity, the first thing to suspect is something in the feeding or the watering. A cow will often fall off in milk when changed from dry feed in the spring, too suddenly or abruptly, to grass. The grass acts upon the bowels as a laxative and diuretic, and, in stimulating other organs, interferes with the secretion of milk by changing the currents of the circulation. It may not follow that a change from moderately good to more stimulating food will always produce an increase in the milk ; if too suddenly made, the change may easily reduce the flow of milk for a time. In the same way the increased feeding will often so stimulate the milk organs as to cause them to pass blood into the milk ducts unchanged, instead of elaborating it into glandular cells which produce the milk, and then the milk is mixed with blood. This result may also occur from any undue excitement of the circulation of the udder, such as excessive exercise in running ; or from bruising or pressure when a cow lies upon a well-filled udder; or from contact of the udder with damp or wet ground at any time, or with a cold floor in the winter.

The careful owner of a cow should always consider that the udder is a highly nervous and vascular organ, provided with a very finely diffused circulatory and secretive apparatus, and that a slight injury may have a very serious effect upon it. It has been explained that the cell structure of the milk glands is itself the source from which the milk is derived, and that these cells are replenished from the arterial blood conveyed to and distributed through the udder. When, therefore, it is considered that in a cow giving thirty pounds of milk in twenty-four hours all this quantity is actually produced by the twofold change of blood into cells and of cells into milk and cream, the activity of the organ which performs this enormous work must indeed be wonderful ; and it should not be surprising that an apparently insignificant circumstance may produce some unexpected and serious results. Bearing this in mind, one who keeps a cow should ever be watchful and cautious against the least variation of treatment that may so easily affect the condition of the milk.

Ropy, bitter, or acid milk, the latter producing specks of curd in the butter, may be and usually are caused by ill-health in the cow, by which the condition of the blood is affected. The milk in its normal, healthful condition is slightly alkaline ; but when the blood is out of condition its alkalinity may be much increased, or the milk may be acid. In one case only, however, have I found ropy milk excessively alkaline ; in every other case in which I have tested such milk it has been distinctly acid, and has sometimes showed, by the test of litmus paper, a high degree of acidity and has become very soon completely curdled ; the long, fibrous clots, placed under the microscope, appear simply as curd formed in the ducts and molded by them into the stringy pieces which pass through the teat into the milk. This ropy or stringy matter is easily dissolved in a solution of carbonate of soda or potash, and would therefore seem to be caused by acidity. The white specks which often appear in the butter are due to a similar cause, and are merely particles of curd or cheesy matter which are formed in the milk and adhere to the cream, and are carried up and mingled with it, and so go with it into the churn. In this case they are only partially removed by the most careful washing, and the butter is unavoidably injured by them.

The best remedy for all these troubles with the milk is to administer one pound of sulphate of soda (Glauber salts) or of sulphate of magnesia (Epsom salts), dissolved in warm water, by means of a common drenching horn ; and after this has operated, a daily dose of one ounce of hyposulphite of soda may be given with benefit, for two weeks, so as to effectually free the system from all acidity. This salt is a most valuable medicine in the dairy on account of its antiseptic and alterative properties, and a pound or two of it may be beneficially kept for use. It is readily taken when powdered and sprinkled over a mess of scalded bran or some cut feed, and it will be found useful in all these cases of trouble with milk. The improper behavior of milk in the churn is due altogether to the after management of the milk, and requires special consideration.

CHAPTER XVIII.

THE CARE OF MILK.

THE proper management of milk includes its disposal from the time it is drawn from the cow up to the time it is skimmed and put to the best practical use under the special circumstances of each case. The first of these various operations is straining it after it is milked. This is done with the greatest care to keep out any specks of dust, or accidental hairs that may fall from the cow. It should be poured through at least two wire gauze strainers, besides that in the milk pail, and through a fine muslin cloth doubled as well. This straining will certainly stop even a small hair going endwise, which it can scarcely do through all these strainers. But while the use of the strainers is imperative, the thorough cleansing of them should not be neglected, lest by any chance a remnant of milk may stay upon them and become sour, and act as a pernicious ferment upon other milk. The effect of a particle of dried sour milk or curd upon any utensil has been carefully explained in

Chapter XV. as a constant threatening danger in the dairy, and is to be most carefully avoided.

When the milk has been strained in the stable and before it leaves there, it is carried to the milk-house for setting for cream. The method of setting varies according to the system practiced. By the use of the centrifugal cream separator, and the immediate use of the

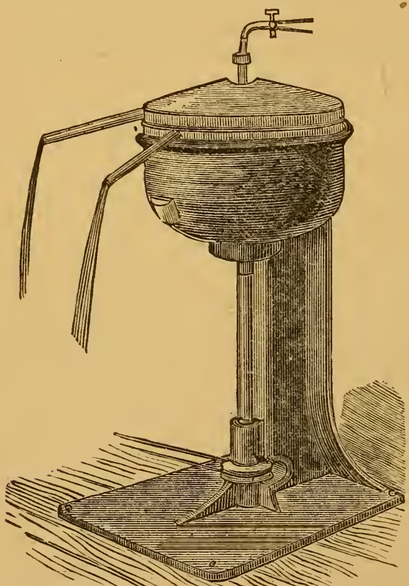

Fig. 32.—THE "CENTRIFUGAL CREAMER."

skimmed milk, nothing more is required than an apartment for ripening, or really souring, the cream to fit it for churning. This invaluable machine for the butter dairy deserves a few words of description. It is the invention of a Swede. It is known as the "Centrifugal Creamer," and is intended to remove the cream by mechanical means—centrifugal force, in fact—to take the cream from the new milk, and thus avoid the necessity of setting the milk at all, whether in pans or in deep cans, with all the trouble, time and cost incident to that so far necessary and risky process. Herewith we give engravings of this new dairy machine, which promises to make a revolution in our dairy practice (figure 32). It was first exhibited at the great English dairy fair, at Kilburn, where it obtained a silver medal, and at Haarlem the Agricultural Society awarded it a silver-gilt medal. Its inventor claims for it the following advantages: The cream can be separated from the milk as soon as it is drawn from the cow and aired; the use of ice is unnecessary; there is no setting of milk for the cream to rise; *all the cream* is taken from the milk, and the production of butter is consequently increased; the skimmed milk is perfectly fresh, and may be used at once for any desired purpose, without loss of sweetness; the quality of the butter is improved, as the cream is separated in a perfectly pure condition; the process is easy and simple; the machine is easily cleaned; lastly, the separation of cream may go on continuously so long as fresh milk is poured in and the skimmed drawn out. The operation depends upon the principle, that in a rapidly revolving vessel the heavier contents are forced, by the action of their weight, to the outside, while the lighter gather in the center. The work is done as follows: The receiver, which is made of steel, and is supported by a vertical axis turned by a pulley 6,000 in a minute, is filled with milk, by means of a funnel, which passes into the chamber, through the central column (figure 33, *a*, which shows its interior arrrangement). The rapid rotary action immediately begins to separate the heavy milk from the light cream, and in a short time the outer layers of milk are completely separated. As the fresh milk is poured in, this separated milk is forced by it into the tube, *b*, and arrives through it into the chamber, *B*, from which it escapes by a pipe. The cream in the center being continually augmented by the process of separation is raised by the entering milk into the tube, *c*, and passing by the tube, *f*, into the chamber, *C*, escapes by another pipe into proper receptacles; thus the process continues, so long as any milk is introduced. It should follow that as water is heavier than the cream,

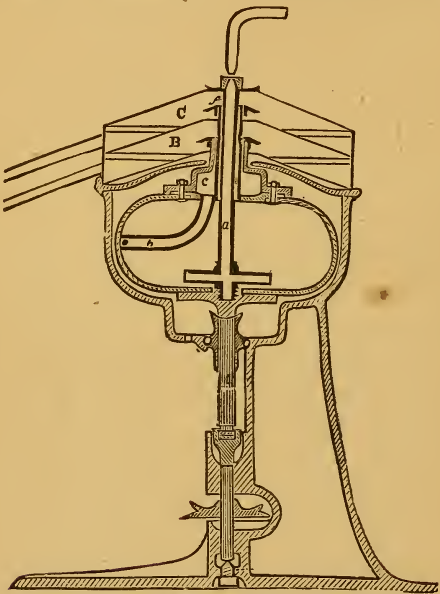

Fig. 33.—"CREAMER" SEEN IN SECTION.

if a quantity of it should be introduced when the milk is all in, the cream remaining may be separated to the last drop, until the milk, too, is exhausted, when a stream of water passed through for a time will cleanse the machine perfectly.

Improved forms of this machine are now made, some of them of small size to be operated by hand, instead of about two-horse power, which the large machine requires, and is thus brought into convenient practical use for small dairies where no more than ten or twenty cows are kept. Cream is lighter than milk, and according to the rules of gravity the former will rise through and float upon the latter. But there are some conditions which control and regulate this movement. The relative densities of the two fluids are changed by differences of temperature. Warm milk is lighter for the same bulk than cold, because cold condenses it; and a cubic foot or a measured gallon of milk at forty-five degrees is heavier than the same bulk at sixty-five degrees. But the gravity of the cream is not changed to so great an extent as that of the milk is, and the cream becomes relatively lighter under these circumstances, and consequently rises to the surface more rapidly. This is the principle upon which the Swedish dairymen have practiced their deep pail and cold water system of setting milk; and this system has been adopted by American dairymen with much success. It may be applied to either deep or shallow pans, or to the earthen pans, a sort of intermediate compromise between the two, in common use in the Eastern Pennsylvania dairies, and also in Holland. In these dairies running spring water is used for cooling the milk, but the temperature is not below fifty-five or sixty degrees in summer, and the earthen pans are not over eight inches deep. It is necessary to use pans of this or even less depths when the temperature is not less than sixty degrees, because otherwise the cream would not have time to rise before the milk became sour and thick. But in the twenty-inch deep pails set in ice-water at a temperature of forty-five degrees the milk will remain sweet for seventy-two hours, and all the cream will rise in twelve hours. But this rapid separation of the cream has another effect which should be mentioned, and this is that as the cream rises it carries with it by attraction and between the globular particles a considerable quantity of the milk, so that in a deep pail, containing twenty inches of milk, and having five inches of cream, so-called, upon the upper part of it, at least one-half of this cream is milk; while in a shallow pan containing four inches of milk, upon which only half an inch of cream has risen, this cream is pure and contains no milk. But this solid cream has been slowly rising through four inches of milk during thirty-six hours, while the five inches have risen in twelve hours through twenty inches of milk, and this rapid motion is the cause of the large admixture of milk with the cream.

There is a common opinion among dairymen that contact with air is necessary during the rising of the cream. This is a mistake. It is true that new milk from some cows contains a highly volatile odor, to which the name "animal odor" has been given. It is a gratuitous assumption, in our opinion, that this is a true animal odor; on the contrary, it is an odor of uncleanness, either in the cow, the food, or water, or in the manner of milking. There are cows from whose milk no odor of the kind is to be perceived, and none but the sweetest, and there are other cows whose odor is so powerful and persistent that it remains in the butter and cannot be got rid of. Truly, the cow may bear the blame in this that belongs of right to her keeper, and doubtless the cow does so to a great extent. But as this odor may in some cases pass off rapidly, it is well that the milk should be exposed superficially to a current of pure air, and the more moist this is the better, for moisture dissolves this odorous gas. In the method known as the "Cooley" system the milk is set in deep pails, which are covered with inverted flaring-edged pans, held down by cross-bars of wood, and submerged in ice-cold water. It may, and does to many, seem at first sight that this is equivalent to using closely covered pans or pails for setting milk; and it would be so, were it not that water has more affinity for odors, and absorbs them more rapidly, than any other liquid, and this peculiarity of water is turned to account in this method. For the covers of the pails are so made and fitted that the vapors which rise from the warm milk are condensed upon the inner surface of the pan, which is purposely made slightly conical, and the condensed liquid flows down to the edge of the pan and mixes with the water, and is absorbed. The cold water, therefore, becomes a purifying as well as a cooling agent, and on this account this system has been so successfully used in dairies that many winners of dairy prizes have gained them through the use of Cooley creameries. This is the only system in use which practices total submersion of the milk, and this chief principle of it is a special claim to superiority, and the patent is based upon it as one of its fundamental principles. This close covering of the milk, therefore, should not be considered as a proof that airing is unnecessary, because a very perfect substitute for this is provided, combined with many other important conveniences and advantages.

There are other methods of setting milk in cold closets, but they are all based on the fact that the low temperature causes a rapid separation of the cream. It is also a necessary consequence that the cream is considerably mixed with milk and quite fluid. This, however, is an advantage of this system, for the cream is taken off in precisely the best condition for churning, and no milk need be added to it before it goes into the churn. This secures constant regularity in the churning and evenness in the quality, and is an example of the great advance in the practice of dairying that has been secured by the use of ice, which makes perfect uniformity possible.

The practice which is common in many creameries and dairies of setting the milk in deep pails in pools of ice-water, where they float with the tops of the pails exposed to the air, differs somewhat from the covered pail system. The difference consists in this, that the cream is exposed to air which is warmer than the milk. Now warmth moves upward and cold downward, and every one knows that hot water may remain upon ice without melting any more than a very small depth of it downward. Further, cream needs to undergo a process of ripening before it is fit for churning, and this ripening is merely the oxidation of the cream by its exposure to air. This change occurs with greater rapidity in warm air than in cold, and most so with the shallow pan setting. In the case above noted, the warm air of the room in contact with the cream hastens this ripening process, at the same time that the cold water hastens the rising of the cream. But, after practicing both these methods with the utmost care and constant observation of results for some years, the author has not been able to distinguish any difference in the product of the butter either in quantity or in quality. The only difference is that cream raised in shallow pans is pure and too thick to be churned without adding an equal bulk of milk or water, and that one quart of it will produce a pound of butter, while that raised in deep pans is half milk, and two quarts produce one pound of butter; yet the same quantity of milk in the dairy week after week yields precisely the same amount of butter from either system of setting, in the same time of churning. So that after all, if the same care is used and the principles upon which butter-making is based are skillfully followed from first to last, it matters little which system is practiced, excepting so far as one may be more convenient than another, under varying circumstances.

The shallow pan system of setting is the most common, and will be first commented upon. The construction of the dairy used for this method differs somewhat from those used for deep setting, as the furnishing necessarily varies considerably. Cellars are mostly used for shallow setting, and as many of these are offensive and injurious to the milk, the proper arrangement of a desirable milk-cellar will be described.

In a building that is not cooled by ice or warmed by a stove, the most regular temperature is secured in a cellar. The common receptacle for milk is a cellar, because every house is supplied with one, or should be, and it is the most convenient place for it. For a family dairy the cellar will be the appropriate place for keeping milk ; and if it is not fit for this particular purpose, which requires absolute cleanliness and purity, it is not fit for human beings to live over. In every such case the cellar should be made fit by thorough cleansing, and draining, if necessary; laying a floor of cement, moderate lighting and ventilation, and the protection of the windows by wire gauze. A slatted outside door is very suitable for a milk-cellar, and this should be on the north side and opened at night. The walls should be closely pointed and whitewashed inside. The common practice of protecting a cellar from frost by heaping litter from the stable around it, is very objectionable. Nor should turnips or potatoes be stored in a cellar where milk is kept, unless it is divided by a tight partition and the root cellar abundantly ventilated.

Ventilation for a cellar may be provided by carrying a tube or spout from the floor to the ceiling, and through the wall out of doors, where it should be protected by fine wire gauze. The arrangement is explained in figure 34, in which the cellar wall is shown with the spout fixed against it. The outlet is divided in the center, and one half communicates with the spout which reaches to the bottom of the cellar, and this furnishes an inlet to fresh, cold air. The other is connected with the short upright spout outside, through which the warm, fouled air escapes, as shown by the arrows. This arrangement has been found very useful both for purifying and drying the air of a cellar; for the cold air coming in at the bottom is drier than the warm air passing out, and the moisture of the cellar is continually absorbed and carried off so long as any warm air flows out of the upper spout. The spouts are provided with slides by which they may be closed when necessary. The cellar should be well

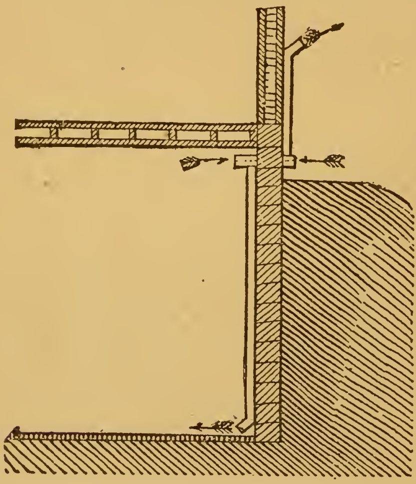

Fig. 34.—MILK-CELLAR UNDER A HOUSE.

ceiled with lath and plaster, otherwise dust will be dropping from the rooms above; and in any case this is advisable, for if no other means of ventilation are provided, air will pass up and down through the floor over the cellar, and it may be bad for the milk, as well as for the occupants of the rooms above. The ceiling not only preserves cleanliness, but regularity of temperature.

Where an outside cellar is desirable, an excellent arrangement is like that shown in figure 35. A cellar is dug twelve feet deep; the walls are built of stone, concrete or brick. A sub-cellar at least eight feet deep is made by throwing a floor over the cellar four feet below the surface. An out-house or shed is built over this as a protection and is lighted by a sash in the roof. A sash is placed over a raised frame in the floor, as shown, which lights the sub-cellar. Steps are provided for access to each cellar. The sub-cellar is furnished with shelves and a bench. In such dry soils as will admit of it a cellar of this kind is one of the best possible for a small dairy, or, indeed, for household purposes. It is light and cool, and the temperature will not vary from about sixty

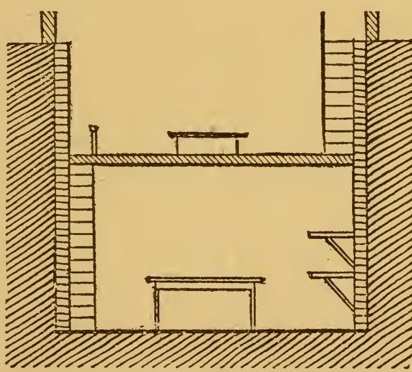

Fig. 35.—OUTSIDE MILK-CELLAR.

degrees, or somewhat less, the whole year. It should be kept whitewashed, by which the light is well diffused about it. It may be found convenient to use the upper portion as a churning-room and for storing milk utensils.

Cellars are apt to be damp. In this case the air may be dried by means of a peck of fresh lime placed in a box or tub in the cellar. Twenty pounds of lime (one peck) will absorb about seven pounds of water, and to take seven pints of water from the air of a cellar will make it very dry. The lime will simply fall to a powder and may then be used for many useful purposes, or be added to the garden compost heap.

Where the cellar cannot be used on account of the wetness of the soil, an above-ground cellar must be provided. This may be partly sunk in the ground, but if there is any danger of water soaking into it, it should be wholly above the ground. It becomes then, properly, a milk-house, and the description of such a house will be as follows:

Milk-houses may be constructed of wood, of stone, or of brick. If well constructed, one kind may be made as useful as another. For some purposes a frame house is the best, retaining an even temperature better

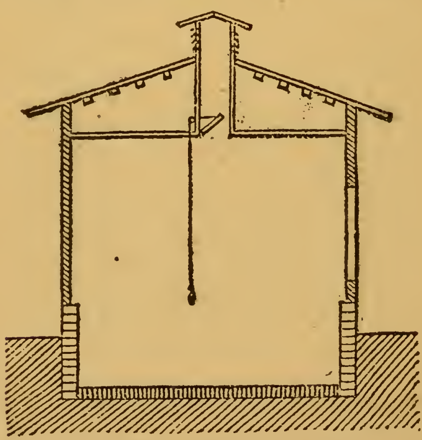

Fig. 36.—FRAME MILK-HOUSE.

than any other. Air passes through brick and plaster with much greater facility than is generally supposed. In a test once made the air, forced by a wind pressure of only three pounds on a square foot, passed through a brick wall plastered inside with such ease that, when collected by a funnel one foot square and discharged through a small orifice, it was sufficient to extinguish the flame of a common candle. It is this passage of air through brick which causes a deposit of ice on the inner surface of the wall of a warmed house when a cold wind is blowing outside, or a deposit of dew on the inner wall of a cold house when a warm wind is blowing in the summer. But a frame house must be well constructed, otherwise it will soon begin to decay at the foundation and this will at once destroy its usefulness. The frame house should be supported upon brick or stone foundations, and if the soil is suitable, the foundation should be sunk at least four feet below the surface. A section through the center of a convenient milk-house is shown in the illustration (figure 36).

The foundation is of brick or stone, and is carried up sufficiently to preserve the timber from decay. The floor is covered with hydraulic cement concrete three inches thick, and is finished with a light coat of clear cement and sand in equal parts. One window is on the north side, and is protected against flies by a wire gauze screen. A space of two feet is left above the ceiling, and through this a ventilator is passed, which is closed by a trap-door that can be raised by means of a cord reaching below. The walls and ceilings should be plastered and a hard-finishing coat of plaster-of-Paris, costing only a few dollars extra, will add much to the cleanliness. Lime wash will be always peeling off, and the scales will fall down upon the milk. The hard-finish is less porous than the lime, which is an advantage.

A brick, stone, or concrete milk-house will be preferable where the material can be procured easily; stone or concrete will be the cheapest where the stone or gravel is abundant, and either is better than brick both for winter or summer use. If the walls are lined inside by means of furring strips four inches thick, upon which the laths are nailed, a considerable air space will be secured and this will help greatly to preserve an even temperature in the house. A section of a house constructed in this manner is shown at figure 37. The outside of the milk-house should be painted or washed white,

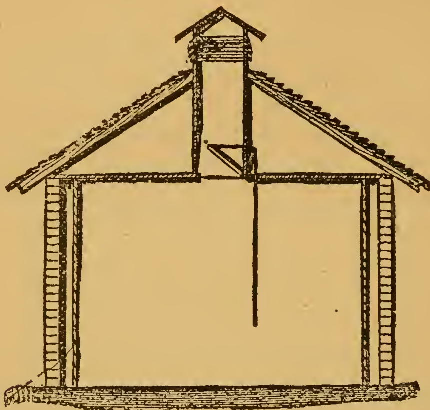

Fig. 37.—BRICK OR STONE MILK-HOUSE.

as this reflects the heat and keeps the inside much cooler than would bare bricks, stone or boards.

For a butter dairy an adjoining room for churning should be provided (figure 38), furnished with water for washing pans and utensils, a stove for maintaining sufficient warmth in the winter, and a sink and drain for carrying off the slops, which are shown at (*a*). In such a dairy-house the furniture should consist of a proper arrangement of shelves (*bb*), a table (*c*) for keeping butter on, and a low bench (*d*) for the cream jars in one corner, out of the way of passing to and fro. In the author's shallow-pan dairy-room the shelves are made in three tiers, the lowest one twenty-four inches above the floor, the others thirty-six and forty-eight inches high respectively. They are made of four pieces of one and one-quarter by three inch slats set on edge three inches apart, and the upper edge is beveled sharp, for the pans to rest upon, and thus to secure a thorough circulation of air around and under the pans. This dairy is a cellar in the rear of a basement, which is used for a churning and wash room. It is entirely below the surface at the rear, the ground sloping downward to the front of the basement. A window protected by wire gauze and on the north side gives ample ventilation. The floor is cemented, the walls are of stone, lathed and plastered, and the ceiling is also lathed and plastered. There is no difficulty in keeping this dairy at a temperature of sixty-two degrees or lower, by having the door and win-

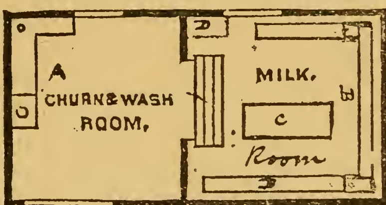

Fig. 38.—GROUND PLAN OF MILK-HOUSES (Figs. 36 and 37).

dow closed through the day, and opening the window at night. Lime is used to keep the air dry and pure. Nothing else is kept in this dairy but milk and butter. The construction of a deep-pail dairy is somewhat different. It requires a supply of cold spring water or of cool well water and ice.

A most desirable milk-house of this kind is one that is supplied with a flowing stream of cold spring water. This secures the requisite evenness and lowness of temperature and an advantageous moisture and purity of atmosphere. The best materials for spring-houses are, first, stone; then, concrete; and lastly, brick. Wooden spring-houses may be acceptable under such circumstances as will avoid dampness: for instance, when water is brought from a distant spring in a pipe laid underground, and made to discharge in a tank excavated or built in the center; or a tank or pool may be constructed upon a spring which fills the reservoir and flows off without wetting the ground. But as one of the important points about a spring-house is evenness of temperature, a solid heat and cold proof wall is desirable.

Spring-houses may be used for either shallow or deep setting, but the economy of the latter is too obvious to be disregarded. For instance, to set 400 quarts of milk in shallow pans holding eight quarts each, a trough of more than ninety-six square feet of surface would be re-

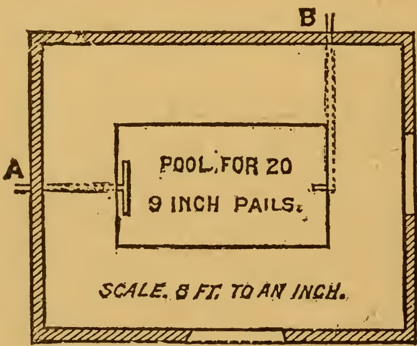

Fig. 39.—PLAN OF MILK-HOUSE.

quired. A useful plan for a deep-tank milk-house is shown at figure 39; (*a*) is the inlet pipe, (*b*) the outlet, and in the center is the pool.

The house should be roomy. A brick or concrete floor is preferable to any other. The concrete is made of gravel or coal ashes, and mixed with a thin mortar of water lime and sand, in the proportion of one of lime to three of sand. The concrete is laid three inches thick and well rammed down. The pool should be lined with brick laid in cement, if it is below the surface; if it is raised above the surface, it may be built of brick laid in cement and painted inside. For a handsome pool the inside may be lined with porcelain tiles and the top of the wall covered with a marble coping. A section of a house provided with such a pool is shown at figure 40. The house may be sunk two feet below the surface, or built on the level of the ground, as may be convenient. The water is brought into the tank by a lead pipe, *a*, at the bottom, and escapes at the water level of the tank, as shown at *b*. The passage around the tank is intended to be three feet wide, which gives ample room for brick benches here and there, upon which cream jars, pails or dishes of butter or spare utensils may be placed.

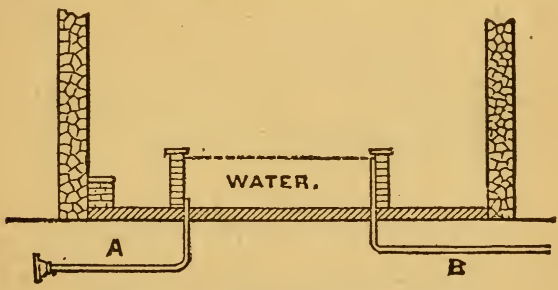

Fig. 40.—MILK-HOUSE WITH RAISED TANK.

The drainage of such a house should be perfect, and good ventilation should be secured by such methods as have been described in previous chapters. The roof should be divided from the lower apartment by a ceiling having two or three feet of space above, by which the heat of the sun beating on the roof is shut off. The cooler the house is kept, the drier it will be; for the evaporation of the water will be less, and the less the evaporation, the less condensation there will be upon the floor, the walls, and the sides of the tank.

A small frame spring-house built, as a preliminary test, by the author, and which had the pool sunk in the ground so as to utilize a spring which existed on the spot, has been found very useful. It cost less than forty dollars and the pool was large enough to hold 200 quarts of milk. The plan is shown by the diagram (figure 41), in which a section across the house and pool is shown. This house is twelve feet square. The pool was sunk until a bubbling spring was reached, and the bottom was paved with flat stones loosely placed, the water rising through the spaces between the stones until it flowed out of a pipe at the top, shown at *b*, leaving a depth of eighteen inches of water in the pool. As the water rises

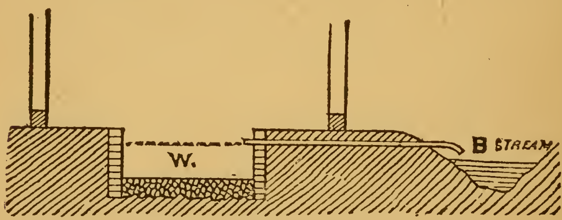

Fig. 41.—SPRING-HOUSE FOR MILK.

suddenly when several twenty-quart pails of milk are put into the pool, the outlet is made of three-inch glazed drain tile, covered with wire gauze as a protection. The drain discharges into a stream close behind the spring-house.

To cool 200 quarts of milk from seventy-five or eighty degrees down to fifty-five, requires either considerable time or a good flow of cold water. With a flow of two quarts per minute of water at a temperature of fifty-five degrees, and an air temperature of eighty degrees, four hours are required to reduce the milk to the temperature of sixty degrees, and the temperature of the milk cannot be reduced as low as that of the water unless the pool is protected by a covering from the air. It may thus be found advisable to provide falling doors to cover the tank when the water supply is not more than two quarts in a minute, which is equal to a flow, without pressure, of a quarter-inch stream of water.

The author has built several dairy-houses for himself and other dairymen; the latest and most improved, however, is the last one made for his own use, and described as follows. The ground plan is shown at figure 42. It consists of a tank-room and a churning-room, with an attic overhead. The tank-room is three feet below the ground level, for the sake of coolness; the churning-room is a foot above the ground. The whole house is ten by twenty feet, inside measurement; the tank-room is ten by eight, and the churning-room ten by twelve. The tank-room is the most important part, and this has a

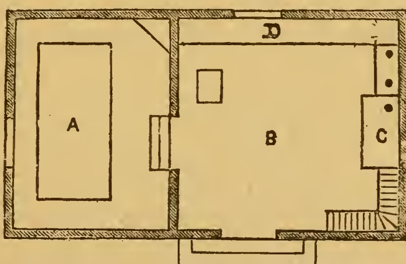

Fig. 42.—PLAN OF MILK-HOUSE.

A, Milk Tank, 4½ feet by 7; *B*, Churning Room, with Pump, Bench and Sink; *C*, Low Sink and Drain; *D*, Table.

stone basement wall laid in cement and a cemented floor. The tank is twenty-two inches deep, made of brick laid in cement, and with a loose brick floor. It has a permanent cool spring running through it, and an overflow pipe eighteen inches above the bottom, to keep this depth of water always in it. The cans used are the deep cans, twenty by eight and a half inches, each holding fourteen quarts, or thirty pounds of milk. The tank has a passageway around it, and has a falling door over it to exclude dust and preserve the desired temperature, when there is need for it, as in extremely hot or cold weather.

To preserve the equilibrium of the pails, racks made of galvanized iron bars, as shown (figure 43), are used; the spaces are nine inches square, and a pail fits in each one. This rests on a shoulder made in the wall of the tank by setting out a row of bricks on each side one inch, so that the rack is three inches below the water level. There is a window at the north end over the tank. A tank of this size will hold thirty-five pails of fourteen quarts each, or the milk of fifteen to twenty cows.

Fig. 43.
RACK FOR THE PAILS.

Light has the effect of deepening the color of the cream a little, but I never found any difference in the butter from cream kept in closed cans in this tank, or in the submerged cans of the Cooley system, which of course exclude light, as compared with that from cream kept in my shallow-pan dairy used at the same time as this deep-setting milk-house.

The churning-room is reached by steps from the tank-room, and a glazed door separates the two. Both apartments are plastered and hard-finished over lath. The walls are made of two-by-eight studs, covered with building paper on both sides, and outside with tight-fitting "novelty" siding. This secures a very good non-conducting wall, and helps very much to preserve an even temperature. A bench or table (*d*) is fixed on the east side the whole length of the room. This is made low enough to work at easily, and is for packing butter and other similar work. There is a small table in the corner of the tank-room for the butter to remain on until it is finally worked for packing during either hot or cold weather. At the right hand of the table (*d*) is a sink with a pump and pipe leading to a drain; this is as high as the table. Another on the level of the floor (*c*), for washing the churn, is at the right hand of this sink.

The butter-worker can be placed in the front of this sink when in use, so that the drainage from it is caught and does not mess up the floor. The floor is of matched boards laid over common hemlock boards, and is oiled so that it will not absorb any spilled cream, which can be wiped off without trouble. An open stairway leads up to the attic, where butter pails, etc., can be stored.

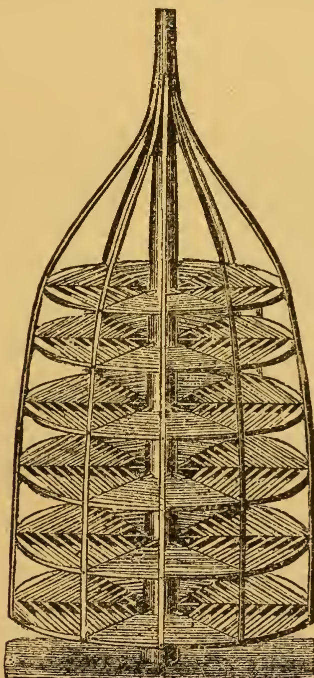

Fig. 44.—ROTATING SHELVES FOR DAIRY.

A large drawer on rollers, under the table, holds the sr t and other drawers are for paraffine paper and small things. After several years' use of this house the author does not know that he could add anything to this milk-house to make it more useful, convenient, or agreeable.

The French dairies, both for butter and cheese, are invariably built solidly and compactly of stone, with stone-flagged floors for cleanliness and coolness, and are exceedingly roomy and airy. The benches are made of stone, and stone benches also serve as tables. Nothing is placed on the floor, or less than eighteen inches above it, as the French dairymen have a dread of "ground air," which they believe confers a bad odor upon milk and butter. These dairies are frequently washed with a copious flood of water, which passes off by a drain.

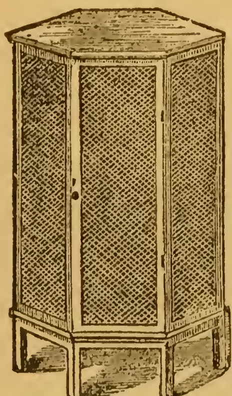

Fig. 45.—MILK CLOSET.

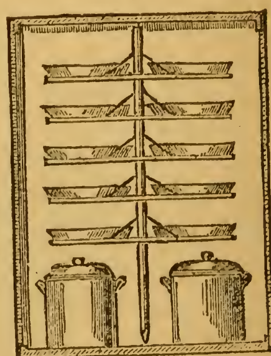

Fig. 46.—INTERIOR OF MILK CLOSET.

A most convenient arrangement of shelves for a shallow-pan dairy, which was used in the Beacon farm dairy at Northport, Long Island, when it was under the charge of Mr. Wm. Crozier, is shown at figure 44. It is made to revolve upon pivots fitted in the floor and ceiling, and saves many steps in the work of skimming and replacing the filled pans.

For a family dairy where one cow is kept it is seldom possible to have a separate milk-house, and a cupboard or refrigerator must be used as the receptacle. An excellent closet, devised by the author and found very useful, is shown at figure 45. It is enclosed by wire gauze to exclude flies and admit air, and is provided inside with revolving shelves (figure 46) by which the milk may be put in and taken out most conveniently. The cream jar is kept under the shelves. A closet of this kind will hold five tiers of two, three, or four pans each, the shelves being six or eight inches apart. The wire gauze covering permits perfect ventilation.

A closet or refrigerator for the use of ice, and practically deep setting on a small scale, is shown at figure

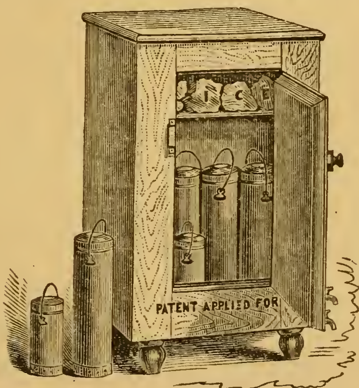

Fig. 47.—REFRIGERATOR CLOSET.

47, and needs no further description than to note that the water from the melting ice is either carried off from the ice tray by a pipe, or drips upon the pails and runs off through a pipe in the bottom. This closet is lined with sheet tin or zinc.

The tin pans in common use for setting milk have one objectionable feature; this is, the seam around the bottom in which sour milk *will* be concealed, unless great circumspection is used. The pressed pan, of which figure 48 gives a section, has no such hiding place for the sour milk, which acts upon the fresh milk in the same manner as rennet, and will often curdle it in a few hours and before the cream has been able to rise to the surface. The pressed pans are therefore much easier to clean and much safer in use. It is also an improvement on the pans to have supports on the bottom at least half an inch thick, to raise the bottom of the pans from the shelf. This permits the air to circulate under the pan and cools the milk more quickly than if it rested closely upon a solid shelf. The slatted shelves are intended to assist in this more rapid cooling. The deep pails which are preferred by so many dairymen are about twenty inches deep and from eight to nine inches in diameter. A rim encircles the bottom which raises it about an inch, and

Fig. 48.—SECTION OF PRESSED TIN MILK PAN.

which is perforated with several holes to admit air to circulate under the bottom. The shape of these pails is shown in figure 47, with the Hardin refrigerating closet, in which they are used. These pails may be used either in dry ice or cold water setting, but cannot be used except with ice or cold water, the effect of which secures the low temperature by which only the cream can be raised rapidly enough through so great a depth of milk to prevent loss by premature souring.

The furniture of a dairy is not complete without arrangements for washing, drying and airing the pans. A sink in the dairy-room or the kitchen, with a small pump attached to it and connected with a well or cistern, will be necessary to save trouble and secure effectiveness. In family dairies every housekeeper will as easily recognize the utility of the best method of cleansing the apparatus and arranging the furniture in a systematic way, as a business dairyman whose living depends upon his success. Nevertheless, there are dairies and creameries where the system in operation is totally devoid of the commonest means of insuring the necessary cleanliness; and in seeing this the natural consequence—a poor quality of product which unfortunately is the rule rather than the exception—is by no means surprising. Above the sink there may be a rack in which shallow pans may be kept upon their sides; or lath shelves upon which deep pails may be placed bottom upwards. An outdoor rack placed in a sunny exposure will be found very convenient. For shallow pans this may be provided on the porch of the milk-house, or of the kitchen; for deep pans a post set in the ground near the dairy, and furnished with a number of pins, as shown at figure 49, will serve as a rack for airing them.

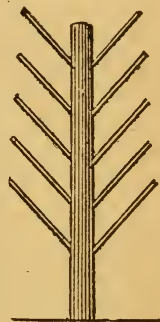

Fig. 49.
DRYING RACK FOR MILK PAILS.

The greatest mistakes in the dairy are made in setting the milk for cream. In the family dairy, where one cow supplies milk and butter, the arrangements are usually better than in some farm dairies. Here the arrangements are often surprisingly bad. At times one may have seen the milk of four cows set in a sleeping-room, and under the bed. The young woman who managed that dairy prided herself on her good butter. What she knew of bad butter must have been fearful to contemplate. In some farm-houses the milk is set in the living-room where the cooking and eating are done, and where, in the evening, the farmer and the hired man smoke their pipes and dry their wet boots and socks under the stove. No wonder some persons prefer oleomargarine to butter made in that fashion. If these lines come under the notice of any one, man or woman, who keeps milk under such circumstances as these, or in any way approaching to them, it may be said to him or her, that good butter cannot be made in that way, and the labor spent over it is only half or quarter paid for.

The first necessity in setting the milk is perfect purity of place and surroundings. Then there should be the following adjuncts :

A moderate circulation of fresh and moist air.

Shelves raised at least three feet from the ground.

A temperature not over sixty degrees in summer, and not below forty-five degrees in winter.

Perfectly clean utensils, and very little light.

It matters little how or where these conditions are secured ; that they *are* secured is sufficient. The following reasons may be given ; viz., milk readily absorbs odors and the odors are concentrated in the cream; with stagnant air the natural odor of the fresh milk, which is disagreeable to some persons, cannot be removed ; in the dry air the cream becomes of a leathery toughness and often produces specks in the butter, and always makes an inferior quality. When milk is kept on the ground in a cellar or milk-house, it is brought into contact with the coldest air, in which all the bad odors of the place are condensed. At a higher temperature than sixty degrees the milk will sour and often thicken before the cream has risen, and to have the best butter, the cream should be taken from sweet milk. At a lower temperature than forty-five degrees the color of the cream is much lightened, and the butter will be too light in color ; besides, there is danger of freezing, and frozen cream will not make good butter. If the milk pans are not quite sweet and clean, the milk will sour too soon. With too much light the butter will not have the rich, deep color that is desired.

When the milk is brought in from the cow stable or the shed it is strained at once into the pans or pails, and these are put away in the place provided for them. If it is not strained at once, some cream will rise, if the milk is rich, and this cream will be caught in the meshes of the strainer and be lost. Before the milk is poured out of the pail it is safe to first pour out a quart or so and return this into the pail; this will remove any stray hairs or dust that may have fallen on to the outside of the strainer spout or lip of the pail. This is more especially advisable with those pails the strainer of which cannot be wiped with a clean cloth. The improved strainer pail, shown in figure 27—which, by the way, is not patented—may be easily cleaned or wiped to remove any hair, dust or other impurity which may have fallen on it, and it is also protected by the hinged cover (not shown in the engraving) which excludes dust during the milking. In placing the milk pans on the shelves, or the pails in the pool, it will be found convenient to have them arranged in regular order and to retain this order always, so that there is never any doubt about the right pans to be skimmed. The shelves may be arranged so as to make this very easy and not to move any pans, but to put the freshly filled pans always in the place of those last skimmed. If one shelf only is used, the pans must be moved along to fill the place of those skimmed at one end and make room at the other end for the fresh milk. The pans should never be covered. If it is necessary to cover anything to exclude flies, mice or other vermin, the windows should be covered with fine wire gauze, and to guard against mice the shelves should be purposely arranged.

When the milk has stood thirty-six hours the cream will have risen, and should be skimmed off. At this time the cream will be thick and adherent, and on good milk that has been set two inches deep in shallow pans should be at least a quarter of an inch thick. This will give twelve per cent of pure cream, which is as much as the author has ever *known* any cow to give, although it has often been said that such a cow gives twenty-five or thirty per cent of cream. Some cows will show twenty-eight per cent of cream in a five-inch-deep test-glass; but this is not pure cream. This same milk set in a twenty-inch-deep pail will show about six inches of cream, or thirty per cent; but when cream rises in a deep vessel a large quantity of milk is brought up with it and stays with it, and the thirty per cent which is shown in a deep Cooley pail, shrinks in a Ferguson Bureau pan to twelve per cent. There is an advantage, however, in this diluted cream, which is, that it is in precisely the best condition for good churning; while in skimming the pure cream at least an equal quantity of milk should be poured off with it into the cream jar, and both be stirred up together. To remove the cream from shallow pans, a small, flat cream knife should be passed around the edge of the pan to loosen it, and the film of cream is then floated and pushed with the cream knife over the edge of the pan into the cream jar. This will remove enough milk with the cream to dilute it sufficiently. Every time cream is poured into the jar it should be stirred, otherwise there will be danger of having white specks in the butter, from some particles of dry cream or from over-sour curd at the bottom.

There are a great many patented methods and apparatus for setting milk for cream. Descriptions of these, however, scarcely fall under the scope of this work, as all of them have good points which secure favor from those who choose and use them. The young or inexperienced dairyman should be cautious about deciding upon any permanent fixtures in his dairy until he has had some opportunity of seeing and examining them. As every dairyman of good sense and judgment should become a member of his State Dairymen's Association, which privilege is most cheaply secured for the small sum of one dollar yearly, and should faithfully attend the meetings of it, he will have ample facilities for acquiring valuable information in regard to these systems of setting milk referred to. And understanding the principles involved in the successful pursuit of his business, which are explained in this work, he will be well able to exercise his judgment in regard to a choice of what apparatus he may desire to use.

CHAPTER XIX.

CREAM AND ITS PECULIARITIES.

We have seen that cream consists of the fatty globules mixed with certain proportions of other parts of the milk. These proportions vary from about seventy-five to fifty per cent of the whole quantity of cream. But there is another constituent of cream which is most important to take cognizance of. It is a most serious disturbing element, producing changes in cream which interfere very much with the process of churning and affecting considerably the quality of the butter. This is an albuminous viscid matter, which appears on examination under the microscope to contain a considerable quantity of membranous or cellular animal tissue, very well described by one observer as a "smeary mass" which is thrown out of the milk, and adheres to the sides of the centrifugal creamer. This viscous matter appears to have the same chemical effect upon milk, and cream more especially, as animal membrane has; viz., to change the milk sugar to lactic acid, and even to produce a certain chemical decomposition in the butter made from the cream. The fact that the use of the centrifugal separator effects the removal of this disturbing element and yields the cream perfectly pure, gives a still greater importance to this machine than would the mere mechanical separation of the cream from the milk.

The differences in cream which necessarily result from its mode of separation from the milk first invite attention. These were not brought prominently to notice until the recent investigations of Danish dairy experts made public the comparisons between the creams separated by the different methods in use, including the cream remaining unseparated in the milk as well as the cream taken from milk transported from the dairies to creameries by railroad or wagon. The results of these experiments for a whole year are given in the following table, the thirty-four-hour setting in ice being taken as the standard:

MONTHS OF	PROPORTION OF BUTTER YIELD.						THE CENTRIFUGAL HAS GIVEN MORE BUTTER PER CENT THAN:				
	Ice 10 hours.	*Ice 34 hours.*	*Water at 50° Fahr., 34 hours.*	*Pans 34 hours.*	*Centrifugal.*	*Churned Milk.*	*Ice 10 hours.*	*Ice 34 hours.*	*Water at 50° Fahr., 34 hours.*	*Pans 34 hours.*	*Churning of Milk.*
April	93 1	100	81.1	102	113	107.7	22.3	13.9	40.5	11.7	5.5
May	92.2	100	87.7	97.5	111.3	98.8	19.8	11.3	36.3	14 2	12.7
June	94.4	100	86.8	98.4	109.6	95.9	16	9.6	26.2	11.4	14.2
July	....	..	...	....	....	....	....	....	....	....	...
August	94 8	100	86.5	97 2	109.2	101.3	15.1	9.2	26.2	12.3	7.8
September	94.7	100	84.1	97.5	111.6	103	17.9	11.6	32.7	14.4	8.3
October	92.4	100	81.8	102	117.6	113.6	27.3	17.6	43.7	15.3	3.5
November	91 5	100	77.5	97	120.2	115.1	31.4	20 2	55.1	21.4	4.5
December	92	100	79.5	101	119.6	115	29.9	19.6	51.1	18.4	4
January	92.3	100	79.7	100.9	118	110.9	27.9	18	48	10.9	6.4
February	92.4	100	83.4	101.3	116.2	110.3	25.8	16.2	39.4	11.8	5.4
March	93.1	100	78.7	100.5	114	108	22.7	14.2	45.1	13.6	5.6
	92.1	100	81.9	99.8	114 6	107 2	23.8	14.3	41	14	7.1

The remarkable difference shown by these experiments in favor of the "centrifuge" is in great part due to the removal of the viscous portion of the milk which tends so much under other circumstances to make the milk impure and difficult to manage.

The report of the Director summed up the advantages of the centrifugal separation of the cream as follows:

1st. The transportation of milk but once a day, which so far has been considered impossible in our butter factories. The cost of transportation of the milk is thus decreased by half. It is no small item in favor of the centrifugal plan.

2d. A great saving of time in skimming. By the old method, the milk required thirty-six hours setting before skimming. By this new system 10,000 pounds of milk will yield its cream in four or five hours, and farmers can carry back their skimmed milk at once. Here again is a saving of time and temperature. The longer the milk has to remain in the creamery, the greater is the risk from the various contingencies to which it is liable, and in proportion as it is quickly rendered marketable and passed out of dairymen's hands are these lessened.

3d. More thorough skimming and greater yield.

4th. The centrifugal allows of the acidulation of the cream being brought under control. This is one of the most important points in butter making, and the only means of producing at will a butter sure to keep. It is also the means of obtaining cream of uniform ripeness, and thus enabling us to churn it equally clean.

5th. The butter obtained is purer and of superior quality. The centrifugal extracts from the milk, from the cream and consequently from the butter, a large amount of impurities which adhere to the sides of the apparatus, and which old methods could not remove.

6th. A great saving of ice. This is an important item; as the best results from the centrifugal are obtained when the milk is used soon after milking, and the amount of cream averages about fifteen per cent of the milk. As by this method nothing but the cream need be cooled, it is evident that there will be a saving of eighty-five per cent of the ice used in a creamery where the "Ice System" is employed.

7th. As the plant necessary for a successful creamery is expensive, economy is an important item. By separating the cream immediately on receipt of milk, all room necessary for vats or pans is saved, except for a small vat for heating milk and a cream vat. The space necessary for the centrifugal is very small, not more than four by eight feet for the large size machine. The expense of maintenance is also greatly reduced by doing away with the large pans, and other appurtenances now necessary.

In regard to the behavior of the cream taken from transported milk, the following experiments were made :

Eight hundred pounds of milk were taken, of which 200 pounds were immediately operated upon by the centrifuge, and 200 pounds operated on after having been transported. At the same time 200 pounds were immediately set in ice water, and 200 pounds set in ice water after having been transported, both of the latter samples remaining in the ice water for thirty-four hours. For the centrifuge experiments, on the one hand, the transported milk had been placed in 100-pound cans and driven about for two hours, the temperature on the return averaging not quite sixty-six degrees Fahrenheit. For the ice water experiment, on the other hand, the milk was first cooled thirty minutes in ice water, and then was driven about one and a half hours, and the temperature on the return was a little over sixty-three and a half degrees Fahrenheit.

Now in these experiments it was ascertained that the centrifuge had been able to separate the cream from the transported milk almost as well as that from the samples not transported ; the proportional figures for the amounts of butter made being in the following ratio : 100 representing that from milk *immediately* operated in the centrifuge ; 99.3 for the transported milk, and 98.9 for the cooled and transported milk. It will be seen, therefore, that the loss of butter has only been 0.7 and 1.1 per cent. But for the ice system the loss of butter was considerably more, amounting to 4.4 and 8.8 per cent, respectively, for the two samples referred to as being treated under that system.

In order to determine more definitely the relative influence exerted on the rising of the cream on account of the milk being transported, or from being cooled, a series of experiments were made in a creamery conducted only on the ice system. Part of the milk was placed in ice water immediately, while another part after having been left standing and then subjected to transportation was also placed in ice water, the time for skimming being the same for both samples. The point sought to be determined was whether the shaking or the cooling of the milk during the drive had the more influence in arresting the creaming, and the result of the experiments will be found in the following table :

AVERAGE FIGURES FOR AMOUNT OF BUTTER AND FOR TEMPERATURE OF MILK WHEN SET IN ICE.

	Set Immediately	After Standing	After Driving.		
			In Wagon.	In Wagon & covered.	Railr'd and Wagon.
Thirty-four hours skimming; driven 2 hours; 3 trials - average figures	100.00	95.00	96.50	98.40	96 80
Temperature—degrees Fahr	82.22	63 68	64.22	75.08	66.74
Thirty-four hours skimming; cooled in ice 1 hour; driven or standing 1¼ hours; 4 trials; average figures	100.00	87.10	86.70		
Temperature—degrees Fahr	88.52	48.56	48 20		
Ten hours skimming; cooled with ice 1 hour; driven or standing 2¼ hours; 4 trials; average figures	100.00	73.00			70.60
Temperature—degrees Fahr	88 34	47 84			47.66

The milk which was left standing was placed outside the creamery, while the other samples were driven about.

For the railroad transport the milk was driven between the creamery and depot, taking say twenty minutes, and on the train (for the first column) from one depot to another and directly back again, in all sixteen miles; and for the last column in all forty-four miles, with a waiting time between of one-half hour.

In looking over the result as indicated in the preceding table, the question occurs whether it is the cooling which the milk has undergone, in connection with the time that has passed before it was placed in ice, that is the cause of the loss of butter, or whether it is the driving or the shaking caused by driving. But this last did not seem to have any, or at least only a little, influence, while the cooling seems to have been the principal cause of the loss of butter, which loss also increases with the cooling.

In the following table of figures it is shown that the milk, after driving, could, by heating, be brought back almost to its natural condition, so far as cream rising is concerned. Indeed, it was proved by several trials that the cooled milk, when raised to a temperature near the natural heat of the cow—say 100 degrees Fahrenheit—exhibited a remarkable change in the separation of its cream, and this influence on the rising of the cream from heating the cooled milk led to experiments in heating the driven milk to 104 degrees Fahrenheit, and also heating to the temperature the milk generally has when it comes from the stable to the dairy-house, say about eighty-six degrees Fahrenheit. This was the temperature of all the samples of milk in the first column of the table; while the other three samples, after driving, had the temperature of the column marked ° Fahrenheit. The heating of the samples for the two last columns to 86 and 104 degrees Fahrenheit was done by surrounding the milk with warm water at a temperature of 113 to 131 degrees Fahrenheit.

AVERAGE FIGURES FOR AMOUNT OF BUTTER AND TEMPERATURE OF THE DRIVEN MILK.

	IN ICE.				
		After Driving.			
Slagelse Creamery.	*Immediately.*	*Not heated.*	*° Fahr.*	*86° Fahr.*	*104° Fahr.*
Thirty-four hours skimming; driven 2 hours; 6 trials...	100	95.7	68.26	97.2	98.6
Thirty-four hours skimming; cooled ½ hour; driven 1½ hours; 6 trials in April.....	100	91.0	54.50	93.6	98.5
Thirty-four hours skimming; cooled ½ hour; driven 1½ hours; 5 trials in March.	100	86.3	48 74	92.9	99.0
Thirty-four hours skimming; cooled 1 hour; driven 1½ hours; 4 trials in April and May	100	86.7	48.20	..	98.9
Ten hours skimming; cooled ½ hour; driven 1½ hours—4 trials.......	100	83.3	52.34	87.0	97.7
Ten hours skimming; cooled 1 hour; driven 3½ hours (railroad); 4 trials.......	100	70.6	49 66	....	96.8
Rosenfeldt.					
Thirty-four hours skimming: cooled ½ hour; driven 1½ hours; 5 trials.......	100	89.4	51.44	90.0	95.6

Some of these columns of experiments are made in connection with those set down in the former table, and therefore the figures in the second column do not give anything new; but the figures in the columns for the heating to 86 and 104 degrees Fahrenheit, show that the heating to 86 degrees certainly does some good, but not much, while the resistance of the milk for creaming, caused by cooling and driving, has been almost entirely overcome by heating it to a temperature of 104 degrees Fahrenheit, and this not only when skimming was done after the milk had set thirty-four hours, but also when skimming was done after ten hours' setting, since the loss of butter for the milk cooled one hour and driven three and a half hours is decreased from 29.4 per cent for the cold sample to 3.2 per cent for the sample heated to 104 degrees Fahrenheit.

It will be observed, however, that in the last column of experiments the result at Rosenfeldt, in heating the milk to 104 degrees Fahrenheit, was not as favorable as at Slaqelse, but the milk at the last establishment was all taken from one stable adjoining the creamery, and was consequently of uniform character as to quality.

These experiments show that there is an important advantage obtained in the quantity of butter by heating such milk to 104 degrees Fahrenheit before setting aside to cream. This will be especially the case where the milk before or during transportation is reduced to a low temperature, as in cold weather, and again in hot weather, when it is found necessary to cool the milk at the farm before transportation, in order that it may arrive at the creamery in good condition. No loss from cooling will be sustained if the milk, before setting, is raised to a temperature of 104 degrees Fahrenheit.

A singular peculiarity was observed in the cream from the milk which had been *cooled, driven, and again heated to* 86 *degrees Fahrenheit.* While by exact skimming the quantity of cream from the three samples was nearly the same (namely, sixteen per cent), it was in this sample eighteen per cent, and the time required for churning had been almost twice as long for the samples heated to 86 degrees as for those heated to 104 degrees Fahrenheit; and this was the case whether the cream was churned sweet or sour. Again, the cream from the sample of milk heated to 86 degrees, though it weighed most, did not appear the thinnest, yielded less butter than that from the milk heated to 104 degrees Fahrenheit, and the cream of this sample also appeared thin.

Some remarkable observations were made in churning *sweet* cream. By the centrifuge experiments it was noticed that when the centrifuge cream, after its separation from the milk, was from 58.1 to 60 degrees Fahrenheit, and directly afterwards was cooled to the usual churning temperature of 57.2 degrees, and was then churned, the yield of butter was about seventeen per cent less than when the cream was first cooled to 33.8 degrees, and then heated to 57.2 degrees and churned. A cooling to 46.4 degrees gave about the same result as cooling to 33.8 degrees.

In a longer series of experiments afterward undertaken at Rosvang with cream raised in shallow pans, partly at a temperature below 55.4 degrees and partly above 60.8 degrees Fahrenheit, it was found that the "pan cream," raised in temperature below 55.4 degrees Fahrenheit, made a yield of butter only 2.3 per cent more, when the cream was coolod by ice before it was heated to churning temperature; while of the samples of cream raised in over 60.8 degrees temperature, there was gained 19.2 per cent of butter by the cooling. Hence in practice it was found advisable during hot weather to cool both the "centrifuge cream" and the "pan cream" with ice.

The chemical changes which occur in cream are produced by the effect of oxidation, and the results of the internal decomposition caused by the breaking up of the atoms of the milk sugar (lactose) in the milk contained in the cream, and the consequent formation of lactic acid. This acid is a viscous substance, and has precisely the same effect upon the cream as a solution of gelatine would have, and when cream containing a large quantity of this acid is churned it foams and becomes beaten up into a still finer and smoother emulsion but will never make butter. This effect may be thus explained:

The milk sugar is changed to lactic (or milk) acid by the action of the caseine of the milk in a manner which is as yet somewhat obscure, but it is merely a changed position, as it were, of the elements forming each of these substances. The following diagram of the change is given, with such explanation as may make it plain to those even who are unacquainted with chemistry. An atom or volume of sugar of milk is composed ultimately of twenty-four atoms of carbon and twenty-four atoms of water; one atom or volume of lactic (or milk) acid is composed of six atoms of carbon and six atoms of water. Using the chemical symbols for these ultimate components we have:

$$\text{Milk sugar} = 24C + 24\ H_2O$$
$$\text{Lactic acid} = 6C + 6\ H_2O$$

If, then, one volume of the former can be separated into four parts, or its components can be transposed, we have four volumes of the latter; and instead of one volume of sugar, or sweet substance, we have four of an acid. Here is no infusion of a new element, nothing is added, nothing is taken away; a transposition, "a shuffle and a new deal," if it may be so expressed, is made, and a sweet liquid is changed into an acid one. The change is very simple to one who is accustomed to consider chemical substitutions, yet its important effects are typical of those changes which are continually occurring in milk and all its products.

The viscosity of cream may be reduced by diluting it with water. The water increases the bulk of the viscous acid milk, and so releases the butter globules from its adhesive embrace and enables the butter to "come." This watering process may be used for the recovery of cream which is too acid for churning or which has been churned without bringing butter. Any considerable proportion of water may be added to the cream and the mixture left for the cream to rise, which it does rapidly. The water is then drawn off from under the cream and more water is added and afterwards removed. The cream may then be churned with ease.

Cream so washed makes butter of the very best keeping quality. The spoiling of butter is due to those elements of the cream which causes this viscosity. Some cream may contain more than one of these; viz., in addition to the acid there may exist the peculiar animal impurities previously mentioned, whose removal will very much improve the character of the cream and butter, and thus this washing may be resorted to for the purpose of freeing over-sour cream from taints of all kinds.

Much has been written about churning sweet cream. There is an unwritten side of this subject, however, which has been ignored by persons who have advocated this practice, but which should be noticed. When sweet cream is put into the churn and violently agitated, the particles are separated and become profusely mixed with air, heat is also generated, and the process of oxidation is rapidly performed ; thus in effect the same results are attained, only in a longer time than in churning sour or "ripe" cream. And sweet cream requires a considerably longer time to churn than cream that is slightly acid, or in the best condition for making butter. So in reality there is but a slight difference between the butter made from sweet cream after its long churning, and the acid or ripe cream ; and that difference is in favor of the ripe cream, the butter from which has a perfect flavor which that from sweet cream lacks.

One of the desirable uses of cream in its sweet state is for making clouted cream, a delicious article of food, a substitute for butter, or a condiment for fruit and pastry. It is made as follows : The milk having stood in shallow pans for twelve hours, the pans of milk are set upon a stove or heater without any disturbance of the cream and are gradually brought to a heat of 180 degrees, at which temperature the cream becomes slightly wrinkled or "crinkled." The pans are then put back into the dairy. In twenty-four hours more a thick solid skin of cream is thrown up, which can be rolled up and lifted off from the milk without falling apart. This cream is then sold for immediate use as above mentioned, or is made into cream cheese, or is churned into butter while it is sweet. The butter thus made has a flat insipid flavor, but will keep good a long time.

The ripening of cream for the churn is a process which requires time and heat in definite ratios. That is, thirty-six hours and sixty degrees of temperature are required to bring the cream skimmed from perfectly sweet milk to the right stage of acidity for churning. If the milk has been kept for twelve hours after it has turned distinctly sour, twenty-four hours will be enough for the perfect ripening of the cream for the churn. If kept longer than this, viscosity is produced, and this is one of the early stages of that final decomposition of the milk which produces the disagreeable flavors of butter arising from the formation of essential oils. These oils result from the decomposition of, first, the lactic acid, and, second, that of the caseine which may remain in the butter. These changes will be more particularly described when we come to consider the nature of butter. But as this viscosity in the cream is the germ, as it were, by which the changes are set in progress, its production is to be avoided most assiduously.

The right stage of cream for churning is when acid is perceptible, and an agreeable aromatic odor is given off from the cream jar. This is reached at the instant when the lactic acid begins to break up into butyric acid by a simple chemical combination. This is brought about by the effect of the caseine which has previously changed the milk sugar into milk (lactic) acid and now still further acts upon this acid to transform it. Such action is accompanied by a fermentation in which carbonic acid and hydrogen with some water are evolved and escape from the cream, and one and a half atoms of lactic acid are wholly decomposed and give off this carbonic acid and water, hydrogen requiring twelve atoms of oxygen to effect the change. This oxygen is taken from four other atoms of lactic acid, which is by this deprivation converted into three atoms of butyric acid, the substance that gives the aroma to butter made from fully ripened cream. Butter made from sweet cream lacks this aroma and flavor, and must be kept for some time to acquire it by an internal process of decomposition, produced from the slow change of its inherent elements in much the same way as here described. This ripening process is analogous to that of fruits in which the woody fiber of the hard, crude, unripe fruit changes to the pulp, gum and sugar of the fully ripe fruit. To explain this let us take

	4 atoms of lactic acid =	$C_{24}H_{48}O_{24}$
	3 atoms of butyric acid =	$C_{24}H_{48}O_{12}$
		— — —
	Leaving............	— — O_{12}
Then		
	1½ atoms of lactic acid =	$C_9\ H_{18}O_9$
	Adding.............	— — O_{12}
		— — —
		$C_9\ H_{18}O_{21}$
Produce		
	9 atoms of carbonic acid =	C^9 — O_{18}
	12 atoms of hydrogen =	— H_{12} —
	3 atoms of water =	— $H_6\ O_3$
		— — —
		$C_9\ H_{18}O_{21}$

In this manner the change, which goes on by an internal decomposition and breaking up of an unstable element of the cream, is entirely accounted for. But it is the business of the dairyman to watch his cream and prevent the ripening from going too far and developing into injurious acidity. Hence the temperature is a most important thing to control and regulate, for if it is in excess of the normal point, time is to be reduced; but the careful dairyman will not work by "rule of thumb" in so serious a matter, when a twenty-five cent thermometer will act as a safe standard and guide in this respect.

Now the behavior of cream in the churn is controlled by this element of ripening, and although all previous requisites, feeding and perfect cleanliness in management in the cows, skillful milking and care of the milk up to this point, may have been secured, yet a lapse in this will spoil all, and previous success be obliterated.

In the management of a public dairy or creamery, where cream is purchased of numerous patrons, some test of quality is required for the interest of the purchaser. There has always been a difficulty in the way of introducing creameries into new and desirable localities, because of the impossibility of making a just division of the proceeds among the patrons. We have seen how cream varies in quality and contents of fat, and how some cows' milk is more productive than that of others. But in the creamery all the cream is taken by measure, and heretofore there has been no precise or satisfactory method of determining the actual value of the cream taken in, for the yield of butter. Every patron cast into the pool, as it were, so much weight of coin, gold, silver, nickel or copper, and each received the same pay for the *weight* only of his contribution. This glaring injustice has been resisted by the dairymen who keep Jersey or Guernsey cows, or improved and costly animals, and who feed them high for the sake of the profit. Hence it has long been the aim of owners of creameries and of manufacturers of creamery supplies to find some means of equalizing the amount of pay with the actual amount of butter in the cream gathered. After many attempts the so-called "oil test" has been adopted.

This "oil test" is simply the actual churning of a sample of the cream gathered from each dairy, so as to ascertain by this practical test the quantity of fat contained in the cream. Each patron skims his own cream and prepares it for the collector. He may safely skim it quite close and take the thickest cream, or he may, if so immorally disposed, put in as much milk or water as he wishes, to thin it and make it measure more. It is all the same to the cream gatherer. He takes the cream, pours it into his own measuring can and notes in his forms or blanks specially provided the inches and tenths in depth by his rule. He then thoroughly stirs the cream and takes from it a certain quantity in a marked glass tube. These tubes are carefully placed in a frame or card provided for them, each marked with the patron's number for identification. There is nothing to prevent each patron from taking a parallel sample and testing it for himself, and everyone should do this for his own sake and satisfaction.

On arrival at the creamery the cards of tubes are handed over to the manager with the cream gathered all in bulk. This bulking and mixing of the cream is indispensable for the production of an even quality of butter. The cards of tubes are set away to be properly ripened, and are then put into a frame in a churn specially provided for them. The cream is churned by oscillating the frame rapidly till the butter comes in all the samples. When this is done the tubes are all set in water hot enough to melt the butter—about 150 degrees. When fully melted, the butter or oil rises to the top and shows a distinct line from the buttermilk, so that its depth can be accurately measured. This done, the manager proceeds to determine the depth of the oil, and to record the results in the blank form partly filled out by the collector. The measuring is done by applying to the oil a scale having for a unit of measure the depth of oil that corresponds to one pound of butter from a gauge of cream, or a pound for each inch in depth of cream in a vessel just one foot in diameter. This unit of measure is graduated into 100 equal parts. If the depth of the oil is exactly equal to one unit of measure, the cream from which the sample was taken will yield just one pound of butter to the inch or gauge; if it overruns or falls short of the unit of measure, the yield per gauge will overrun or fall short just according to the number of hundredths it varies one way or the other. As he measures the oil the manager sets down the rate per inch in the collector's blank, and by multiplying the inches of cream by the rate per inch, fills out the last two columns with the weight of butter due to each patron's cream. It seems to be difficult to get any more satisfactory test than this, because the dairyman can duplicate it by procuring a set of the marked tubes and using them for himself.

A few lines may be usefully devoted to the subject of the value of cream in the market as food, and as a medicinal agent for the nutrition of dyspeptics and consumptive patients. The use of fatty emulsions in medicine is very extensive, cod liver oil being the material used because of its close similarity in composition to the fats of the human body. Butter fat, as it exists in cream, however, is identical in composition with human fats. As the fat of cream is in a state of already prepared emulsion and perfectly fitted for digestion and assimilation, cream becomes a most valuable article of food and of wholesome nutriment for persons of weak digestion and assimilation. The producer of any useful food substance should make himself fully acquainted with every valuable characteristic of it, and this most useful purpose to which cream may be applied should not be ignored by dairymen. No doubt if some enterprising dairyman, able and willing to do it, should put pure sweet cream upon the market in sealed cans or bottles, he would find a most remunerative demand for his product.

CHAPTER XX.

CHURNING AND CHURNS.

THE process of churning is a very simple one. From what has been previously stated in regard to the physical character of milk and cream—the nature of the minute globules of butter fat suspended in the cream; the chemical composition of milk and cream, and the changes which occur in these substances as the process of decomposition begins and proceeds; the results of changes of temperature upon the cream and the progress of this decomposition, with the absolute necessity for the observance of perfect cleanliness all through the work of the dairy—it may be easily understood that a certain carefulness of management, up to the point when the cream is put into the churn and the process of churning is begun, is strictly indispensable for the production of good butter.

Let us repeat in a few words some simple rules for the guidance of the dairyman in his work up to this point, when a new departure is undertaken.

First.—The best cows should be procured, and they should be well bred, well fed, well lodged, and kept thoroughly clean and comfortable, contented and happy.

Second.—The milk should be drawn in the most cleanly manner, thoroughly strained, and carried at once to the milk-house, where it is set in a pure atmosphere at a temperature of forty-five degrees for deep setting and sixty to sixty-two degrees for shallow setting.

Third.—Twenty-four hours is long enough for the milk to stand in deep pails, and thirty-six hours for shallow pans, before the cream is removed, and under the above rules the milk should be perfectly sweet at the skimming.

Fourth.—The cream should be kept twenty-four to thirty-six hours at a temperature of sixty degrees; but no longer than until it is slightly acid, the time being wholly immaterial. This condition of the cream is the important point to be watched with extreme carefulness, whatever the time or temperature; but those above mentioned will be found to secure the desired result as a rule.

Fifth.—Every utensil used in the processes up to this point should be of tin and kept scrupulously clean.

Sixth.—Whenever fresh cream is added to the jar the whole should be stirred, to secure a thorough mixture of the whole, that all may ripen evenly.

The careful observance of these six rules will bring the cream to the churn in the right condition for making butter in the best manner. The French have a proverb to the effect that "one who excuses, accuses himself." This should be adopted as a guiding rule in the dairy; for whenever anything goes wrong, and an excuse that this or that is the reason for it, the dairyman accuses himself of some mistake, neglect, or ignorance, and one is as blamable as another. Accidents should never (or hardly ever, for we are all weak creatures at the best), occur in the dairy; constant vigilance is the price of safety from these blunders called accidents, ill-luck, etc.

The churn is next to be considered. And there are churns and churns, 1,200 or more of them; but not more than a dozen in use. Perhaps no more painful instance of the waste of energy, thought, time, and money exists in the history of mankind, than is shown by the collection of models of useless churns stored in the Patent Office lumber-room at Washington. And yet they come, more futile efforts to get something for nothing, and to annihilate time or power in futile attempts to produce a certain mechanical effect by the use of unavailing substitutes.

Churning is a mechanical effect, the simple aggregation of the butter globules into masses by throwing them violently together. There is now no caseous follicle to be rubbed off by pressure of the dasher and squeezing the globules between a close-fitting dash and the sides of the churn. No weary woman need now keep on an exhaustive effort to effect this wearing away a tough envelope, hour after hour, with the laborious up and down churn (most injurious to the vital organs of a female), because the follicle has no longer any existence, even in the imagination of the dairy experts, and because she may sit at ease in a chair and get the very best of butter in twenty minutes, or less, if she choose.

What we know of cream now makes the work of the churn plain and simple. Most of the work heretofore supposed to be necessarily done in the churn is now performed previously. There is no chemical action to be secured by aëration and oxidation; the churning might, in fact, be quite as well performed in an air-tight closed box, were it not that the friction of the particles of cream affects the production of more lactic acid and the decomposition of some of it into butyric acid, with the disengagement of some carbonic acid and hydrogen gases, as was explained in the last chapter. These gases require a vent, and hence an opening in the churn is provided which is closed by a cork or peg, excepting as this is taken out to let the gas escape at the early period of the churning. This chemical action, however, is incident to the churning, and is not one of the effects desired or calculated for. The sole effect is to throw the particles of fat in the cream against each other so as to cause them to adhere.

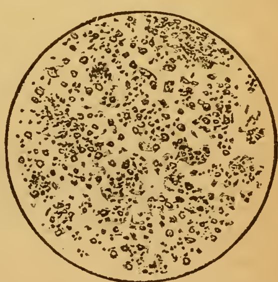

Fig. 50.—MICROSCOPIC APPEARANCE OF CREAM.

A study of the illustration (figure 50) will clearly explain the mechanical effect of the churning. It represents a sample of thick cream taken from a Cooley pail after the milk had stood forty-eight hours and the cream had consolidated until it had fifty per cent of butter in it (a quart of it made two pounds of butter), and was almost of the consistence of clouted cream. It will be seen that the globules of butter have gathered into masses, each mass forming a nucleus for a larger aggre-

Fig. 51.—GRANULAR BUTTER AS IT COMES FROM THE CHURN.

gation. This particular lot of cream, eighteen and a half pounds in weight, was prepared for churning to ascertain the time required. It is easily seen that cream such as this might be supposed to churn very quickly, because the butter globules had already come together in considerable loose masses. The butter was made and taken from the churn in the form shown at figure 51, in eight and a half minutes, the churn used being the Rectangular, a section of which is shown at figure 52 (*c*), for the purpose of illustrating the actual process of churning.

When cream is first put into the churn it is violently agitated. But the amount and force of the agitation varies with the kind of churn used. The common dash churn (figure 52, *a*) is operated by a flat dasher which is forcibly moved up and down in the cream, causing a motion of the cream in the way indicated by the lines. The cream is forced from the center of the churn to the

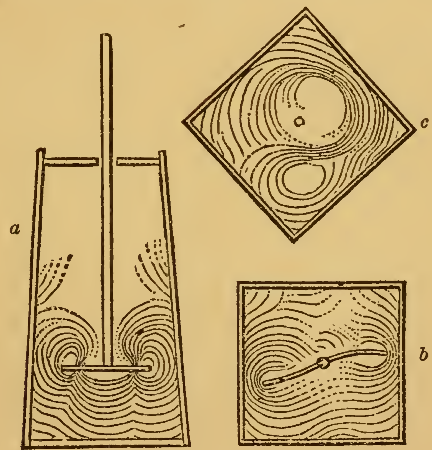

Fig. 52.—EFFECTS OF CHURNINGS.

sides, over the edge of the dasher and back to the center, where it meets the cream from opposite sides, and thus it is dashed together. Being unconfined, however, the force of the collision is very much lessened, and the cream escapes in spray or waves which rebound from the sides of the churn and fall back.

At *b*, in the same figure, is a representation of the horizontal dash churn, of which the well-known Blanchard churn is a popular type. The bottom of most of these churns, however, is rounded and not square, for the sake of more easy cleaning. This advantage, however, we think is gained at the expense of effect, but it accords with the popular preference. In this kind of churn, when it is not filled quite so high as the axle, the dasher comes down upon the cream with a sudden impact and forces it into close contact as it is thrown by the arm against the top and opposite side of the churn. The dasher being partly open permits part of the cream to pass through and complicates the agitation.

At *c* is a section of the Rectangular churn, a square box mounted on gudgeons at the opposite angles. The cream, never more than to half fill the churn, is most violently dashed against the sides of this churn as it is rotated by the handle; and as the box is hung by opposite corners, the cream comes twice into collision with each of these six sides, being dashed against one and rebounding to the other to be forced instantly against the next one, and so on continually. As the rotation is made about eighty times in a minute, there are no less than 960 distinct blows given to the cream in this short period. Consequently the butter is quickly brought to the granular condition in this churn; on one occasion the churning being fully completed by the author in five minutes.

The violent dashing of the cream brings the globules of butter into collision, and when the temperature is quite right, and the globules are consequently in an adhesive condition, they rapidly gather into small masses, and these into larger ones, until the butter appears in grains like those of wheat and buckwheat, when the churning is completed. Any further churning is injurious to the butter. If the temperature of the cream is too low, and the butter globules are consequently too hard, they will not adhere together; they may gather into masses by the force of cohesion, as is shown in figure 50, in which the attraction of the globules for each other has caused the aggregation of most of them into masses, but these masses will break apart again and the butter will appear as grains of sand washing back and forth in the buttermilk, but refusing to be collected any more closely together.

If the temperature is too high and the butter is too soft, the globules may gather into masses, but are beaten apart again and may even be broken up more finely than when in their natural condition, and so form a smooth viscous emulsion which is beaten into a foaming mass from which it is in vain to try to procure butter. The normal temperature for churning cream is sixty to sixty-two degrees, but this may vary either way with the weather. In winter sixty-five or seventy degrees may be permitted, and in hot weather fifty-five degrees may be right. In case of difficulty in either direction, water, cold or warmed, as the condition of the cream may need, may be added to the cream in the churn to remove the trouble and bring the butter. When the cream is too sour, and is thick and adhesive and foams in the churn, the addition of water is sufficient to obviate the impediment to the churning, by thinning the mass and reducing the viscosity of it.

When the butter appears in the churn in small grains or pellets the churning should stop. One can very soon learn to recognize the sound made by the churn when butter has come ; yet it is well to have some other guide, and this is easily secured by fitting a piece of plate-glass in the cover of the churn. When the butter has come the glass will become very nearly clear, and the small fragments of butter may be seen upon it. Over-churning has the effect of injuring the texture of the butter, and changing the waxy, almost crystalline appearance into a soft, greasy one. When the butter is in the best condition after churning, it appears as a mass of small granules loosely adhering together, but which easily fall apart when floated in cold water. These granules are no no larger than the capsules of beet seed, and many of them are not more than half or a quarter as large, and when some cold water is poured into the churn to harden them, they are kept separate and do not adhere in a mass.

The principal complaints of the behavior of the cream in the churn are—difficulty of procuring the butter; foaming of the cream; white specks in the butter; soft, white butter; and waste of cream in the buttermilk. These troubles may arise from improper feeding of the cow; from too long keeping of the cream; from keeeping the cream at too low a temperature; from churning at too low a temperature; and from the condition of the cow. I will consider them one by one, as these are very frequent causes of complaint, especially by inexperienced dairymen and in family dairies.

When the butter will not come, the dairywoman may work for hours and all her labor may be spent in vain, unless she is told to raise the temperature of the cream by throwing into the churn a quantity of water. On one occasion in churning a lot of cream which was full of small butter the butter would not gather, the cream being smooth and somewhat stiff. To test the case the churning was continued for seven hours, and still the cream was unchanged. The temperature was sixty-two degrees. A few quarts of water, sufficient to raise the temperature to sixty-five degrees, were turned in, and in two minutes the butter gathered, but it was white and of bad flavor. This was in the winter. Over-churning had added six months to its age, for the excessive exposure to the air in the long churning had been equivalent to several months' keeping in the pail and had utterly spoiled the quality. But the low temperature was not the real cause of the trouble, for the next churning, noted exactly because it was made in a new churn, was at a temperature of sixty-two degrees, and the butter came in eleven minutes. The next churning was at sixty-five degrees and butter came in eight minutes. So that it could not have been the temperature at which the cream was churned ; but—as it was on January 3d, and the weather had been very cold, the cream-cellar having been down to forty degrees for several days—it was the low temperature at which the cream had been kept that caused the difficulty. Cream that is kept at a temperature of at least fifty-five to sixty degrees, and not more than three days, may always be churned in thirty minutes at a temperature of sixty-two to sixty-five degrees, if the churn is a good one, and in the best churns butter will come in from ten to twenty minutes.

Foaming of cream in the churn may be due to too low or too high a temperature, or too long keeping ; slow, delayed churning is often accompanied by foaming. As soon as the churning begins, air is rapidly intermingled with the cream and innumerable vesicles are formed, each containing air. This expands the cream (as in whipped cream for cooking), and it is really foaming ; but under proper circumstances this foaming subsides as rapidly, and the noiseless motion of the churn quickly changes to a "slap-dash" sound, which precedes the more sharply liquid sound of the coming butter. If the cream is too warm for the particles of butter to unite, the emulsion (foaming) continues until the remedy—a decrease of temperature by addition of cold water—is applied. But this emulsion may be formed in another way, and is often thus formed in the summer, by too long standing of the cream on the milk, or too long keeping of the cream before it is churned. The cause of it is the formation of alcohol in the milk by the decomposition of the milk sugar, and the combination of the alcohol with the fat and the formation of a soap. When this happens no amount of churning will bring the butter. It may be expected when, on skimming the cream from the milk, a layer of whey-like or watery liquid is seen to have been formed between the milk and the cream, and the milk is thick and loppered under it. To prevent the trouble, half a teaspoonful of baking soda or saleratus may be stirred in the cream pot when the cream has been poured into it; and this should always be done, when this has occurred, at least one day before the cream is churned. The washing of the cream previously described will also remove the cause of this trouble.

White specks in the butter are the result of a too rapid souring of the milk or of keeping the cream in too warm a place and not stirring it every day when fresh cream is added to it. When fresh cream, with milk mixed with it, comes in contact with the sour cream, this milk is immediately curdled and the small flakes of curd become inclosed in masses of cream. When the cream is churned these hardened flakes of curd become mixed with the granules of butter and cannot be separated from them by washing. Coloring will not disguise this fault, for the curd will not take the color as the cream will; the coloring is prepared either with potash or oil, and either of these easily unite with the butter, while they will not mix with curd. The only cure for this defect is prevention, by care in managing the cream. But sometimes these specks may be caused by small particles of dry, hard cream from the sides of pans when the milk has been kept too long. Or the milk, from some condition of the cow, may contain an excess of albumen, which is quickly coagulated by a very low condition of acidity, and thus these small masses of albumen appear as soft specks in the butter.

Soft, white butter is caused by uneven temperature in the dairy and by the freezing of the cream or the milk, as well as by the food given to the cows. Some kinds of food will spoil the best cows as regards the quality of the butter, for the time being, and all such should be discarded from the dairy. Potatoes, fed raw, have this effect, with the addition of a disagreeable flavor; and buckwheat bran or meal has a very distinct effect in this way. A week's feeding of buckwheat bran will produce butter of the texture and color of lard. But just here it is a question of management of the cream rather than of feeding that is to be considered. It is of importance that everything about a dairy should be regular and unchangeable. And in the care of the dairy, temperature is one of the essential conditions. If this is neglected and the cream is permitted to freeze, the butter will be white and soft, or sometimes crumbly and break into small fragments. The color may be made right by the addition of coloring, but the soft texture will remain and the butter will lose its proper waxiness and become greasy, and this is beyond remedy. The cause must be prevented by providing some means of warming the dairy to keep the temperature even.

Waste of cream in the buttermilk is the effect of too long keeping, and not stirring the cream to secure evenness of condition. When the cream is turned out into the churn, if the bottom is watery and has a peculiar sweet and whey-like smell, that part of the cream will foam and form an emulsion, and will not mingle with the butter. When the butter is removed from the churn, this remains in the buttermilk, and after standing some time will appear as an oily substance on the surface. Some persons have supposed that the mixing of different cows' milk, or the cream from such milk, produces such a waste as this, because when one portion of the cream is churned another is not. The author has carefully investigated this point for some years, but has never found any evidence tending to support it until the recent publication of some experience by a person who stated that he had churned the cream of several cows separately, and then mixed, and the result was a very marked loss in the mixed cream. The loss was so enormous that some error might be suspected, and at any rate nothing has ever been found to support this statement. On the contrary, it has been found many times that the cream of a cow, which by itself required thirty minutes to churn, was made into butter in twelve minutes when churned with that of another cow whose cream always churned rapidly. A great many trials of cows by churning their cream separately and then with that of others never yet showed any loss. This result is reasonable; for when we consider how butter is gathered in the churn and one particle collects with itself other particles until small granules of butter are formed, and these gather into larger grains by their natural cohesiveness, it is impossible to believe that the butter of one cow can remain in the churn by itself without mixing with the rest, or that if it did it would not leave such very apparent traces of itself in the buttermilk that it could not be lost. If any cream is lost it cannot happen in this way without palpable evidence; but it is lost frequently by mismanaging the cream in the manner previously indicated. The cream is then found floating on the buttermilk, but it is not in such a condition that it can be made into butter of good quality.

CHAPTER XXI.

BUTTER.

When the butter is brought to the granular condition mentioned in the preceding chapter, it goes through the first operations by which it is prepared for use and market. The most important of these is the separation of the buttermilk, which, from its character, is a very potent element of decomposition, and would soon spoil the butter. Buttermilk is a thick viscous fluid containing a large quantity of lactic acid, and we have seen how this acid not only rapidly changes into products injurious to butter, but it contains caseine, which is another element of destructive change in the butter. This will be more fully treated of further on, but is mentioned here to impress upon the butter-maker the very great importance of getting rid of every particle of the buttermilk. The granular form of the butter very much facilitates this separation of the buttermilk, and if the churning is stopped, as it should be, when the butter is no larger than grains of wheat or buckwheat, the buttermilk is drawn off and cold water is poured into the churn. The churn is moved back and forth a few times, and the milky water is drawn off; more water is then used, and this is repeated until it is no longer colored by the buttermilk, and the butter is entirely free from it. There cannot be too much care given to this part of the work. This done, the butter is removed to the butter-worker for salting and working.

Butter is a compound substance consisting of fatty acids, combined with a base known as "oil sugar" or glycerine, and forming neutral bodies known as margarine and oleine; together with certain acids, called butyric, capric and caproic. It is a question, however, whether these acids really form a part of the butter originally, or are not produced in it by decomposition of its fatty elements, aided by the too common impurities which exist in it.

When butter, as it is taken from the churn, is melted in water of a temperature of something less than 180 degrees, and is then washed repeatedly with warm water, oil is obtained which is nearly colorless, and when filtered is clear and transparent. When cooled this oil hardens into a hard whitish fat. By putting this fat into a linen wrapper and pressing it forcibly at a temperature of sixty degrees, a slightly yellow fluid oil is procured from it, while a solid, pure white fat remains in the cloth. This solid white fat is called margarine from its pearly appearance; the fluid oil is called oleine, butter-oil, or oil of butter, and sometimes butyrine.

These two fatty substances are themselves compound in character, for if treated with a hot solution of caustic potash they readily dissolve and form soap. When one of these soaps made from the margarine is dissolved in water and decomposed by the addition of diluted sulphuric acid, a white waxy substance separates, and after having been dried and dissolved in hot alcohol, crystallizes on cooling into pearly scales. This substance has all the properties of an acid and is known as margaric acid.

When the other (the oleine) soap is treated in a similar way an oily substance is separated, differing from the butter oil and having all the properties of an acid. This substance is known as oleic acid of butter, because it has never been obtained from any other substance than the oil of butter. The liquid remaining after the separation of these acids contains a sweet, syrupy, oily substance which, when separated, is the glycerine so well known as the base of neutral oils and fats.

The composition of butter varies considerably in regard to the proportion of these fatty bodies, margarine and oleine. In summer the proportions of these fats are about as follows:

COMPOSITION OF SUMMER BUTTER.

Margarine	40	per cent
Oleine	60	"
	100	

In winter this proportion is nearly reversed, as follows:

COMPOSITION OF WINTER BUTTER.

Margarine	65	per cent
Oleine	35	"
	100	

These compositions are by no means constant, but vary considerably, being affected by the individual animal, the breed, the food, and even by the management of the dairy. This latter is important, because it shows how bad or injudicious work in the dairy may affect the quality of the butter even in chemical composition, as will be shown more fully further on.

Margarine is not only a prevailing constituent of butter, but it exists also in the fat of cattle and in olive oil, and in human fat to a very large extent. Butter is therefore a naturally excellent food for the human race, containing as it does so large a proportion of one of the materials—margarine—of which the human frame is built up. This is white, hard, brittle, and its melting point is 118 degrees. When pure it is unchangeable; but when mixed with the various substances which exist in butter—sugar, lactic acid, and caseine—it absorbs oxygen from the atmosphere and changes into oleine, or one of those odoriferous fatty acids which are present in ripened butter to a small extent, but in old butter to a larger extent, varying from one and a half to two per cent, and potentially to an even greater degree as the provocative impurities may be present. Just here might be mentioned, once more, the very great importance of the preservation of the most perfect purity in every operation of the dairy; because every impurity in milk, cream, butter, or cheese is an active ferment, producing either inherent or internal decomposition or oxidation, by which elements are changed in the most unexpected and surprising manner. Thus by the absorption of a few atoms of oxygen from the atmosphere margaric acid becomes changed into oleic acid and water; the quality of the butter being materially altered for the worse, the firm, waxy texture being lost and a soft, oily, greasy character being assumed. And again, these solid and fluid fats are also changed into the injurious acids which cause the disgusting rancidity which makes bad butter so obnoxious and totally unfit for use, and reduce it far below the so-called bogus butter which is the bugbear and enemy of the dairyman.

The preservation of butter is effected not only by the removal from it of these obnoxious elements, but also by the addition of some antiseptic substances. Salt is most commonly used for this purpose, and this is quite sufficient for pure, well-made butter; but for the neutralizing of impure influences in poor butter, or for concealing the undesirable flavor of it, borax, saltpeter, and sugar are often used, with reasonably good results, considering the difficulty of the operation of reforming bad butter.

Salting and packing butter for sale are two important parts of the business. Salt is a preservative of butter, notwithstanding the statement to the contrary made by persons who evidently do not understand the nature of salt and the action of antiseptics or the character of butter.

Salting butter, however, is a nice operation, and requires a good deal of knowledge and care. The salt should be absolutely pure, and be ground as finely as possible. In our dairy, although using the finest English dairy salt, we ground it over again in a small hand buhr-stone mill, until it was an impalpable powder, and dissolved so quickly on the tongue as to leave no sense of grittiness to the teeth in less than a minute. The butter is salted at the rate of one ounce to the pound, as has been previously described, and after having stood twenty-four hours on the working table, during which time it gradually drains off the surplus water, it is worked over for packing.

In its granular condition it consists of a mass of rounded particles, with brine occupying the interstices, and the working consists of pressing the mass in thin sheets or slices so as to squeeze the grains close together and press out the salt water. By carefully directing the pressure to merely squeeze the butter the rounded grains are pressed flat or lengthwise and intermingled with each other so as to give the butter, under the microscope, a fibrous appearance, much like that of lean meat, the fibers passing in and out among each other, and having a texture much like that of felt. It is this which gives the irregular, waxy fracture to well made butter and makes it solid and free from excessive moisture. To the eye no water appears in butter so made, but when it is newly cut minute drops of clear brine exude from the fresh surface. When examined under a microscope of two hundred diameter power the moisture is seen in very small globules among the fibers, but no crystals of salt are detected. This moisture amounts to about ten or twelve per cent of the weight of the butter. As water holds in solution a large quantity of salt, the ounce of salt to the pound of butter which has been mixed absorbs all the water from the butter and makes it really dry; the salt brine left after the working simply forming a superficial coating over the fibers and protecting them from the atmosphere and the consequent oxidation. The antiseptic effect of salt is due to this absorption of water from whatever substance it is brought into connection with. Water is the most active agent of decomposition and dry matter is indestructible by decay. It is quite a mistake to suppose that animal fats are free from water, and hence salt has no preservative influence upon them. These fats contain a large proportion of water, and salt abstracts the water from them and thus prevents decomposition. Clear mess pork is all fat, and yet it is preserved by salting, and so butter in the same way is preserved from rancidity, which is decomposition of the oleine or soft oily part of it, by this action of the salt, which is called antiseptic, or opposed to decay.

Good butter is wholly spoiled by improper salting, while butter that is not good may be improved and kept from getting worse by salting it carefully. The first requisite is good salt, and few dairy farmers are willing to get salt of the best quality, because of its slightly higher price. The next requisite is to mix the salt thoroughly with the butter. We give two illustrations which will show why these two requisites are indispensable to the making of good butter. At figure 53 is

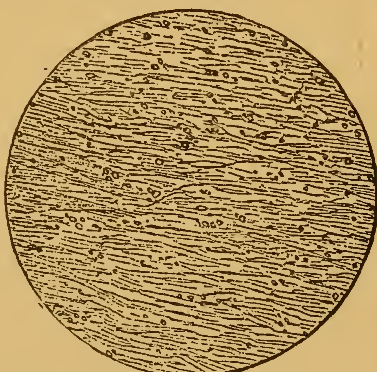

Fig. 53.—BUTTER PROPERLY SALTED.

shown a sample of well-salted butter, as it appears under a microscope. At figure 54 is shown a sample in which salt of a poor quality has been used, and this has not been evenly mixed in the butter. In the first sample, the salt has been entirely dissolved ; not a single crystal remains visible, although the magnifying power used was equal to five hundred diameters. The complete solution of the salt, with thorough mixture of the brine in the butter, and the very perfect working of it, give to the butter a firm, dry and waxy consistence, and an even quality and flavor.

The other sample shows a large quantity of salt undissolved; the peculiar form of the salt crystals is readily perceived. This unevenness injures the quality, and causes the butter to deteriorate very rapidly, because a large portion of it is not affected by the salt, which remains undissolved, and cannot exercise its desired antiseptic action. Moreover, the salt is impure, as is shown by the arrow-head crystals, which are evidently sulphate of lime, a common impurity in a poor quality of salt, which gives a bitter taste to the butter, and causes white spots to appear in it. The bitterness is probably caused by the formation of sulphate of soda (Glauber's

Fig. 54.—BUTTER NOT PROPERLY SALTED.

salt), and the white spots by chloride of calcium, both being produced by the reaction of the dissolved sulphate of lime, and the chloride of sodium (salt), in the butter. The white spots with a dark center are no doubt caused by the action of this chloride of calcium upon the butter; an evidence of this may be found by testing a little of the same with a small fragment of this substance.

When the butter is freed from excess of moisture by this action of pressure above described (and this method is important to be observed), it is ready for packing and should be packed at once. Every minute's exposure to the air tends to injure the quality of the butter. If the butter is intended for immediate use it should nevertheless be as carefully packed as if for a year's keeping. The fancy ways of putting up butter in cakes is not advisable unless they are immediately wrapped in paraffine paper, packed in a tight box and shipped at once. For family use we prefer a small pail holding five pounds, made of spruce or maple veneer, and supplied with a cover and a wire handle (figure 55, *a*). This is very convenient and cheap. The pails are coated inside with paraffine, which makes them air tight, and when closely packed with butter and pressed smoothly on the top a sheet of paraffine paper is carefully spread and turned over the

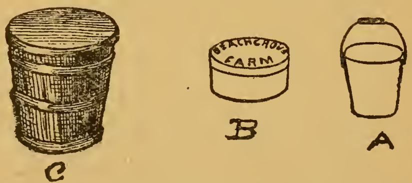

Fig. 55.—*A*, VENEER PAIL, holding five pounds; *B*, VENEER BOX, holding five pounds; *C*, WELSH PAIL, holding twenty pounds.

edge and the cover is put on over it. The pail is then wrapped in strong paper and tied with twine, a pasteboard ticket with the address being tied to it. We have been in the habit of pasting a printed paper over the cover for the purpose of a business card and to further protect the butter from the air. Another very useful package is a five-pound box made of the same material. It is shown at *b*, in figure 55. For the regular trade we prefer the Welsh pail (*c*), holding twenty pounds, and made of spruce. This pail has a tight cover and costs less than a cent a pound for the butter in it. As this pail will generally sell the butter at considerably more than the usual price, it is easily afforded. All packages should be free. A returned butter pail is not a sweet thing and should never be used, hence the advantage of such packages as may be given to the purchasers.

In packing pails of this size some precautions are advisable. The pails should be soaked in salt water the night before they are used. When the butter is ready for packing the pail is rinsed out with boiling water, which stands in it a minute or two, and then with clear cold water; after this the butter is packed at once. A small quantity is pressed down firmly in the bottom, and no more is put in at once than can be packed so closely as to exclude the air and squeeze out any moisture which may be in it. When the pail is full to the edge, a sheet of paraffine paper is pressed over it and the cover is put on and nailed down. Larger pails, tubs, or firkins are packed in the same way. If the packing is carefully performed the butter will improve in flavor by keeping. The slow, gradual ripening process of butter is akin to that which goes on in cheese or in wines and also in fruit. It is an intrinsic change of the elements by chemical decomposition and the formation of new compounds. New butter is no more perfect than is new cheese or new wine. Certain acids are produced in the butter by the slow decomposition of the oleine, as they are in cheese by the slow decomposition of the caseine. The popular idea of decomposition is that it is decay, rottenness, and putridity. To the chemist it is something entirely different. The most delicious odors and flavors are produced by the decomposition of alcohol, and the flavoring extracts and many perfumes are thus produced. The ripening of fruits is a process of decomposition, and so is the ripening of butter and cheese, and the exquisite bouquet of the finest wines. But bad butter or bad cheese, and the *vin ordinaire* of the common kinds, do not contain the pure elements which produce fragrance and exquisite flavor, but their impurities produce the most disagreeable results. Hence the dairyman who can turn out perfect butter may pack it away for long keeping, in the sure expectation that it will go on improving for a considerable time, if he will only secure it safely against the influence of the germ-laden atmosphere.

Other packages used are the half-tub, holding about thirty pounds, a cheap and good package, but not tight enough for long keeping. It is made of white oak, and the firm, solid cover is nailed down and held by three small pieces of tin or hoop iron over the edge. The return pail is a popular package among groceryman; it is made of white oak, and the best kinds are varnished on the outside. It holds fifty pounds. The cover fits closely, and is wedged down by means of a bar, which goes into the ears on the sides. Good butter, well packed in these tubs, will keep a year in perfect order, and if the butter is of the finest quality it will improve in flavor by ripening, when well packed in such a pail, and stored in a cold place. The one hundred pound firkin is used for the foreign trade. It is made very tight, well hooped, and of white oak, and butter packed in it can be kept for months in perfect order. It is also popular in the home market for the retail trade. In packing these firkins it is advisable to bore a small hole in the head just before it is shipped and pour in as much clear, well skimmed brine as will fill any vacancies between the butter and the package. The hole is closed with a well fitting peg cut off flush with the surface.

The vital importance of fine quality in butter cannot be dwelt upon too forcibly or reiterated too frequently. And when the simplicity of the methods required to secure this fine quality and their complete practicability are considered, it is amazing to know that really fine butter that will keep for a few weeks or months is so scarce an article. It is often thought that there is some secret process in it, and worthy persons who try and try, and yet fail to reach their ends, become discouraged because they have not learned the secret. Professor Sheldon, the English dairy expert, gives the following pertinent example:

"Some years ago we knew a widow lady whose butter, especially with respect to flavor, was of a very superior kind; we asked her what her secret was, for we had never tasted such butter at a farm house. 'I have no secret,' she said, 'beyond this. I am always very particular about keeping thoroughly clean every vessel with which the milk and cream come in contact. I frequently have them scalded with boiling water, scrubbed with a hard brush, and well rinsed in clear, cold water, and I am also careful to keep the milk-room clean and dry, and well supplied with fresh air. I am not aware that I have any secret beyond this; in fact, there is no secret in the matter.'"

Many so-called "experts" in dairying, but whose information is gained from theories and not from practice, claim to know a secret or two. Some say brine salting is the secret; others, granular butter; others, again, say ripening of the cream is the one thing needful, while some interested persons will say that Jersey cows, or Holstein-Friesians, or Guernseys, must be kept, or there can be no fine butter made; forgetting that brine salting and granular butter are not new by any means, but as old as our grandmothers, who "ripened" their cream too by simply keeping it until it became slightly acid (the modern ripening), and there was as good butter made by these excellent old ladies as by any modern dairyman, or professor or expert in the dairy art.

The author can never forget the excellent butter made by his mother fifty years ago—the sweetest, most fragrant and well-flavored ever tasted—and can never dissociate it from her exquisitely neat and clean management: the sleek clean Ayrshire cows; the sweet green clover; the old brick stable with smooth stone floor, so clean that the mistress could go about in it with the dainty satin slippers of those days, and silk dress and lace cuffs, and pet her favorite cows; the milk-house of stone into which a clear spring bubbled from its rocky course close by, cold and clear in the hottest day; the long pool inside made of stone slabs, in which the bright red earthen milk jars stood, covered with golden cream; the cool clean brick floor, over which a stray sunbeam flickered as it escaped through the mass of ivy and roses which festooned the barred window, so made to exclude the cats and admit the cool night air, which came sweeping over the green meadows and the waving rustling trees; and the long stone bench raised on brick piers, which held the tubs of butter, packed for sale in the fall, or the jars put down in golden June for the domestic winter supply, and the great bowl filled with the newly churned butter of which it was a grand luxury to steal some to eat with a fresh biscuit. All this, fixed like a photograph on the mind, made a dairyman of the author, and gave him the ambition to own at one time just such a dairy with such a cold spring, and such a solid structure with so pure and sweet surroundings. For if there be a secret in making fine butter these comprise it.

Cleanliness may be said to be entire absence of unnecessary and inappropriate matter. Dirt, as anything unclean is commonly termed, has been aptly described as any matter that is out of place, and there are a great many things connected with dairying which may be out of place. Some articles of food may be wrong; sour food is unclean, for instance; an excess of any kind of food may also be considered in the same light, because it is essentially out of place in the cow's stômach, causing disturbance of the digestive organs, and consequent impurity of the blood, and this injuriously affects the milk and necessarily the butter.

Impure water and foul air are also essentially unclean, for they carry unclean and impure matter directly into the blood and irritate the very source of the milk. All these matters may very easily be ignored or neglected, as not appearing to be proximate elements in this matter of cleanliness, but the experience of every fine butter-maker, of every cheese-maker, and of every person who produces milk for sale, or who sells it, or who manufactures it in any way, all concurrently proves that these errors in the management of the cows are really most serious and have much to do with the very frequent poor quality of butter.

Then we may consider what may be called the gross instances of uncleanliness, the avoidance of which constitutes one of the chief points in the successful management of the dairy. It can be hardly necessary to particularize these, for they are palpable to the commonest understanding, and any dairyman who will milk a cow fouled with manure from a night's rest in dung and filthy litter, or with hands soiled by the coarser work of the stable, or who goes all unwashed from his own bed to the stable to milk, or who can quietly and contentedly go on milking while a filthy stream courses down into the milk pail, or who will dip his filthy fingers into the milk to wet the unclean teats that he may get a firmer hold upon them, or who never uses a brush or card upon his cows, such a man is totally destitute of that natural instinct of cleanliness without which no teaching can influence his reason, any more than talking to a blind man can give him an idea of the beauties of a picture gallery.

Lastly may be mentioned the chemical changes in milk and cream, which are to be most carefully controlled. Milk, as has been explained, is a most complex and unstable fluid, and has within it all the elements and natural proclivities for change and decomposition. It does net need to wait even for the omnipotent oxygen to exercise its action. It merely needs to break apart its atoms to produce within itself the acid which is at once the servant, the master, and the bane of the dairyman. And the presence of this acid in excess is a thing out of place, hence an uncleanliness, an impurity, and destructive of the good qualities of butter. The mere presence of the acid in milk or cream is enough ; one must not wait for its action. It is the same in regard to cheese. As the cream is ripe for the churn as soon as the acid becomes perceptible, so the curd is ready for the press when acid is apparent, and in either case its action is to be prevented by completing the final process at once and before it can produce decomposition in the cream or the curd. Every fine butter-maker will tell us to skim the cream before the milk is sour to the taste ; it then has a slight acid reaction and turns blue litmus paper red or reddish purple, and the cream is to be churned as soon as it is slightly acid. At a temperature of sixty degrees, in a pure atmosphere, milk exposed to the air will be precisely in the right condition for skimming, and at the same temperature and under the same circumstances the cream will be ready for the churn in twenty-four hours ; or if the milk has been kept in the deep pails in water of a temperature of fifty degrees or less and skimmed in twenty-four hours, when all the cream will have risen, the cream will require to stand thirty-six hours at a temperature of sixty degrees to acquire the right stage of acidity for the production of good butter. There is no secret in all this ; it is the alphabet, the rudimentary knowledge, in dairy business.

The disposal of fine butter is an element in the profit of making it of no little importance. When one mentions the fact that choice butter brings a much higher price than the regular market rates for that of an average good quality he is apt to be overwhelmed with requests for information as to where this good butter can be sold for high prices. This is a point upon which dairymen and farmers must exercise their own skill and discretion as they may find means and opportunities. For special products special markets are to be found; in the general market they go to make up an average, and the dealer gets whatever benefit may result from the better quality. If he finds some special purchaser for a few tubs at higher prices than are usual, he considers the profit so made as justly due to him for his trouble in seeking purchasers and handling the butter. To get the desired advantage from the better quality of the product the dairyman must be in direct communication with the consumer and avoid the charges incidental to the services of a middleman; moreover, the butter must be put up in packages or small size suitable for domestic use, and must be delivered at regular periods without any failure, and constantly, through the year. This should be evident to persons who are desirous of going into this business, for a family using a certain quantity of butter weekly needs it on stated days, and any disappointment disturbs the whole domestic arrangements. This is a part of the price, and the trouble thus caused to the dairyman is an equivalent for the higher price received.

The question is, How can the maker of butter of first-rate quality, who is able to supply families in the winter, chiefly, and in the summer except for the few weeks when these families are spending vacations in the country, bring his product to the notice of these consumers?

As in all similar cases, a work of probation is required to gain the requisite experience and success in catering to the wants of these persons. The dairyman, ambitious of a reputation, and desirous of the profit incident thereto, begins at home. In his nearest village he will find by inquiry some families who desire what he has to dispose of. He may supply these as far as he can, and in the meantime continue to sell his surplus by the regular commission agent. But while doing this he may secure a very great advantage by advertising himself and his product. He may choose a name for his dairy, and with a proper iron brand the bottom (inside) of his pails with his name and that of his dairy and his full address. In short, he should publish his business cards upon his packages in such a manner that the commission agent cannot obliterate it with his shaving tool. A dairyman who in the course of a few years built up a most profitable private trade began in this way. He made good butter and shipped it in fifty-pound pails to the New York market, where it brought the highest ordinary market price. He happened to have an application from a resident of the adjacent village for a casual supply in an emergency, and in accordance with his constant custom did his best in accommodating the purchaser. This led to a yearly contract for a regular supply at ten cents a pound above the highest price heretofore obtained. A brand, with his name, was then burned into the inside bottom of every pail shipped, and the greatest care was used to pack the butter in the very best manner. Fine bleached cheese-cloth linings were used for the pails and for covering the butter. In a short time a letter was received from a city caterer who had bought a pail of the butter, asking for direct shipments, and a trade was thus opened which soon enlarged, and included eggs, poultry, spring chickens, home-made sausages, fruits, vegetables, and spring lambs. Some months this single customer took $200 worth of such produce from the farm. Then an advertisement in a city daily newspaper brought several private customers, who paid still higher prices for five-pound pails delivered weekly by express. In this way a trade was secured by which prices were gradually advanced until seventy-five cents a pound was readily secured for the butter and equally good prices for fresh eggs and poultry.

It is by similar methods that the fancy prices, some equal to $1.00 and $1.25 a pound, have been procured for butter which was really no better than some put up in large packages and sold only at the top of the general market, or one-half or one-fourth as much. The difference in the price paid was procured because of the good and even quality, the freshness, the certainty of supply, and the neat and attractive package, which contained enough for a week's use, and which could be thrown away when used. All these conveniences are paid for without stint by a certain class of purchasers, and the only trouble is for the dairyman to find them and so secure his market.

The use of some materials for the preservation of butter that is exposed to unusually adverse influences is often necessary. As fresh butter is a very perishable product, and to a large extent in both small and large dairies is required to be preserved in good condition for lengthened periods, the methods of preserving it are worthy of notice. At the outset it is necessary to utter a caution against all the so-called butter powders which are offered for sale and pressed upon public notice as agents for increasing the quantity of butter as well as for preserving it. Some of these deserve to be called frauds, for they are not what they are set forth to be, and the stuff produced by them is not butter, but a mixture of butter and curd made by means of alum, saleratus and other similar substances, with sufficient coloring matter to give it some appearance of butter. But it is not butter by any means, and can only be disposed of by false representations. As a matter of course, no person would make such stuff for his own use; but many might be deceived by the delusive advertisements into purchasing and trying these butter powders, to their own disappointment and injury. As a general rule, all these mixtures by which the quantity of the butter is proposed to be increased may be considered as injurious, because the butter cannot be increased in any manner whatever, except by the addition of milk, curd, or water, and any one of these is hurtful to the butter, and to the extent that the additional weight and bulk are not butter it is a deceit and a fraud.

The quantity of salt used is from one-half to a whole ounce for a pound of butter. The quantity is varied as the butter may require to be kept for some time or is intended for immediate use. In the latter case half an ounce to the pound is sufficient; when the butter is to be kept two or three months three-quarters of an ounce should be used, and for the longest period a full ounce will be required. It depends very much upon the way in which the butter is made. If we take the butter as it comes from the churn, as described at the opening of this chapter, in the form of small grains and quite free from buttermilk, and drained from all surplus water by remaining in the churn for two hours, half an ounce of salt is enough. This is sprinkled evenly over the butter, which is then gathered with the ladle or worked with the butter-worker so as to incorporate the salt thoroughly with the butter. The water in the butter immediately dissolves this salt. For the complete solution of salt about three or four times its weight of water is required. If half an ounce of salt is completely dissolved in a pound of butter, there will be at least two ounces of brine in it, which is equal to about ten per cent of moisture, which is considerably less than the average. Hence it is seen that there must be nearly twenty per cent of water in butter to dissolve one ounce of salt and completely avoid the presence of salt crystals in it. But when this amount of moisture exists in the butter a large part of it will be worked out after the salt has been dissolved. In the majority of cases, perhaps, butter of the ordinary character salted at the rate of one ounce to the pound will lose nearly one-half of it by drainage, and if the butter—as is exceedingly probable—contains some remaining buttermilk in it, this full allowance of salt will be required for its preservation from early rancidity. In short, the salting of butter must be done judiciously, and with a knowledge and consideration of the principles involved in it, as heretofore explained in the full and careful statement made of the character and behavior of the milk and the cream, and the action of the chemical agents to which they are exposed upon them.

Saltpeter, sugar, borax, and some preparations of borax have been and are used in packing butter. Saltpeter and sugar are both antiseptics and add an agreeable flavor to butter. On this account they are used with salt to repack butter that has been badly packed at first, or to mix with inferior and poorly made butter as a means of disguising its bad qualities. They are really for the use of the incompetent dairyman or for the professional packer of "store butter," who gathers from all sources butter of all qualities of badness and repacks it for sale. For this purpose, one part of saltpeter and one part of white sugar finely powdered are added to four parts of salt, and an ounce and a quarter of the mixture is used with each pound of butter previously well washed with pure water.

The use of borax in dairying is somewhat new. There is no doubt that this salt—borate of soda, which is a combination of 36.58 per cent of boracic acid, with 16.25 per cent of soda, and 47.17 per cent of water—is an excellent antiseptic ; but its effect upon the human system is said to be injurious. Some experiments have been made in Europe with borax as a butter preservative with no positive ill results; and it seems that its suspected disadvantages may, after all, be more fancied than real. It has been used as a substitute for salt in the usual quantity, viz., about six per cent, having first been freed from the water of crystallization by heating it on an iron plate and then reducing it to a fine powder.

Several other butter preservatives are in the market and are offered to dairymen. Of these one known as glacialine is a powder, the base of which is probably borax. Another is a liquid used by the Aylesbury Dairy Company of England in their business, and is said to be an excellent substitute for salt. It is believed to be a preparation of phosphoric acid. A trial with this preparation has so far been satisfactory, a pail of butter packed with it being in unusually good condition after five months, and the butter having no objectionable qualities. Certainly, the butter seems to keep better than with salt under the same circumstances. One liquid ounce of the preparation is used for sixteen pounds of butter along with one-fourth of the usual quantity of salt. The liquid is first thoroughly well incorporated with the butter spread out upon a slab or the bowl and roughly indented with the ladle, the indentations being then closed over carefully to prevent escape of the liquid, and salt at the rate of one ounce to four pounds being then added and the whole well mixed. Butter so prepared is said to keep perfectly well even when exposed to the air.

A most effective method of preserving butter is by cold storage. Few dairies have facilities for the safe keeping of butter during the summer. This requires a low, steady temperature and a moist atmosphere, but more particularly an air-tight package. Those who make a business of storing butter at this season, when prices are low, and sales are not nearly equal to the production, make use of ice-houses or refrigerators, in which the butter may be kept at a low and even temperature, varying from thirty-eight to forty-five degrees. In the hands of any but an expert, cold storage with ice is dangerous, because if the temperature varies, damage is done immediately; for the effect of a low temperature is to so change the molecular arrangement of the particles of perishable substances as to hasten their disorganization and decomposition on the occurrence of a higher temperature. And once this higher temperature occurs, the mischief is done, and cannot wholly be arrested by restoring the former conditions. So that unless one is well provided for maintaining a steady degree of low temperature, it is better to avoid the use of ice altogether, and trust solely to a deep, closed cellar, used only for this storage. June butter is better adapted for long keeping than that made at any other season, for its quality is of the best, and its texture is firm and solid, and if it is well packed in air-tight tubs, pails, or firkins, it may be very well kept at the ordinary temperature of a fairly good cellar or well-constructed spring-house. The packing, however, has much to do with the preservation of the butter, for the air must be excluded so that its decomposing effect is avoided and the evaporation of the moisture in the butter is prevented. When the butter is packed, the top may be covered with a sheet of paraffine paper, and if the whole inside of the tub or firkin were covered with it the air might be better excluded. The butter should not come within a quarter of an inch of the top edge of the package, and this space should be filled with a mush of wet salt plastered evenly over it and level with the edge. This will dry in a solid cake, and if covered with paraffine paper would be still more resistant to the atmosphere. Packages so prepared may be safely kept in a good cellar. But it would be preferable to prepare a cellar specially for this use. An excellent one for this purpose will be a two-story cellar—so to speak—or one that has a sub-cellar under it. These are common in the Southern States, but are seldom seen in the North, where, however, they would be equally useful, for our summers attain as high a temperature sometimes as those in the South. These cellars are made about twelve to fifteen feet deep, are lined with brick or stone, and are provided with a winding stair around the sides, and a floor eight feet from the bottom. In the center of this floor there is a square opening covered with a sash similar to a skylight; at one side is a trap-door leading to the stairs. The lining should be cleanly whitewashed, which reflects the light and makes the cellar bright, clean, and fresh-looking. A raised bench of brick or stone work, at least eighteen inches high, should be built around the cellar, upon which the butter is ranged, as this precludes all danger of earthly contamination when so raised. The upper part of the building is raised about four feet above the surface and covered with a broad roof. The wall above ground should be double, with a foot of air space between the two, and the door should be protected with a porch. A window on the north side only will be sufficient for light. The upper part may be used for a dairy-room, but nothing should be done or permitted in it that could in any way cause impurities to collect in the cellar below. The temperature in a cellar of this kind may be kept at fifty-five degrees through the summer, if it is opened in the winter time so that the walls may be made cold. Any excess of dampness may be reduced by the occasional exposure of a basket of fresh lime in the cellar. A peck of lime weighing twenty pounds will absorb three quarts of water without becoming moist, and this dry-slaked lime will always be found useful, so that there will be no waste. The release of this moisture from the walls and floor of the cellar will lower the temperature, and, with the water, the lime will absorb any injurious or odorous matter dissolved or taken up by it. A cellar twelve feet square will be sufficiently large to store the butter, and also to set the milk, if that is desired. There will be no harm in this to the butter, if the milk is not spilled about or suffered to become very sour in it. A well-kept milk-cellar should have nothing in it that could injure butter that might be kept there, and the cellar could be used very well for both purposes. A plan of this kind would be preferable to the use of ice, and would be cheaper in the end. The use of ice for the cold storage of butter and for the cooling of dairies will be treated of fully in a future chapter.

CHAPTER XXII.

CREAMERIES.

The creamery is a co-operative dairy, in which the labor is done by one person, either hired by the owners of the farms which supply the milk, or by the owner of the creamery. Usually they are of two kinds: private business establishments which purchase cream at a stated price from the patrons, or joint stock concerns in which the capital is procured by the sale of shares, the shareholders being any persons who may desire to invest money in such an enterprise. A creamery is of the greatest advantage in any community where a sufficient number of cows are kept within convenient distance for gathering the cream, as a large number of families are relieved of the care and labor of making butter, by selling the cream; the butter made is of far better quality, being made under the best conditions by one person who is an expert, and it is also all alike, which is important in marketing the produce.

The following description of a very successful creamery in Connecticut may be given as a type of what a creamery should be, how it is managed, what it costs, and the results gained. It is a joint-stock concern, having a capital of $3,500, divided into 140 shares of $25 each, and no shareholder can hold more than eight shares. The stock is held mostly by the patrons, the remainder being owned by residents of the village in which it is situated. The building (figure 56) is situated on a hillside, and has a road entirely around it, which is found a great convenience in doing business. The cream is thus delivered on the upper floor (figure 58) and is poured through the cream-receiver in the vats on the lower floor. There is an ice-water tank on this floor, which is supplied from a spring several feet above its level and a short distance away from the building. This tank supplies the cold water used in the cream vats for preserving it sweet

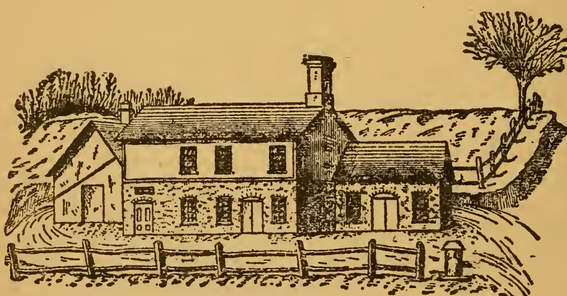

Fig. 56.—THE WALKILL CREAMERY.

in the hot weather, and keeping the temperature even during all the sudden and violent changes of it in the summer season, and, in fact, during the whole year, for a too low temperature in the winter is quite as disastrous as a too high elevation of it in the summer.

The cream-room below is reached by a staircase. This room is on the ground floor or basement. The addition at one end (figure 57) contains the engine and boiler, the coal bins and the office. The work-room contains two large churns, the butter-worker, and a drain for carrying away the buttermilk. The cream is drawn off from the vats by means of pipes, as shown, the vats being elevated above the churns sufficiently for this purpose. The cream-room is furnished with three cream vats, and pipes from the receiver above carry the cream into the vats. Everything of this kind is done through pipes ; the water and steam for cleansing the utensils and floors are brought in

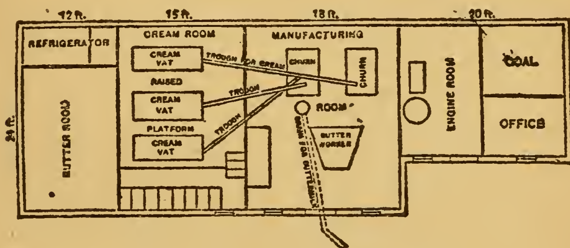

Fig. 57.—PLAN OF GROUND FLOOR.

this way, and thus labor is saved in every possible manner. The buttermilk is run into a large cistern below the creamery, and at a sufficient distance from it to avoid any disagreeable odor, and it is pumped from this cistern into barrels for those farmers who may wish to purchase it, at one cent a gallon, for feeding hogs. The butter-room is used for storing the butter, and is furnished

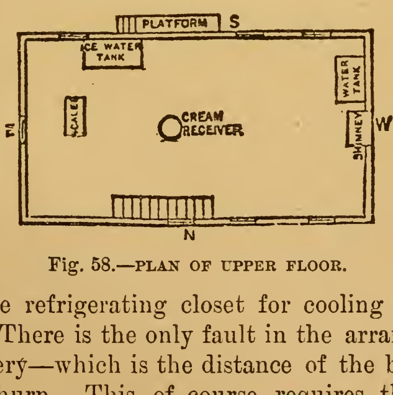

Fig. 58.—PLAN OF UPPER FLOOR.

with a large refrigerating closet for cooling it in warm weather. There is the only fault in the arrangement of this creamerý—which is the distance of the butter-room from the churn. This, of course, requires the labor of moving the butter quite a distance to the store-room, when the store and packing-room should adjoin the churning-room. The arrangement, however, was so made on account of the ice-house being next to it, and because of the nature of the ground preventing an addition to the main building in the rear, where, otherwise, the ice-house and butter-room should rightly be placed. The ice-house is at the end of the butter-room. This is a building eighteen by twenty feet and twelve feet high, finished in a neat and complete manner at a cost of $180, and holds sixty-five tons. The creek which flows past the creamery has been dammed, and forms a pond in which ice is cut. Just here might be said a word or two in regard to the supply of ice in Southern creameries. It is by no means necessary that ice should be a foot thick to be fit for cutting and storing for summer use. If it is one inch thick it may be taken up then as well as at any other time, for ice has a peculiar property called regelation, by which it adheres and freezes together in a solid mass when thin sheets of it are placed in contact. Thus, if thin ice is stored during freezing weather, it is equally safe as if it was put away a foot thick, and it is rare that ice of two or three inches thick could not be procured in any locality where dairying may be carried on satisfactorily. The ice-house for a creamery in the South should be larger than one in the North, because of the longer warm Southern summer; but, on the other hand, the most of the Southern dairying would naturally be done in the winter, when good grazing is possible for the greater part or the whole of it, when the right arrangements are made, and thus the ice question is reduced to a very easy solution. Yet, it would be wise to have a large ice-house, and to have it divided into two compartments, one to be reserved until the other is exhausted.

The cost of such a building as is here described, constructed in the very latest manner, is about $1,700, inclusive of land; water privileges, drains, and the furniture all included would take $1,200 to $1,300 more. The main building is forty-five feet long and twenty-five feet wide; the addition is twenty-five feet long and seventeen feet wide. The basement is brick, with walls twelve inches thick and eleven feet high; the upper part is of frame, and eight feet high to the plates. In most localities in the South, and many places in the North and West, the building may be put up for much less money. In the Southern States a very good and useful building of this size may be finished for $1,000, and furnished for $1,200 more. The cost of the furniture, of course, depends upon its completeness and kind, and the above estimate includes the very best and most improved and effective apparatus. This creamery uses the cream of 400 cows, and 2,000 to 2,500 pounds of butter are made weekly, according to the season. This is quite as large a product as is consistent with the most profit. It is one of the interesting facts in regard to creameries, that the butter sells for fully one-third more than can be procured for that made in small dairies, which gives the patrons a great advantage in addition to the saving of labor. The work done in this creamery in 1886 was as follows:

Butter made, pounds	83,147
Total sales	$ 27,125
Paid to farmers	23,158
Expenses	4,074
Cost of making a pound of butter	4½ cts

EXPENSES.

Wages of butter makers	$1,075 00
Gathering cream	1,873 35
Delivering butter to market	1,045 00
Insurance, taxes, and pasturage	254 36
Coal and salt	183 45
Management and small expenses	642 84

The system of gathering the cream is as follows: Every patron uses the Cooley or submerged system milk pails, each holding eighteen quarts of milk. These are kept in vats of ice water at a low temperature; so that when distant from the creamery the cream need not be gathered more than two or three times a week. These cans have a glass window in the upper part through which the cream can be seen as it separates from the milk. This glass strip is marked into spaces of nineteen-sixty-fourths of an inch each, and the spaces are taken as the standard measurement of the cream. The eighteen-quart can of milk gives from eight to seventeen spaces of cream, as the quality of the cows vary. Good cows giving more than poor ones, the owner gets more money from the milk, and thus the injustice of selling milk of poor cows for the same price per quart as that of good cows is done away with, and every farmer is paid precisely what his milk is actually worth. About six to seven spaces of cream yield a pound of butter, varying from six and a half to seven and a half, as the feeding differs through the summer. As the price paid is 3.83 cents per space, the average twelve spaces will pay nearly forty-six cents per eighteen-quart can of milk, from which two pounds of butter is made, yielding nearly twenty-three cents a pound for the butter without any labor or cost of making it. In this creamery the 400 cows produced an average of 207.60 pounds per cow net, and free from labor and cost, except for milking and caring for the milk.

There are several other kinds of cans used for raising cream, but all are of the same character: viz., they are deep and are set in ice water, and have a standard gauge for measuring cream. Most of these gauges are marked with inches, and one inch is taken for one pound of butter. But as all patrons of any creamery use the same kind of milk-cans for setting for cream, every one stands on exactly the same footing in this respect, and gets the same value for the cream.

The advantage of keeping only good cows and of feeding them well is apparent. The milk is drawn by a faucet from the bottom of the can, leaving the cream, which is then drawn off into the cream-gatherer's pails. The quantity of cream is noted and a ticket is given for it, and these tickets are paid for at the end of every month in cash when presented at the office of the creamery. In co-operative creameries a certain price is fixed for the season, in accordance with the price of butter, and leaving a small fund in hand, which is divided at the end of the season; or the price of the cream is raised from time to time, as can be afforded. In private creameries the cream is bought and paid for at a fixed rate as the butter market may afford.

The creamery system is of general application, and may be made available both for the associated dairies, and for large single dairies. Its greatest and most effective development, however, is through association, by which a large number of farmers and small dairymen may enjoy all its benefits. There are creameries which work up the product of several hundred cows and are patronized by fifty or more farmers. Deep setting requires much less space than shallow setting, and this economy of space lessens the necessary amount of floor room in the creamery, which, of course, reduces the cost of the building, The cost of the necessary apparatus for a 600-cow creamery, with cheese-making furniture complete, including a six-horse power steam engine and an eight-horse power boiler, amounts to about $1,500. The cost of a small creamery for butter alone for eighty to one hundred cows would be little more than $350, including the building, if the deep pails be used, and strict economy be exercised.

Such a creamery as this, arranged on a low basis of cost, may be constructed as follows:—A frame building with double walls, the studs being six inches wide and covered under the boarding with air-tight roofing paper.

The outside is of novelty siding which lies close upon the studding; the inside is sheeted with narrow, matched stuff. This gives a sufficient and perfect air-space which equalizes the temperature. The main building is thirteen by twenty-one feet outside, has two windows, and one outside door. The annex is nine by nine feet outside and has an arched passageway, but no door; in this is a water heater, and a sink provided with a pump; a window over the sink lights this wash-room. The main room contains a pool, six by twelve feet, which holds 120 eight-inch fourteen-quart or thirty-pound pails, twenty inches deep. This will be sufficient for nearly 100 cows, and it is best to have the pool of ample size rather than barely large enough. The pool or vat should be built up of cream-colored brick laid in cement, and, if not wholly sunk in the floor, should be inclosed in a pine-plank frame strengthened with two three-quarter-inch galvanized iron rods passing from side to side and held by washers and nuts on the outside of the frame. A raised vat will be found more convenient than one sunk in the floor, as stooping will be avoided. A one-horse power is placed under a shed, with the driving pulley brought into the building; a belt from this works the churn. The butter-worker may be kept in the wash-room. The whole floor should be of matched pine with the joints calked and the boards well painted; the floor should incline one inch from the sides to the center, where a wide groove or narrow gutter should lead the drainage to a pipe under the sink where it escapes into the trapped drain. A pump to supply water to the vat, if needed, may be set near the vat and worked by a belt from the horse power. Both the pumps may be connected with one well near the house, if running water is not available. This plan may be adapted to small private dairies, and the smallest dairy may be arranged in a similar manner. A hanging rack above the vat may be provided to hold the spare pails and utensils that are not in use, so that the space occupied by the vat will not be lost. A ventilator should be made in the roof and the building should have half a story above the main floor to aid in the ventilation. An extra pump should be located in some convenient place.

For a large creamery the following plan and specifications, given by a leading creamery furnisher, will be

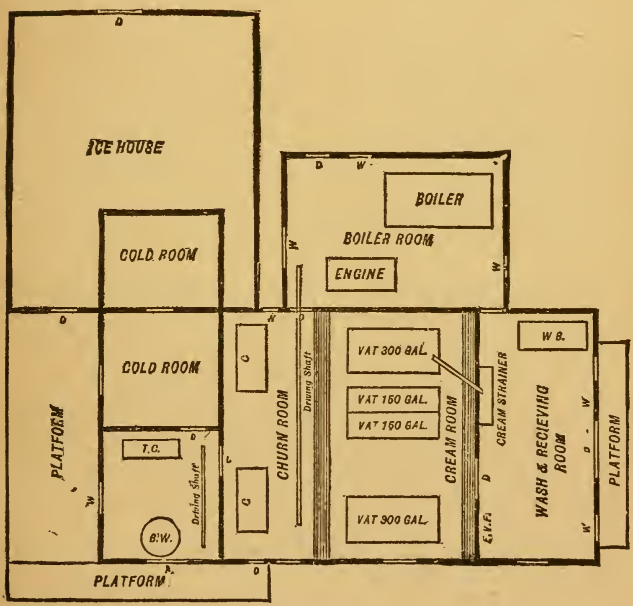

Fig. 59.—PLAN OF CREAMERY.

found useful (figure 59). The main creamery building is 20 x 40 feet; ice-house 20 x 30 feet; boiler-room 16 x 18 feet; divided as follows: Main part divided into five rooms. Receiving room 9 x 20, slanting floor and drain. Can be used for receiving and straining the cream, washing cans, etc. Floor elevated four feet above sills. Cream room 12 x 20 feet, with slant floor draining on the churn floor, floor elevated two feet above sills; used as a cream-tempering room. Churn room 9 x 20 feet, floor on level with sills, slanting towards cream room, with drain at the junction with elevated floor of cream room. Butter room 10 x 10 feet, slant floor, drain connects with main drain in churn room. Cold room No. 1, 10 x 10 feet, used for storage for salt, tubs, butter, etc. Cold storage room No. 2, for storing butter, is 10 x 10 feet, built in the ice-house and covered with galvanized iron, and is surrounded with ice.

The creamery is built as follows: Joist for elevated floor, 2 x 8, spiked to studs supported in center with 4 x 6 timbers, shored up on pillars. Ends shored up with 2 x 4 studs; outside walls 2 x 4 studding, 12 feet long. On outside of studs nail rough inch boards; paper with building paper, fur on it with inch strips; side with drop siding, or stock-boards stripped; on inside of studs, rough board, paper, fur out with inch strips and ceil with fence flooring, ceiling overhead with fence flooring; floor laid with clear flooring; partitions ceiled on studs set flat ways, on both sides, leaving two-inch air space. Cream and churn rooms can be in one, or partitioned, as desired.

The above-described creamery has capacity sufficient to manufacture from 700 to 1,200 pounds of butter a day. To enlarge its capacity add to the width of main building. The raised floors are constructed for convenience in handling cream. Cream taken into receiving room, strained and carried into vats through conductor pipes; also from vats to churns, through conductor pipe, saving all lifting of cream in cans, rendering it possible for one man to do one-half more work than in a creamery without raised floors. An office can be taken off of wash-room if desired.

The following list of apparatus is suitable for this size creamery:

1 6 H. P. Engine with Vertical Boiler all complete	$ 315.00
3 300 gallon Steam Vats @ $40.00	120.00
2 250 " Creamery Churns @ 35.00	70.00
1 Power Butter Worker	50.00
1 Covered Crank Suction and Force Pump	25.00
1 240lb Union Family Scale	6.00
1 Butter Salting Scale	5.00
2 Butter Ladles @ 25	50
2 14-quart Iron Clad Milk Pails @ 1.00	2.00
16 feet $1\frac{7}{16}$ Main Shafting @ 55	8.88
6 " Counter " $1\frac{7}{16}$ 55 @	3.30
6 $1\frac{7}{16}$ Drop Hangers @ 3.50	21.00
1 Pulley 24 x 5 x $1\frac{7}{16}$	6.76
1 " 16 x 5 x $1\frac{7}{16}$	4.40
2 " 12 x 8 x $1\frac{7}{16}$ flat face @ 4.60	9.20
2 " 12 x 5 x $1\frac{7}{16}$ round face @ 3.50	7.00
1 " 6 x 6 x $1\frac{7}{16}$ flat	2.80
400 Common Sense Cream Setting Pails	300.00
12 30-gallon Jacketed Cream Carrying Cans	126.00
	$1,082.75

The following will be found a complete bill of material for this creamery as shown in the plan (figure 65).

MATERIAL FOR MAIN BUILDING.

For Sills 6 pieces 6 x 8, 20 ft. long
" " 2 " " 20 "
" Lower Joist, 32 pieces 2 x 8, 20 ft. long.
For Upper Joist, 32 pieces 2 x 6, 20 ft. long.
For Rafters, 42 pieces 2 x 6, 14 ft. long.
" Studding, 109 pieces 2 x 4, 14 ft. long.
For Flooring 1,000 ft.
" Siding 1,900 ft.
" Casing and Cornice 1,200 ft.
" Sheathing, 4,100 ft.
For Ceiling 4,300 ft.
" Strips 1 x 2 in., 900.
" Paper 2,000 square ft.
" Shingles 10,000.

MATERIAL FOR ICE-HOUSE.

For Sills 2 pieces 6 x 8, 30 ft. long.
" " 2 " " 20 "
" Rafters 32 pieces 2 x 6, 14 ft. long.
" Studding 62 pieces 2 x 6, 12 ft. long.

For Sheathing and Roof Boards, 2,300 ft.
For Siding 1,750 ft.
For Cornice and Casing 300 ft.
" Strips 1 x 2 in., 300 ft.
" Shingles 9,000.
" Paper 1,400 square ft.

MATERIAL FOR BOILER-ROOM.

For Sills 2 pieces 6 x 8, 18 ft. long.
" " 2 " " 16 "
" Studs 40 2 x 4 12 ft. long.
" Rafters 14 2 x 4, 18 ft. long.
" Sheathing 1,000 ft. Ceiling Joist 2 x 4, 16 ft. long.
For Siding 800 ft.
For Shingles 3,000.
12 10 x 16 12-light windows.
One Keg of 6 d Nails.
" " 8 "
" " 10 "
" " 20 "
75 ℔. of 4 d "
Labor equivalent to four men's work for 25 days.

The lumber bill includes material for window casings and doors. It will take about five and a half rolls of sheathing paper, costing about $5.50 total. The cost of the lumber, including shingles, may be estimated at $512.25. Thus it will be seen that the total cost of the creamery, according to the plans and specifications here given, is as follows, viz:

Cost of lumber, including shingles	$ 512.25
Windows glazed	27.72
Sheathing paper	5.50
Nails	14.25
Labor, 100 days at $2.50 a day	250.00
Cost of machinery and outfit	1,082.85
Total cost	$1,892.57

The method of gathering the cream from the patrons and valuing it, has been fully explained in a previous chapter and needs no reference here. The management of a combined creamery and cheese factory for the utilization of the whole milk will be described in a future chapter.

Before closing this chapter, the following directions, given by Mr. John Gould, of Ohio, a well-known dairy expert, for the information of persons about to embark in the creamery and factory business, may be read with much benefit. The information given relates more particularly to Ohio and the Western States.

"A suitable building will cost $300 to $600, according to construction, and the machinery as much more. It is always better to get estimates from reliable houses in the dairy furnishing business. Don't fall into the hands of the 'creamery sharks' who rope in the farmers only to wreck the business and make $5,000 by the operation. Deal only with the best houses and firms.

"A creamery can afford to pay what cream is worth, not what inferior store butter will bring. An inch of cream in the common deep pails represents a pound of the finest creamery butter, worth in the market three or four times that of poor, white store butter. Cream should be purchased on the basis of what fine butter brings in New York. Find out by correspondence what it will cost to collect the cream, make and market the butter; add a reasonable sum for your investment, and give the rest to your patrons. Cream should be bought about five cents below New York butter prices.

"Butter and cheese can be made with well water if it can be had in abundance. A butter-room papered on both sides of double walls will be all right if a shallow tank of running water is kept in it. Ship the butter as fast as made. The market has got through paying fancy prices for 'storage' butter. A room to *keep* butter in is not needed. Don't set up a summer butter factory. The market now has threefold too much butter in the summer and not enough in winter. This makes high prices in winter and low prices in summer. It costs no more to winter a cow that gives thirty pounds of butter per month than to winter a dry cow, if one goes at it right. The produce of the winter milker brings two and a half times as much as that of the summer cow.

"The drainage should be good. Large sewer pipes are good if you have water enough to flush them.

"A cellar is not objectionable under a factory. The trouble is to get floors that are water tight; if they are not tight the cellar is bad business.

"On the Western (Ohio) Reserve, as a rule, the milk is all made into cheese. In a less dense dairy district it might be better to sell the cream to a factory and feed the milk on the farm; that is, if fed sweet, and with grain. If it is allowed to sour there is little profit in feeding it.

"Factories pay a sliding scale of prices for milk, governed largely by the price of cheese in New York. Last year the price of all new milk ranged from 80 cents to $1.20 per 100 pounds, from spring to fall. During the five winter months it was about $1.35. In summer the farmer delivers twice a day; in winter, once, but no cream is taken off.

"The profit of the different kinds of cheese depends upon the kind made. The best quality of American cheese sells better than Switzer or any other imitation of the foreign kinds, unless they are of first rate quality.

"If the milk or cream is sold, the buyer owns the buttermilk. At the cheese factory the buttermilk is very apt to find its way into the cheese vats, especially since sweet cream butter is demanded by the market. At a patron factory it would be run into the whey vats, and any patron who would be foolish enough to want to haul home some whey swill, would get his share.

"It takes all the way from nine to eleven pounds of milk, and often more, to make a pound of cheese, according to the season, early or late, and the amount of butter that has first been taken from the milk. A hundred pounds of skim milk is *rich* in cheese, but poor in quality.

"The quantity of milk for a pound of butter depends altogether upon the cows and their feed. *Butter* cows would do it with from fourteen to eighteen pounds of milk. "General purpose cows" want from twenty-two to thirty-one pounds, and some cows would require fifty pounds of milk to make a pound of butter. Average dairies require somewhere about twenty-five pounds of milk to make a pound of butter.

"Patron are paid at the factories usually, once per month, in checks on the nearest bank. Usually this is about the fifteenth of the month. April milk or cream will be paid for on May 15. Patron factories usually pro rata their sales whenever made.

"A practical butter maker usually receives about $50 to $60 per month, and board. A good man is worth $200 per month over a poor one. A poor one should not be tolerated. The best man is always the cheapest. Good butter and cheese makers are often combined in the same man.

"Cream collectors are usually paid by the day or month. The collector usually furnishes his own team, and working by the day is the best plan.

"The per cent profit that could reasonably be expected on the investment of, say an 800-cow creamery would be difficult to decide. It is a purely business venture, and is governed exactly like any other speculation. You must first know your business or you will get left. You must fix prices so that you can stand a big drop in butter in August, and if it drops lower than that, out drops your profit and some more money with it. It would be a good thing to study the market reports for the past five years, and get some value out of 'dry figures.' You are as liable to 'get left' on your *inch of cream* as a basis of a pound of butter as upon anything. You are apt to find afterwards that it only churns out about twelve ounces of butter. There can only be one way to buy cream safely, and that is by the *oil test*—pay for the butter fats in it as demonstrated by hot water. Then you are not paying for a thing you do not get, nor is another man selling more butter fats than he gets credit for. If there are twenty ounces of butter fat in his inch of cream, he gets paid for it, and justice is done all around. And the cream buyer is safe in this, that the estimates of the oil test are verified by the final churn test. It makes the farmer 'squirm' who finds it takes thirty-five pounds of milk from his dairy to make a pound of butter, and is credited with this amount, and another farmer gets credit for a pound for every twenty pounds of milk."

CHAPTER XXIII.

ICE-HOUSES.

A LIBERAL supply of ice is indispensable for a dairy which is operated in the summer. A winter dairy, on the contrary, requires some expenditure for fuel. As regards cost there is little difference. Even the family dairy requires a supply of ice to preserve the milk and cream in good condition during the hottest weather, but the business dairy and the creamery cannot be carried on without it. With the ice-house is also required a cold storage room, for keeping the butter.

The requisites for a supply of ice are—first, a pond of clean pure water; second, a well-constructed house; and third, a sufficient quantity of dry clean sawdust or other similar material for packing. A small ice-house will be sufficient for a family dairy, and the supply may be generally procured from some adjacent mill-pond or a pond made by damming a stream for the purpose of raising a sufficient area of water. As forty cubic feet of ice make a ton, a space ten by eight feet will yield one ton of ice, if it is six inches thick. A pond, then, one hundred by eighty feet, will yield one hundred tons, if of no greater thickness than this. As ice is usually sold on the pond for one dollar per ton, an ice pond will be found an excellent investment in any dairy country. All that is required is a clear running stream, with low banks bordered by flat bottom land. A dam may be thrown across the stream to back the water up to the higher ground on each side.

The dam must be built upon sound principles, or it will not retain the water. The bottom must rest on solid fresh ground, free from stone, grass, or decaying

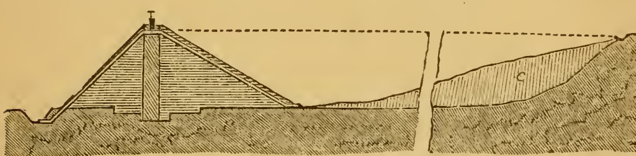

Fig. 60.—SECTION OF DAM AND POND.

vegetable matter. The following method will be found satisfactory. A trench three feet wide is dug out on the line of the dam down to solid ground, clay, or hard pan. Stakes are then driven in the middle of the trench reaching as high as the top of the intended dam, and tongued and grooved or otherwise tightly-fitted planks are nailed to these stakes. Solid earth is then packed and puddled in the trench on both sides of the planks, and the dam is then raised to the hight desired over this foundation (figure 60). The slope of the dam should be such as to make a six-foot dam nine feet wide at the bottom on the inside and six feet wide on the outside, or fifteen feet in all. This slope is needed to prevent leakage and the washing down of the soil. The earth for the dam may be dug out of the intended pond.

The house for storing the ice must be made with non-conducting walls, a dry foundation, and ample ventilation in the roof. A cheap ice-house is as effective, if properly constructed, as the most costly one. There are some general principles to be observed in the proper construction of any kind of ice-house, and all else is of secondary importance. There must be perfect drainage, and no admission of air beneath; ample ventilation and perfect dryness above; and sufficient non-conducting material for packing below, above, and around the ice, by which its low temperature may be preserved. The cheapest ice-house may be made as follows: The foundation should be dug about eighteen inches to two feet deep in a dry, gravelly or sandy soil. If the soil is clay, the foundation should be dug two feet deeper, and filled to that extent with broken bricks, coarse gravel, or clean, sharp sand. To make a drain beneath the ice of any other kind than this would be risky, and if not made with the greatest care to prevent access of air, the drain would cause the loss of the ice in a few weeks of warm weather. Around the inside of the foundation are laid sills of two by six plank, and upon this are "toe-nailed" studs of the same size, ten feet long, at distances of four feet apart. Around these, matched boards or patent siding are then nailed horizontally. A door frame is made at one end, or if the building is over twenty feet long, one may be made at each end for convenience in filling. When the outside boarding reaches the top of the frame, plates of two by six timber are spiked to the studs. Rafters of two by four scantling are then spiked to the frame over the studs; a quarter pitch being sufficient, or if felt roofing is used, a flat roof with a very little slope might be used. In this latter case, however, the hight of the building should be increased at least one foot, to secure sufficient air space above the ice for ventilation. The roof may be of common boards or shingles, or of asbestos roofing; but the roof must be perfectly water-proof, and should have broad eaves to shade the walls as much as possible from the sun's heat. The outside of the building, roof included, should be whitewashed, so as to reflect heat. The inside of the building should be lined with good boards placed horizontally, and the space between the two boardings should be filled closely with the packing. If packing material is scarce, air-proof lining, such as is used in the walls of dwelling-houses, may be substituted for it; but the joints in this case should be carefully made, that the outside air may

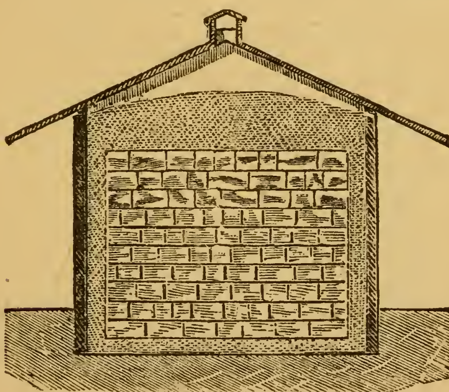

Fig. 61.—SECTION OF ICE-HOUSE FILLED.

be excluded and that within the wall be kept stationary. In figure 61 is shown a section of the house filled with ice; the lining between the walls is shown by the dark shading. The packing around the ice should be a foot thick at the bottom and the sides, and two feet at the top. There should be a capacious ventilator at the top of the house, and the spaces above the plates and between the rafters at the eaves will permit a constant current of air to pass over the upper packing, and remove the collected vapor. The method of closing the doors is shown at figure 62. Boards are placed across the inside of the door as the ice is packed, until the top is reached. Rye or other long straw is tied into bundles, as shown in the illustration, and these bundles are packed tightly into the space between the boards and the door. The door is then closed. We have found these straw bundles to seal up the door-space of an ice-house in summer, as well as the door of a root-cellar in winter, very effectively. When the house is opened in the summer, and the upper packing is disturbed to reach the ice, it should always be

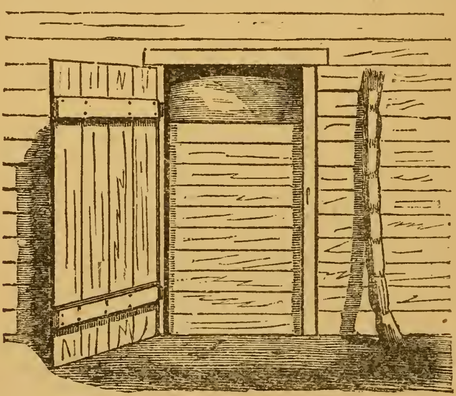

Fig. 62.—DOOR FOR ICE-HOUSE.

carefully replaced, and the door closed up again with the straw bundles. The bundles of straw may be fastened together by means of two or three cross-laths, and they can be removed and replaced very readily. The material required for a house such as is here described, twenty feet long, sixteen feet wide, and ten feet high, and which will hold over sixty tons of ice, is as follows: 324 feet 2 x 6 studding; 12 rafters 2 x 4, 12 feet long; 576 feet matched boards; 720 feet boards for lining; 480 feet roofing boards, 3,000 shingles, or 480 feet of roofing; one batten door, hinges and nails. About twenty-five wagon loads of sawdust or other non-conductor would be needed for a house of this size.

The best packing is dry hard-wood sawdust. About seven hundred bushels will be required for a house twelve feet square, and ten feet high, to give an ample supply. If sawdust cannot be procured, dry waste tan bark will do very well; dry swamp muck, forest leaves, cut straw chaff, or chaff from the threshing machine, are all very good substitutes; but an open air space is only about forty per cent as effective as any one of these substances. A house twelve feet square will hold a mass of ice ten feet square, which will give about five thousand pounds for each foot in hight, yielding a supply of one hundred pounds daily, for about two months. One hundred pounds of ice will cool one hundred pounds of water from one hundred and seventy-four degrees down to thirty-two degrees, absorbing one hundred and forty-two degrees of heat from the water, in the slow process of liquefaction alone. These figures will enable any person to calculate how much ice may be required for any specified effect. Thus as one hundred pounds of ice absorbs fourteen thousand and two hundred units of heat, and we want to cool seven hundred and ten pounds of milk from sixty-five to forty-five degrees, we shall find that the ice will just do it, because seven hundred and ten pounds cooled twenty degrees equals fourteen thousand and two hundred units. In the use of ice, it is therefore seen to be a great economy to cool the milk down to just as low a point as possible, by means of cold well or spring water, before it is set in the ice-water pool. For a three hundred quart dairy, or for twenty-five cows, then, one hundred pounds of ice will be required daily, and for the season of eight months, when ice may be necessary, the ten feet square of ice should be raised eight feet, which will allow for waste, which is usually about forty or fifty per cent on the average of the season. The receptacle may be made in a corner of a barn or shed, or a plain shed may be made out-of-doors, or a space in a mow of straw may be utilized; any device is effective, if only the above named requisites are secured.

A very simple ice-house is made in this way. Nine poles are set in the ground in a spot where surface water will not give trouble. Boards twelve feet long are nailed to the posts lengthwise all around, and the corners are covered with strips, lapping one on to the edge of the other, to make a neat and close finish. The boards are cut out between the two posts in the center of the front to make a doorway, and two inch door-cheeks and lintel are spiked to these posts. The boards from the inside are kept for the loose inside door, to be put in one by one, resting against the door-cheeks, as the ice is filled in, and the outer boards are nailed with wrought nails to upright cleats to make a door. The spaces between the doors are filled in with sawdust; two-inch planks are spiked on the posts flat for plates, and a conical roof with broad eaves, left open at the plates for ventilation, is put in. The ice is packed in as shown in figure 61, and has eighteen inches of sawdust under it, and a foot on each side around it. A covering of eighteen inches should be put on top. In cutting the ice, care is to be taken to get the blocks of even size, so as to pack it closely. A convenient tool with which to get the ice out of the water is made of a piece of board about six or seven feet long, with a handle put through one end, and a cleat nailed on the other end to hold the ice. This slippery stuff is held more firmly if a few sharp-pointed nails are driven through from the back, so that the points project about an inch.

A very neat building suitable for an ice-house for a private dairy is shown at figure 63. This house is twelve feet square, with sills and plates eight-by-eight inches, of hewn logs, and eight-by-eight-inch corner posts, eight feet high. Studding is set in as needed. Rough (or planed) boards are nailed horizontally within and perpendicularly without, and the cracks battened with narrow strips. The wall space is filled with sawdust. Dry wheat chaff might be used in the absence of sawdust. The roof is of single boards, with a ventilating opening at the top. The doors are single, with short cross-boards inside to hold the ice up. The ice is packed in solid,

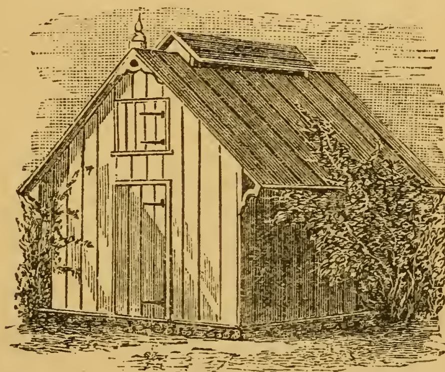

Fig. 63.—ICE-HOUSE FOR PRIVATE DAIRY.

except a space of six or eight inches all around filled with sawdust. When full, a foot or so of sawdust is put on top of the ice. The flooring is of inch boards laid on a bed of cobble stones.

A rustic ice-house on the farm of Donald G. Mitchell, the popular writer, is shown at figure 64. It is given here to show how simple a thing a really effective ice-house may be, and that the materials for its construction are wholly immaterial so long as the principles before mentioned are effectively carried out.

Cold storage is indispensable for the preservation of butter made in the summer time; and at times it is a matter of convenience to use ice for the cooling of the pool in which the milk is kept for the cream to separate. In considering the cooling effect of ice it must be remembered that the low temperature is only gained by the expenditure of the ice, and that it is a question if it is better to make use of an ice-house constructed in the most economical manner, or to so use the ice as to procure a continuous low temperature with the certain large waste of ice that would be inevitable. There may be some cases, however, in which the ease of operating a cooling apparatus may be more convenient, although it may consume more ice, than to handle blocks of ice in carrying them from the ice-house to the

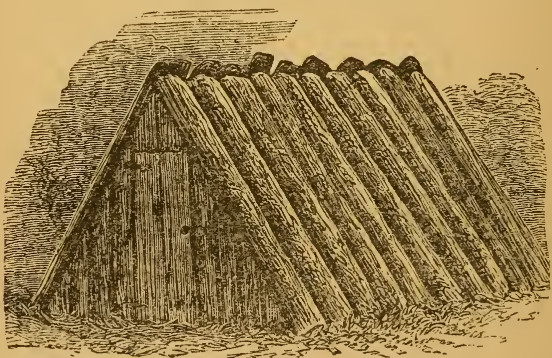

Fig. 64.—RUSTIC ICE-HOUSE.

creamery for use. Where ice is abundant this view of the question may be reasonably considered. A point that bears strongly upon it is that the ice may be stored in the winter when the labor may cost comparatively nothing, because there is plenty of time and opportunity for the work, and in summer time is more valuable and business presses closely upon opportunities, so that the handling of the ice in the summer would, in fact, be more irksome and costly than the waste involved. For to open the ice-house, take out the blocks required, carry them to the creamery, wash from them the sawdust or other packing, and dispose of them as may be required, is, we know from experience, work which occupies considerable time, when time is scarcely to be spared from other pressing duties. The good manager will aim to distribute his work so that it may be done in the easiest manner consistent with the best results, and as time is money, time gained when it is worth the most money is equivalent to three or four times as much expended when it is very cheap. We will give a plan that will be suitable for each method, leaving those interested to choose between them. A self-acting ice-house may be constructed in the usual manner, but requires the addition of ventilating tubes through which cold air may be brought into the cooling room; and drainage pipes by which the water produced by the necessary melting of the ice may be drawn off from the bottom into a cold pool where it may be utilized to the best advantage. A horizontal section or plan of an ice-house of this description is given at figure 65. Here the ice-house adjoining the creamery is shown. Through the body of the ice are four zinc or galvanized iron pipes or tubes having a number of holes bored through the covering at the top to admit the air.

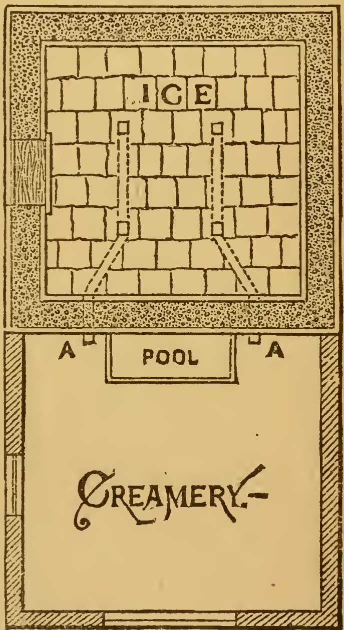

Fig. 65.
PLAN OF CREAMERY AND ICE-HOUSE.

The spiral galvanized water spouting for buildings serves excellently for this purpose. These pipes are brought along the bottom, as shown at figure 66, which is an upright section, and open into the creamery on each side of the cold pool. The current of air which passes through these pipes of course melts and uses up the ice and causes a quantity of cold water to be produced which must be drawn off, or the whole body of ice would rapidly waste. The floor of the ice-house is made to slope a little from each side to the center, and the center slopes to the front just enough to cause the drainage to flow into a pipe provided to receive it. This pipe is protected by a fine wire-gauze covering to prevent the packing from being washed away. The pipe is carried down through the ground and made to discharge at the bottom of the pool. This is important, for if it discharged into the top, air would pass into the ice through it and waste it considerably. The outlet of the pipe being always covered with water prevents any access of air through it.

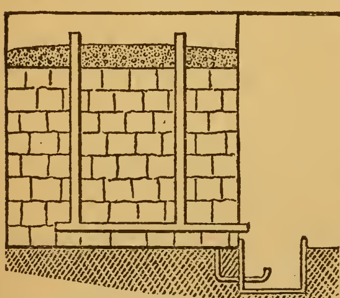

Fig. 66.—CROSS-SECTION OF CREAMERY AND ICE-HOUSE.

At figure 67 is shown the front view of the wall of the creamery with the openings of the cold-air pipes and the tank between them. On one side may be made a refrigerating closet for keeping butter in, or one may be made on each side if desired. This provides cold storage of the most effective kind for a dairy and for keeping eggs for sale in the winter. This may be made of sheet iron nailed on the inside and outside of the studding and also overhead, and painted outside with brown mineral paint and white within. The roof of this closet should slope considerably to the rear (figure 68), and a metal gutter should be provided to catch the water of condensation which will gather on the roof, and this should be carried off outside through a pipe having an ɷ trap in it to prevent air passing in. This arrangement provides in every way for economizing the ice and utilizing the water which wastes from it. It would be necessary to provide stoppers for the pipes, to regulate the flow of cold air and prevent a larger consumption of ice than is neces-

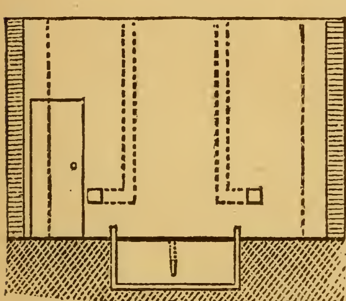

Fig. 67.—ELEVATION OF ICE-HOUSE.

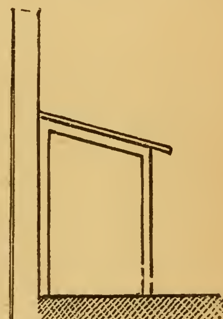

Fig. 68.—COLD CLOSET.

sary; and also to use but one pipe at a time, leaving the other for use when the ice which supplies one is exhausted.

The cold storage houses for use in a larger way, as for large creameries, cheese factories, or for dealers in dairy goods, are constructed upon the simple principle of an ice-house without any packing around the ice, but with a water-tight and well-drained floor over a lower apartment. There is a space of a few inches left between the body of ice and the wall, through which air may circulate and pass down to the room below. A number of holes or gratings are made in the floor for the cold air to descend. The house is built with non-conducting walls, having usually a space of a foot between them packed with dry sawdust, or a new and most excellent material known as mineral wool, which is made of furnace slag blown by a blast into fine threads. These cold storage houses are now in frequent use by fruit growers, butchers, brewers, and poultrymen, as well as dairymen, and are extremely useful.

CHAPTER XXIV.

CHEESE MAKING.

The manufacture of cheese is one of the most important industries connected with the preparation of human food from a raw material. Milk is a complete food. That is, it contains every chemical element required for the perfect nutrition of an animal. It has the fat and sugar needed for combustion in the lungs to support the animal heat and the respiratory process, the caseine to make flesh, and the salts to furnish material for the bones. And cheese is the most convenient permanent form in which milk can be preserved for consumption. It contains the caseine or nitrogenous part of the milk and the fat, leaving only the sugar and the mineral salts in the whey which escapes. These elements are most easily made up or substituted in the form of bread, and hence bread and cheese make the most nutritious food for its weight that can be produced. Cheese is composed of varying proportions of caseine, fat, water, milk acid and some other extractive matters and mineral salts, chiefly the salt used in its manufacture, as follows :

COMPOSITION OF CHEESE.

Per Cent of	*Water.*	*Fat.*	*Caseine.*	*Acid, etc.*	*Ash.*
Extra good	30.53	41.58	23.38	2.45	2.06
Full milk	31.70	36.18	27.19	1.95	2.98
Half skim	38.43	23.28	32.37	2.10	3.82
Skim milk	38.39	23.21	28.37	6.80	3.23

The considerable difference in the quality of these samples of cheese is not any exact criterion of the market values. The excessive quantity of fat in the first mentioned gives no proportional money value to it in the market, the quality most desired in cheese being due to the manner of making and curing it, rather than to the amount of butter fat that may be contained in it. This, however, is to be taken as a general rule only, and one to which there are some exceptions. Thus, while it is true that by certain methods of making and ripening a cheese from half skim or skimmed milk may be advanced in value over some full milk cheese, yet there are some kinds of cheese, as the exquisite English Stilton, which has cream added to the new milk and contains one quart of cream to ten quarts of new milk, which bear a very high value in the market; but this, again, is due quite as much to the peculiar method of making, by which a most delicious flavor is given to it, as to the large quantity of fat contained in it.

But while quality is conferred upon cheese by care and skill in making, and by its contents of fat, there are some other causes for the variation in quality. Soil and climate have something to do with quality, for they control to some extent the character of the herbage, and undoubtedly food has much to do with the flavor of its products. The flesh of animals acquires certain qualities from the feeding; this is unquestionable. The Southdown mutton, fed upon the short rich herbage of the "downs," or hilly rolling seaside pastures on the chalk districts of southern England, and the tender high-flavored meat of the Welsh mountain sheep are examples of this fact. The hams of Westphalia, fed upon the mast of the forests, also have a most agreeable flavor. The wines of some vineyards surpass those of all others in richness of flavor, and the hops of certain localities surpass all others in desirable qualities. Consistently with these analogous facts it cannot be doubted that the pasture, which is affected by soil and climate, has some effect upon the character of dairy products. But, as has been stated in the chapter (II.) on dairy farms and the selection of localities and soil for dairying, the expert and experienced dairyman may make up for all defects in these respects by good culture, fertilizing, and the growth of such crops as will afford every necessary element in the food for the production of good milk, and by such skill in manipulation as will produce the very best quality in the butter and cheese made from it.

In this respect "doctors differ," and some of the American experts have stated as their belief that locality, soil, herbage and water all have a most important influence upon the quality of dairy products. A few years ago it was said that Kentucky could never be made an excellent dairy region, because of the lack of suitable running water and the prevailing character of the soil. The author did not join in this belief and hazarded the opinion that good well water, Kentucky blue grass, clover and other fodder crops, were quite sufficient as a foundation for a successful and profitable dairy business, if the skill could be acquired. This view has been justified by the capture of $300 in various premiums, by a Kentucky lady who manages a well-conducted butter dairy, for her product, which was awarded first place in the competition at the National Dairy Exhibition, held in the city of New York, in the year 1887.

As coinciding with this view, the author's belief is confirmed by leading English experts who cannot fail to see that their famous Cheddar cheese, supposed to be a special product of a favorable locality, soil and pasturage, is actually beaten in competition by the best American "Cheddar," made under wholly different conditions, but by the most skillful dairymen in both the United States and Canada. At the same time we may see American

Limburger, Brié, Edam, Neufchatel, Schweitzer, and other special makes of French, English and German cheese, made in various, widely distant localities, and fully equal in all respects to those made in the localities which became famous a century ago for these cheeses.

"Skillful labor conquers all difficulties," and we do not hesitate to affirm that in cheese making, while there are some naturally favorable conditions for the most successful prosecution of the industry, yet by the application of the necessary skill quite as good qualities, in all the varieties which are produced anywhere in the world, can be made in America upon farms well chosen for their adaptation to the special pursuit, as in any locality elsewhere.

The curd of milk is the material of which cheese is made. This consists of a nitrogenous substance known as caseine, and is included among a group of similar substances which are nearly or quite the same in composition. These substances are—besides caseine—albumen of eggs, blood and vegetable matter, fibrin of flesh and blood, gluten of various grains, as of wheat, oats, and legumin of peas, beans and other luguminous or pod-bearing plants. All these substances are free from color, taste, and odor, are insoluble in water and alcohol, but dissolve in alkaline solutions, coagulate from their solutions on the addition of acids or rennet, and ferment readily, emitting a most disagreeable odor, and producing among other compounds some acids and ammonia. Legumin is used by the Chinese for making cheese which is identical in all respects with the cheese of milk curd.

The caseine is held in solution in the milk by means of the free soda, and is precipitated by the addition of any acid substance; being insoluble in water or any neutral liquid it becomes solid as soon as the soda is neutralized, and the milk is rendered neutral instead of alkaline. A clear understanding of these facts in regard to the caseine is indispensable to the dairyman, who must be able at all times to make his own rules for guidance in emergencies when unexpected difficulties and obstacles arise and are met with.

The caseine may be precipitated or changed into curd—which is its solid form, but rendered soft by the mechanical mixture with it of a large proportion of water—by any acid, and in making some kinds of cheese acetic acid, hydrochloric acid, or lactic acid in the form of sour milk, is used for making the curd. But the commonly used agent for procuring the curd is rennet or the dried stomach of a young unweaned calf which has sucked the dam. Other similar substances are used for this purpose.

The calf's stomach will always be the most popular substance used for this purpose in cheese making, and its preparation may well be considered particularly. The stomach of the newly-killed sucking calf only is used. This contains some of the curd of the milk upon which it has been fed, and in some dairy districts the calf is given a copious drink of milk shortly before it is killed, so that the stomach may contain a larger quantity of this curd, which is preserved with the stomach. The stomach, either emptied of its contents or with these intact, is salted inside and out and dried in a warm place. The usual method is to turn the stomach, shake off the curd, salt the stomach, return it and salt the outer side, then stretch it upon an elastic twig and hang it up to dry (figure 69). When the rennets are perfectly dry they may be put into a bag and hung up in the dairy-room for preservation. Other methods are used in different localities, such as to pickle the stomachs in brine and dry them,

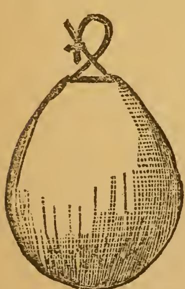

Fig. 69.

or to pack them in jars or barrels in salt and keep them until required for use. In Italy and Switzerland the stomachs are chopped up very fine, mixed with salt, pepper, bread crumbs and whey into a paste which is pressed into jars or bladders and kept for use. The rennet improves with age and is the strongest when ten or twelve months old. New rennet is charged with producing heading, swelling or "huffing" of the cheese. This peculiarity strongly corroborates the view above taken as to the nature of the action of rennet, for time is necessary to produce most effectively the organic change which takes place in the membrane and upon which its action depends.

Rennet is used in a liquid form, because it can then be quickly and intimately mingled with the milk. For its proper action it must be thoroughly stirred into the milk which is brought to a certain temperature, lower or higher according to circumstances, for the reason that the germinative action is hastened by a proper degree of warmth. Usually the dried stomach is infused in warm water or whey, and some dairymen add the juice of lemons to the infusion, one quart of the liquid being used for each stomach. Half a pint of the infusion to 100 gallons of milk is generally sufficient to bring the curd in one hour, with the milk at a temperature of about eighty degrees.

The procuring of the curd is one of the most important manipulations in making cheese, as the quality of the product and its ripening or curing depend very much upon this part of the process being carried out with great carefulness and skill. The flavor of the cheese may be seriously affected by bad and impure rennet, and if putrefactive germs are contained in it, the decomposing ferment will assuredly be communicated to the cheese with disastrous effect. Doubtless many of the inexplicable troubles of the dairyman arise from the use of ill-conditioned rennet, and this should be carefully guarded against. It is always a safe precaution, when doubt exists as to the purity of the rennet, to filter it through flannel or even through cotton fiber or blotting paper. By varying the character of the rennet the character of the cheese may be changed, and where many varieties of fancy cheese are made the rennet used differs very much. Some very celebrated French cheeses are made of rennet prepared with water to which brandy is added in the proportion of one-third, and spices and aromatic herbs are steeped with the stomachs in this mixture. For other cheeses pig's bladder is steeped in white wine and vinegar, and others again are made with diluted acids only.

The exhausted stomachs need not be thrown away, but may be again salted and left to renew their strength. This they will do in the course of some months, and as yet no one has been able to say when this power of recovering their activity will be entirely lost. If this activity depends upon, or belongs to, the membrane, as almost conclusively appears, it may last until the membrane itself is dissolved away.

It has been stated that a certain quantity of the liquid rennet is sufficient to produce a certain effect upon a given quantity of milk at a stated temperature. If one of these elements of the process is varied, the others are subject to a proportionate change. Thus if the temperature is higher the time is reduced ; if the quantity of rennet is increased the time is lessened. At a lower temperature more rennet is required or more time must be given. These nice calculations must be based upon the normal conditions given as well as upon the quality and strength of the rennet ; and these vary as the age of the dried stomachs or the mode of preparing the solution. A standard preparation of rennet is made for use in the dairy, and the dairyman will be able to make his calculations more precisely and more safely by using such a material as is always of the same strength and effectiveness, than by the too common "rule of thumb" or haphazard or guesswork method in use in dairies. The temperature too should be noted exactly by an accurately graduated thermometer, which should be tested carefully before it is used; as it is not uncommon for the cheap thermometers in use to vary two or three or even five degrees, and such variation might be fatal to success and a continual source of unsatisfactory work, the reason for which would perplex the unsuspecting dairyman.

Acidity is not a necessary element in making curd. Indeed it is at once the surprise and the bane of the cheese maker, and must be guarded against with the greatest care. Acid is produced no doubt in the milk by the action of the peculiar organism or ferment of the rennet, but it is instantly neutralized by its own effect; viz., the precipitation of the caseine and the formation of the curd. Thus the curd is sweet and the whey is sweet, until, by a process of internal change in the curd, lactic acid is formed from the sugar held in the moisture of the curd and acidity becomes induced. This subject, however, is too important to be passed over lightly, and will be more fully treated of when the chemistry of cheese making is considered further on in this chapter.

There are several methods of making cheese, each differing in some important particular. The most frequent is by using the whole milk, or milk half skimmed; some is made by adding cream to the new milk, and some is made of skimmed milk. At least one very popular kind of cheese is made of ewe's milk, and several kinds have some foreign matter, as herbs or spices added to the curd. The greatest variety in cheese making, however, is in regard to the curing, and, in fact, this is by far the most important part of the industry, and requires the most experience and skill in its practice.

THE MECHANISM OF CHEESE MAKING is now to be considered. This has been more highly developed in America than in any other country, although foreign dairymen are rapidly adopting the American system and practice. The factory system, as it is called, is now almost universally practiced. A few farm dairies are still worked, but even in these the method is practically that of the factory on a small scale. This system was begun in 1860 by a dairyman named Jesse Williams, who lived near Rome, in Oneida Co., New York, and who was drawn into it by force of circumstances, and for the sake of convenience, just as the factory system of making cotton and woolen goods, iron goods, nails, and other products of general use, grew from family work at home into concentrated industries in buildings especially fitted with labor-saving machinery for these manufactures. It was a foregone conclusion, from the necessities of the case, that the household manufacture of cheese upon dairy farms should be supplanted by associated enterprise in this direction, because the isolated farm dairy cannot produce cheese nearly as cheaply as several dairies working together can do. And in the case of Jesse Williams, it was first the union of a family of cheese makers to secure the skill of the father in helping to work up the product of his own dairy and those of his sons which in time led to the establishment of the thousands of factories now in operation.

Necessarily this concentration of labor and apparatus greatly reduces the cost of manufacture, for whereas it costs nearly two cents a pound to make up the milk of twenty cows into cheese, the milk of forty cows can be made up for less than one cent a pound; and while the building and apparatus for working up the milk of forty cows costs $300 or $400, a factory in which the milk of twenty times as many cows can be worked up will cost scarcely more than six times as much, and where the profit in working a factory for 600 or 800 cows would be more than $1,000 the same factory with 300 or 400 cows would make no profit at all. In fact, the advantages which accrue from this associated dairying are such that as few as ten dairymen could profitably combine in establishing one for their own herds and without securing aid from other neighbors.

The saving in the cost of furniture, building, and working is not all; there are in addition the advantages of better quality, through the skilled work of one maker, and the better market price which can be realized from this uniformity of make and quality. There are two methods of managing the business of a cheese factory; one is by purchasing the milk outright from the farmers at a stated price, and another by making the cheese on a co-operative principle and distributing the proceeds, *pro rata*, according to the quantity of milk delivered by each member, after a certain fixed charge has been made for manufacturing. This charge is usually two cents per pound of manufactured cheese. The method, however, of organizing the business is immaterial just at present; it is the management that is more pertinent to us at this point.

A cheese factory consists of a building adapted to the requirements of the machinery used in the manufacture, for the proper reception of the milk, and for the curing of the cheese. It is provided with a steam boiler for heating purposes, a curing-room for storing the cheese, and apartments for the manager. It should be constructed in such a manner as to maintain an equal and steady temperature with economical consumption of fuel and be connected with effective drainage by which the refuse whey may be carried off to a safe distance. A frame building with an eight or ten-inch air-space between the inner and outer walls, and protected by air-proof lining, answers every desirable purpose. The ground floor should be amply spacious, and a two-story building with curing-room above is the cheapest. As an even temperature and a stable condition of moisture and good ventilation are required, it would seem that a basement curing-room would be preferable to any other. It would certainly provide every requisite in a more certain manner than an upper floor.

The factory site should be on high, airy, well-drained ground. A permanent supply of water sufficient to fill a two-inch pipe is needed for a factory of 500 cows. A

Fig. 70.—CHEESE FACTORY.

building of this capacity should be seventy-five feet long by thirty-two feet wide at least, and the floor should be nine feet in the clear. If the curing-room is in the basement, a story-and-a-half building only will be needed. The frame should be substantial; the lower floor of matched hard pine plank, slopes three inches from front to rear, where a trapped drain is made to convey away all the slop and whey and the washing of the floor. The whole interior should be double plastered. The upper floor should be matched and tight, and to avoid pillars in the lower room the beams should be supported by iron rods attached to collar beams in the roof. An ice chamber, or, which is far better, one of the ice and cold-air machines now made and to be procured for a moderate sum, is needed to control the summer temperature. The most ample arrangements for thorough ventilation are indispensable.

The space on the lower floor required for manufacturing will be about forty feet in length. This is separated from the rest of the building by a close double partition having a large sliding door in the center or otherwise

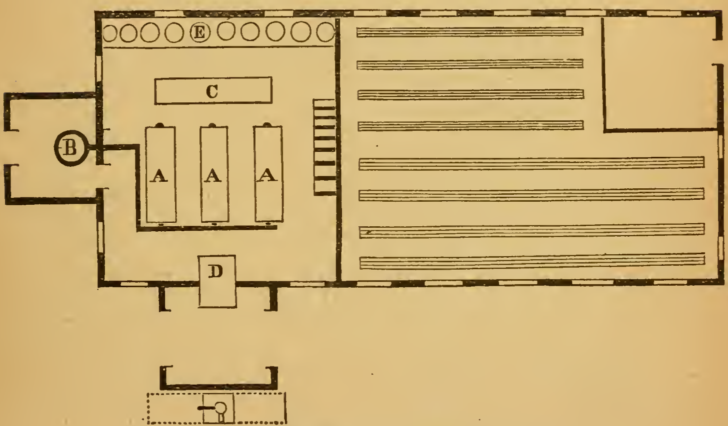

Fig. 71.—ARRANGEMENT OF CHEESE FACTORY.

placed, as may be found convenient for the removal of cheese from the press to the curing-room, for which this space is set apart.

A convenient arrangement is as shown at figure 71. At *d* is a covered driveway for unloading, with a platform for receiving and weighing the milk. The milk is then conducted by means of the milk conductor to the vats, *a*, *a*, *a*, here represented as 600-gallon ones, and three in number. The curd sink is at *c*; the boiler at *b*; the presses at *e*, and the cheese tables are seen in the curing room adjoining. The drain is shown by the dotted lines (figure 71).

The curing-room is furnished with benches, twenty-four inches high and three feet wide, made of strips

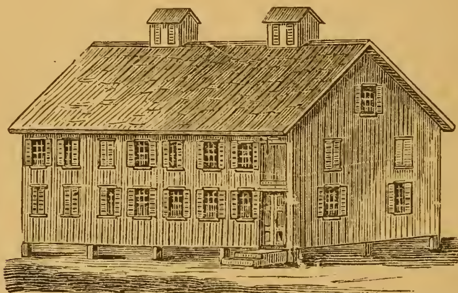

Fig. 72.—CURING HOUSE.

having spaces between them to facilitate circulation of air. These benches should be carefully made to avoid cracks or spaces in the joints which would harbor cheese maggots, the great pest of the cheese factory. They should be ranged at a distance of two feet apart and the

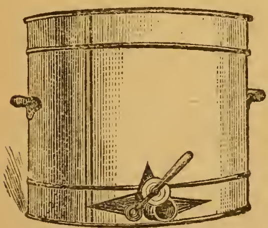

Fig. 73.—WEIGHING CAN.

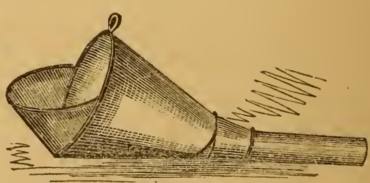

Fig. 74.—CONDUCTING PIPE.

cheeses are placed on them in double rows. A roomy closet should be provided in which to keep the numerous small utensils and for a wash-stand and towels for the men. The factory is best warmed by steam coils supplied from the boiler, and a small engine of five-horse power at least will do all the hoisting, pumping, or forcing water for washing, and grinding the curd. The upper curing-room, or the basement if that is used, is furnished in the manner described, and an elevator for moving the cheese will be found very convenient. A sliding trough will also serve to pass the cheese from the upper to the lower floor.

The style of building for a factory may be varied to suit the taste or ambition of the owners. Fancy work

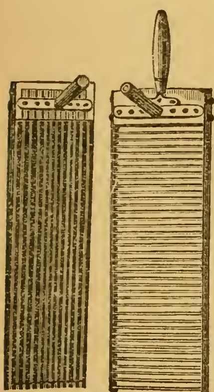

Fig. 75.—CURD KNIVES.

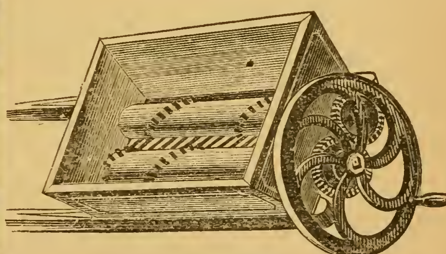

Fig. 76.—CURD MILL.

pays nothing, and plainness and substantial work and material only are required for economy and for use. Figure 70 represents a well-arranged factory in Northern Vermont in which the whole is under one roof. In some factories the curing and store-houses are made separately, with every appliance for coolness, such as shutters and ventilators, double walls, and an open space under the building. A separate curing house belonging to a well known New York factory is shown at figure 72. These buildings are plain but sufficient for every purpose.

The apparatus for a factory of this size consists of the weighing can (figure 73); a conducting pipe (figure 74), by which the milk is conducted, as it is received on the platform (this is raised to get the required flow), to the vats; the vats, of which there are several kinds in use,

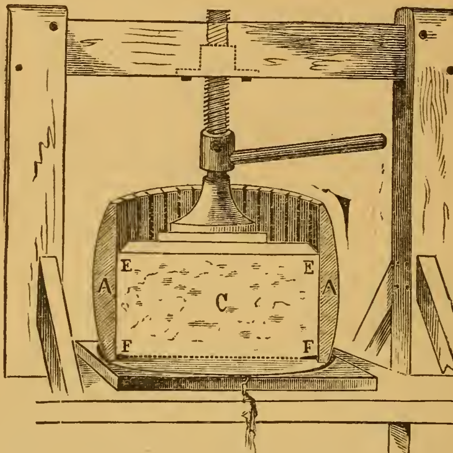

Fig. 77.—CHEESE PRESS.

are arranged for heating by steam from the boiler; the curd knives (figure 75), of which there are two, one for vertical cutting and the other for dividing the curd horizontally, so as to leave it in small cubes; a curd mill

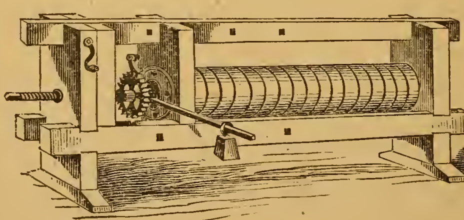

Fig. 78.—GANG PRESS.

(figure 76) for breaking up the curd when it has been solidified by the cooking, and the press and hoops (figure 77), or the gang press (figure 78), by which a large number of cheeses are pressed at one time. For a factory for 500 or 800 cows, a seventy-gallon receiving can will be required; two gang presses, or twenty self-bandaging hoops and five or six single presses. The whole apparatus will cost about $80 for 20 cows, $100 for 30 cows, $140 for 40 cows, $250 for 100 cows, $450 for 200 cows, $600 for 300 cows, $700 for 400 cows, and $1,000 to $1,200 for 600 cows and upwards.

The process of making cheese in a factory is as follows: The milk received at the factory in the evening is cooled down to about sixty degrees, at which it is kept until morning. The morning's delivery is added, and the whole is thoroughly stirred and heated to eighty degrees. The rennet is then added and well stirred through the milk, sufficient being used to bring the curd in forty-five minutes to one hour. When the curd has become solid enough that a cube of it three or four inches square will retain its shape when lifted, it is cut four times, twice with each curd knife at intervals of a few minutes. The curd is then gently moved to separate the whey, and the vat is heated gradually to ninety-five or ninety-six degrees; a little more or less is often preferred by different cheese makers or for special makes of cheese, this process being used for what is known as the American cheese. The heating is continued for an hour to an hour and a half; the less period is used for a soft cheese and the longer one for a harder and firmer one, as may be desired by the maker. When the heating has been completed, the curd is stirred for fifteen minutes to cause it to separate more completely and to pack at the bottom of the vat, where it remains until the whey is completely separated.

Up to this point there is no important difference between the so-called Cheddar method and the ordinary one known in England as the Cheshire process, except that the Cheshire cheese is made of curd set at ninety degrees and not heated afterwards. But here a divergence of method between the two systems begins, and a slight difference between the so-called American method and the English Cheddar, which will be noticed as we proceed.

The separation of the whey from the curd is the initial point of difference. The whey is not drawn off in the American system until some slight acidity has been developed, when it is run off, and the curd is then removed to the sink to drain and cool. The management at this point requires experience and skill, for the formation of acid is to be regulated, retarded, or hastened, with the greatest nicety, on the principle that heat rapidly develops the acidity, while cold retards it. Hence it is sometimes necessary to spread or otherwise cool the curd in the sink, and sometimes to heap it to retain the heat. When the curd has become solid it is torn into fragments of two or three pounds in weight and left to cool, to harden the fat in it and avoid its loss. The curd is then ground into small pieces in the mill and salted at the rate of a pound and a half to two pounds per 100 pounds of curd or 1,000 pounds of milk used. The curd is then put into the hoops for pressing.

In the English Cheddar system, by which the best plain cheese in the world is made, milk of the morning and evening is brought to a temperature of from seventy-eight to eighty-four degrees, according to the condition of the weather; if that has been warm, the rennet will be as effective with the lower temperature, as with the higher after a cold night. The evening's milk is placed in vessels to cool during the night, being stirred at intervals during the evening. It is skimmed in the morning, and the cream with a portion of the milk is heated up to 100 degrees. The whole is poured into the vat or tub, into which the morning's milk is being strained, so that the whole is brought to the proper temperature above mentioned. The rennet, half-a-pint to 100 gallons of milk, is then poured in. The rennet is made from small stomachs of calves killed at a week old, cured, and kept eighteen months before being used. The stomachs are steeped in salt water—one quart to each—for three weeks. The rennet is strong enough to form the curd in one hour at the above temperature. The curd is cut in the usual manner with curd-knives, but with great care lest the cream should escape with the whey, and with several interruptions of the process, which in all takes half an hour. It is thus broken into pieces no larger than peas. The whole mass is then gradually and carefully heated, by means of hot water let into a space around the cheese vat, up to 100 degrees. This takes half an hour. The hot water is then drawn off, and the curd is stirred for half an hour in the hot whey, being then reduced to still smaller fragments. Another half hour is allowed for the curd to settle, when the whey is drawn off into a vat six inches deep, where it is cooled, skimmed, and the cream made into butter. This is equal to about half a pound per cow per week. After standing another half hour, to develop the right degree of acidity, the curd is cut into pieces, turned over, left for half an hour longer, and again cut and left for a quarter of an hour. It is then slightly acid to the taste. If the acid becomes too much developed, the cheese will not press solidly, but will sink and become misshapen. It is then torn to pieces by hand and cooled, packed in thin layers in the vat, and after being pressed for half a day, it is again broken up by hand. When cool, sour, dry, and tough enough, it is ground in the curd-mill; two pounds of salt are added to 112 pounds of curd, and when quite cold it is placed in the hoop with the cloth, and taken to the press. The pressure is about 1,800 to 2,000 pounds. The cloth is changed the next day, and again on the second day. On the third day the cheese is taken from the press to the cheese-room, bandaged, and turned daily for some time. The temperature of the cheese-room is kept at sixty-five degrees. The cheese is ready for sale at the end of three months. The weights of these cheeses are from seventy-five to one hundred and twenty pounds, this being dependent upon the size of the dairy.

The American Cheddar method differs but slightly from the above. The milk is warmed to about eighty degrees, the proper temperature for coagulation; it is then well stirred to insure the even distribution of heat, and the rennet is added and thoroughly mingled by stirring. The curdling is complete in forty to sixty minutes, when the mass is stirred, or broken by a many-bladed curd-knife into small blocks to facilitate its separation from the whey. When the curd has acquired sufficient firmness, it is more thoroughly broken, either by the hands or by what is known as an agitator. After the curd is broken up, heat is applied by means of steam pipes until the whey and curd together are brought to a temperature of about 100 degrees. During this heating the curd is stirred, and after the "cooking" is complete it is left to rest, with occasional stirrings, until a proper degree of approach to acidity is observed in the whey. The whey is then drawn off, and the curd is heaped in the vats and left to become sour. Upon the exact degree of acid that is developed in the curd, depends, in a great measure, the quality of the cheese; and the skillful practice of an experienced cheese maker is perhaps more needed just here than in any other part of the process. Those who need it can use what is known as the hot-iron test; this is to take a bar, or rod, of iron heated to a point somewhat less than a dull red heat, and bring it into contact with a piece of curd. If, when the hot iron is drawn from the curd, it brings with it a quantity of glutinous strings, the curd is ready for removal from the vats. It is dipped out from these with the curd dipper, a pail having a flat side, into a cooler, the vat being tipped by means of winches. The curd is left here to cool for a few minutes, when it is turned over and again left, to acquire a certain mellowness. It is then pressed for ten minutes, when it is taken out, ground in the curd mill, and salted, two pounds of salt being used for 100 pounds of curd. The proper temperature of the curd is kept up during these processes by covering it with a cloth. After having been ground, and salted, the curd is put into the presses, in which it remains under pressure for two or three days. The pressure, which is regulated by means of a screw, should be sufficient to force out the whey and consolidate the cheese. It is obvious that much tact and experience are needed to produce cheese of first quality, when it is considered what a multitude of interfering and complicated changes may occur in the condition of the curd, through atmospheric effects, the quality of the milk or the rennet, or unavoidable difficulties in securing the precise degrees of heat or fermentation of the curd. But in the well-managed cheese factory all danger of failure is reduced to a minimum, as compared with the chances of a hundred small dairies all differently managed, and without the machinery needed for accurate manipulation. It is on account of this uniformity in quality that the American factory cheese fills a place in the markets of the world that no other dairy product has ever done, or is likely to do.

When the milk is somewhat sour, different treatment is required. As milk slightly sour will coagulate more easily than sweet milk, less rennet might be supposed necessary. But in practice and for very good reasons the quantity of rennet is increased by good makers, so as to produce curd as quickly as possible, thus preventing excessive acidity. As soon as the curd is set, the manipulation is hastened for the purpose of producing the requisite acid, but without heating to more than eighty-six degrees, and if the milk has been quite sour no heating is given. It will be easily understood that as heat tends to encourage rapid souring, a less amount of it will equalize the excess of acidity in the milk and bring the curd to the required degree of sourness for the best condition of preparation for the salting and pressure.

It sometimes happens that the milk becomes tainted, or contains putrefactive germs, in the hottest part of the season. This condition of the milk is doubtless due to some abnormal state of the cow by overheating, and sometimes it is known to occur from the use of impure water. When such milk is curdled there is a production of gas in the curd which causes it to float, and this interferes very much with the work of the cheese maker. To overcome this defect in the milk, some of the best cheese makers do not cool the night's milk, but permit it to develop incipient acidity and then proceed as with good milk until the whey is separated from the curd. The whey is left on the curd, and the separation postponed until acid is distinctly developed, when it is drawn off and the usual process is completed. Curd made from such milk will swell up and emit an offensive odor; this odor, however, is neutralized by the gradually increasing acid, by which the putrefactive germs seem to be destroyed, and in the end, by the most skillful management in the final handling of the curd, a very fair quality of cheese can be made.

A long experience and close observation and study are requisite to make an expert cheese maker, but a knowledge of the principles involved in the art will very much facilitate the gathering of the necessary experience. With such a complex substance as milk, and with so many incompletely understood changes and results of fermentation, oxidation, and heat, it is not surprising that no precise rules can be laid down for the guidance of the beginner. All that can be done by the most enthusiastic and painstaking learner is to study the preliminaries and the principles of his business, and then work out his own practice after many mistakes and defeats.

The Chemistry of Cheese Making is a very involved and intricate study, but it is not difficult to reduce it to a system and explain the causes for the curious effects of the process. When milk is left exposed to the atmosphere for a varying length of time it becomes acid, and separates into two parts, one a solid and the other a liquid. The time required for this change varies with the temperature, being longer or shorter as the temperature may be lower or higher. The production of acidity is due to the formation of lactic acid by the decomposition of the sugar of the milk. The acid thus formed combines with the free soda which always exists in normal milk in its fresh state, and this combination goes on until the alkali is all exhausted, when acid begins to accumulate.

The caseine of the milk is soluble in an alkaline fluid, but not in a neutral one. Consequently, when the alkali (the free soda) in the milk is neutralized by the formation of lactic acid, the caseine is precipitated or becomes solid, being no longer soluble in the milk. But the curd does not separate from the whey until heat is applied, when the curd contracts in bulk and forces the whey out from among its particles, all the more freely when it is cut into small pieces and is raised to a considerably high temperature, as that used in cheese-making; viz., eighty to one hundred degrees. In making cheese it is not usual to permit the milk to become sour and precipitate the curd in that way. This process is performed by the addition of some substance which acts chemically upon the milk to hasten the production of the curd with developing acidity. Any acid will curdle milk, and in the manufacture of some kinds of cheese, vinegar, tartaric acid, lemon juice, cream of tartar, hydrochloric (muriatic) acid, and even oxalate of potash (salt of sorrel) have been used, besides sour milk, and the common rennet, to produce the curd.

Caseine itself is an acid substance and combines with the soda of the milk under certain circumstances, and then becomes soluble in the water of the milk, although it is practically insoluble in pure water. When any acid is added to the milk it takes the soda from the caseine and combines with it, thus causing the caseine to resume its insoluble condition and separate from the fluid. The action of rennet differs in some degree from this, but it is quite as simple and easy to understand. This substance is the digestive or fourth stomach of a young calf, cured and preserved for keeping and use. The stomach in its fresh state always contains a quantity of curd in it which is sometimes washed out, together with some mucus, which is almost always found with it in the stomach. In some localities this curdy matter is salted for immediate use; in others it is left in the stomach and both are salted together, and it is not unusual to feed the calf a short time before it is killed, so as to procure a large quantity of this curd.

The mode of salting varies. Sometimes the stomach is partly filled with salt and some is applied to the outside, and the stomach is then rolled and hung in a warm place to dry. Other dairymen pickle the stomachs in brine for a few days, and then dry them; this pickle is then preserved for use as rennet. In Cheshire, England, the stomachs are packed in jars in layers with salt inside and outside of them, and kept for a year; in some European countries the stomachs are chopped finely, mixed with salt and crumbs of bread into a paste, and preserved in bladders for use. In Italy, where the famous Parmesan cheese is made, the stomachs are chopped up and made into a paste, with salt, pepper, and whey, and this paste is dried for use.

The common practice is to keep these various preparations for twelve months before using them, in the belief that they gain strength during this period and then yield the best and strongest rennet. When used, the various dried preparations are steeped in water or whey, the infusion being saturated with salt, and this liquid is bottled and kept for two months before it is made use of. In some places the stomachs thus steeped are dried and salted and used a second or even a third time, after a period of rest, and it is possible so to use the stomach repeatedly for an indefinite period. The question then occurs, By what means does the rennet effect the coagulation of the milk ?

Rennet is a digestive agent. In the process of digestion of milk the gastric juice which is secreted by the stomach is always acid ; and it contains a considerable proportion of lactic acid as well as of hydrochloric acid. The cells of the stomach known as the peptic cells secrete this fluid, which contains in addition to the acids a small quantity of an albuminous compound known as pepsine, and this substance is supposed to be chiefly concerned in the digestion of albuminoid portions of the food. Then we must believe that the coagulating property of rennet is a true digestive function, and that the liquid rennet is really an artificial gastric fluid. We know further that the ripening of cheese is really a digestive process, and the well-ripened cheese is used as an aid to digestion ; proving that the influence of the rennet is carried into and shared with it by the cheese. But whatever may be the hidden secret—as yet undiscovered —we cannot free our mind from the conviction that the coagulation of the milk, and the production of curd, are really due to the action of lactic acid produced in the milk by the rennet.

Then the question arises, Why does milk curdle so much more quickly under the influence of rennet than by the ordinary process of souring ? This more effective action is explained by the fact that the active principle of the rennet is dissolved in the water which is intimately diffused though the whole mass of the milk and an infinite number of centers of action are produced in contact with every particle of the caseine. Acid is thus formed all through the milk; the soda is neutralized all through it, and the caseine is precipitated very rapidly. But by ordinary souring the caseine is first precipitated by the action of the air; this action is diffused very slowly through the milk, chiefly from the surface, and the curdling is therefore effected very slowly. Moreover, this action of the rennet explains why the curd is solidified and the whey remains sweet; because the acid is neutralized as soon as it is formed, by its combination with the soda of the milk, and the caseine becomes insoluble as soon as the alkali has been completely neutralized by the acid; the acid is then, of course, neutralized by the mutual action of itself and the soda. Thus the milk becomes a neutral or sweet liquid, while the caseine is precipitated as an insoluble curd. If soda could be added again to the whey the curd might be redissolved.

As soon as the curd is set, a further change immediately becomes imminent. This is the acidification of the whey by the continued decomposition of the remaining milk-sugar, and as the caseine contains about forty per cent of whey this change necessarily affects the curd. It has considerable influence upon the quality of the cheese and is watched very closely by the dairyman. This change is called the ripening of the curd and of the cheese, and is due to the internal decomposition of the curd, and of the cheese which the curd becomes by its continuance. The whey remaining in the cheese contains lactic acid, and as some of this is necessarily left, there is a leaven of fermentation remaining, which is the basis for a continuous decomposition, the end of which would be putrefaction if the cheese were kept long enough. To prevent this result salt is used. The effect of salt is to arrest the progress of acidity—which is preliminary to the more complete decomposition ending in putrefactive fermentation—and to flavor the cheese and make it palatable. The salt is added to the curds when they are cool, and this practice is universally considered as requisite to the securing of a fine delicate flavor. The antiseptic effect of salt necessarily affects the process of ripening, hence when rapid ripening is desired the least quantity of salt or about two per cent of the green curd is used, and when a slower curing is wished for as much as two and a half or three pounds per 100 are used. Only the very purest and finest salt should be used, and to get its best effect it should be ground very fine.

Temperature, as has been stated in previous chapters, is a most energetic chemical agent, and has consequently an important effect on the ripening or curing process, and this agency is the most critical part of the treatment to which the class of cheeses noted for their high flavor is subjected. The size of the cheese, too, necessarily becomes a serious element in this regard, for a long time will be required to affect the whole mass of a large cheese, while a small one may be brought under the influence of heat or cold in a few hours. The warmth of the curing-room, the steadiness of the temperature, the freshness and purity of its atmosphere, the periods of turning the cheeses, the greasing of the surface for the purpose of excluding air, all these circumstances have an important chemical effect upon the condition of the cheese.

A comparatively high temperature produces rapid ripening, while a low temperature so controls the chemical changes which go on in the cheese, and which are due to the peculiar character of the caseine, as to cause a long period to elapse before the ripening is completed.

Caseine contains a large proportion (fifteen and a half per cent) of nitrogen, and during its decomposition in the ripening process some of this nitrogen is converted into ammonia, and it is to this product that the strong and pungent ammoniacal odor of such cheeses as the Limburger, Brié, and others that are highly ripened is due. These are all soft unpressed cheese, and are ripened in rooms kept at a temperature of sixty to seventy degrees. These cheeses contain much fat, and as caseine has the ability to produce butyric acid from the oleine of the butter fat, this strongly odorous compound adds to the strength of this class of cheeses. But all highly-cured cheese must contain more or less of these odorous compounds as the result of the ripening process.

The presence of fungi also affects the character of cheese, from their chemical action upon the nitrogenous portions of it. Mold is the principal agent of this character which affects milk and cheese, and the particular variety is known as *Penicillium crustaceum*. This plant is very abundantly spread in dairies and wherever cheese is stored. It forms the greenish-blue mold which is seen in old cheese that has been kept in a rather damp place, and it also attacks and feeds upon bread and other moist substances which are rich in albuminous matters, viz., caseine, gluten, albumen, etc. The plant consists of fine, white, silky threads bearing upon their ends a mass of exceedingly small germs or spores which appear as fine dust. These spores are the germs of the plants and when dry are floated off in the air and scattered far and wide. The air contains myriads of these germs too small to be visible, and the dust everywhere contains them in enormous numbers. No place where the air enters is free from them.

When any albuminous or nitrogenous liquid is exposed to the air, some of these spores fall upon it and immediately begin to grow, in time forming cells which become detached from the parent cell and go on increasing and forming other cells which separate and increase to an incalculable extent. It is supposed by some chemists that rennet is highly charged with these germs, and being a nitrogenous substance they grow in it and increase with amazing rapidity. When rennet is mixed with warm milk these germs are carried all through the mass and each one becomes a center of most active growth which is encouraged by the heat. One effect of these germs is to produce acidity, and doubtless they are able to cause the coagulation of the milk and produce curd without producing apparent acidity; perhaps because of the effect of the coagulation being to neutralize as fast as it is produced any acidity which may be formed. We know, however, that acidity is only the work of time, and if it were not prevented by cooling and salting and pressing the cheese, by which moisture and air are expelled, the curd would soon become acid, next ferment, then decay, and finally putrefy. Putrefaction and destruction seem to be the ends and purposes of these germs in nature, and the whole art of the dairyman, from beginning to end, is a conflict with these abounding spores, to prevent or control their action and turn them to account in producing such effects as he desires and prevent any further action beyond that.

The coagulation of the curd and its ripening, and the curing of the cheese, are all results of the action of these germs, aided by variations in temperature. And we cannot doubt that they may be so used as to very greatly affect the flavor of the cheese in its curing. This will be more particularly referred to in describing the processes by which the most highly valued kinds of cheese are cured and caused to acquire a certain texture, condition, and flavor. It is known that these fungi live and grow and feed at the expense of the nitrogenous substance of cheese, hence a cheese rich in caseine and poor in fat may be rendered richer in fat and soft in texture by the process of curing in which the abundant growth of these fungi or molds is turned to account.

Another effect of these germs, probably of a specific kind, is to render cheese unwholesome and even poisonous. That cheese is sometimes poisonous is a well known fact. But what causes the poison is not so well known. Recent discoveries, however, lead us to believe that a certain fungous growth in cheese is able to produce a substance which is poisonous to animals, causing nausea, vomiting, and diarrhea, with intense nervous depression, and this supposed poisonous product has been separated from the cheese and tested with similar results which occur from eating the cheese. Another supposition is, that the rennet is the origin of the trouble, and that the poison is introduced into the cheese by means of rennet that has become tainted or putrid. An analysis of the cheese has caused the separation of an offensive putrid animal matter which produces vomiting, and which seems to be exhausted or dissipated when the fermentation has passed away. It is an instructive example of the most injurious effects of any uncleanness whatever in the various operations of the dairy, and the absolute and imperative necessity for guarding most carefully every avenue of approach against injurious matter of every kind.

FANCY CHEESE.

Cheese, like all other products used us food, is made more attractive and salable by putting it into convenient forms, and making it of excellent quality and of desirable flavor for the many consumers who differ in taste and fancy. The standard American cheese weighing sixty pounds is too large for domestic use, and the smaller ones of about thirty pounds are still too heavy and last too long for ordinary domestic consumption. There are many varieties of small cheeses made, however, which find an excellent market, and there is room for more. The small round cheese known as Edam, for instance, which weighs about four pounds, sells readily for about one dollar each; the English dairy cheese in imitation of the favorite Gloucester cheese, flat and circular in shape, and weighing about twelve pounds, sells for twenty-five cents per pound; the cylindrical cheeses made to imitate the English Wiltshire retails at twenty-two cents per pound; the American French Brié, a soft fat cheese, and the American Limburger, Schweitzer, Neufchatel, Gonda, and other highly-flavored kinds are also in good demand and sell at highly remunerative prices. Small home-made cheeses, too, are easily salable, and are exceedingly desirable for domestic use. Such cheeses weigh about ten pounds each and sell easily for eighteen to twenty cents per pound.

The process of making small cheeses of this kind is as follows: The morning's milk, well aired by pouring it through a strainer from one pail to another several times, by which it is reduced to about seventy or seventy-two degrees, is mixed with the evening's milk in a wooden vat or tub of convenient size. The temperature of the whole should then be raised to not less than seventy-eight or more than eighty-four degrees. The rennet is then added in the proportion of one liquid ounce to fifty quarts of milk, or at the rate of half a pint to 100 gallons. The rennet is made thus: The stomach of a sucking calf in which the milk is digested is emptied of its contents, well salted inside and out, and hung up to dry. The dry stomach is kept in this condition for two or three months or even twelve to eighteen months, during which time it becomes stronger and more effective for its purpose the older it is. It is then steeped for three weeks in a quart of water in which salt has been dissolved until no more is taken up. The liquid is bottled for use and the stomach is again rubbed with salt and hung up in a dry place for several months, when it will have regained its strength and is ready for a second use. This salt extract is the rennet that is to be used. The rennet is well mingled with the milk by stirring thoroughly, and in one hour the curd will have formed. If the curd is sooner formed and too much rennet has been used the cheese will have a sharp flavor and will be hard and tough. The curd is then cut with a long-bladed knife into small dice or squares not more than a quarter of an inch in size. A frame having small wires stretched the right distance apart is used for cutting the curd. This facilitates the separation of the whey from the curd. Some of the whey is drawn off after the curd has stood half an hour and is heated to nearly boiling. It is then turned on to the curd, which is stirred well until the whole is brought to a heat of 100 degrees. It remains in the hot whey for half an hour, when this is drawn off and the curd well broken with the hands, thrown into a heap in the center of the tub, covered with a cloth, and left for half an hour. It is broken up fine and again heaped and left half an hour more, and this is once more repeated, when it will be found slightly acid.

The acidification is at once stopped by breaking the curd fine with the hand and spreading it to cool, when it is pressed by the hands in the molds and left under slight pressure for half a day. It is then broken up fine once more, salted at the rate of two ounces of salt to seven pounds of curd, and is put into a hoop lined with a cloth and pressed under a screw or a lever, the pressure being at the rate of twelve pounds to every square inch of surface of the cheese. A cheese seven inches in diameter will require a pressure equal to 450 pounds. If a lever is used and the long arm is five times as long as the short one a weight of ninety pounds would have to be suspended at the end of the longer arm. The wrapper is changed the second day and again on the third day. The mold is placed on a bench in which a small groove is cut to carry off the whey which drains from the press. After three days' pressure the cheese is taken from the press, bandaged, and turned daily for several days. It should be kept in a room or dry cellar where the temperature is not more than sixty-five degrees. At the end of three months the cheese is ready for use, but may be kept in a cool place for several months longer without deterioration. To keep out the cheese maggot the cheeses may be wrapped in oiled paper, being first covered with melted beef suet well rubbed into the crust. The maggot is the larvæ of a small fly which lays its eggs in cheese. Small cheeses may be made in this method by adding the curd of one day's making to that of the next day, and even a third day's curd may be grafted on to the second day's make. All that is required is to slightly break up the surface of the cheese as it lies in the press and add the new curd to it in the mold and apply the pressure. One hundred pounds of milk (48 quarts) will make about ten pounds of cheese. Skimmed milk makes a very good cheese if care is taken not to overheat the milk, nor to use rennet too freely, nor to leave the curd to become too distinctly acid in the vat. For a small cheese all the material required consists of a cedar tub of the proper size, a low bench or table, and a lever or screw press of the simplest construction.

Still smaller cheeses may be made as follows: The fresh sweet milk is curdled by the liquid rennet made by steeping a fresh or dry salted stomach of a young unweaned calf or lamb in a quart of clear strained brine for three weeks. Of this liquid rennet one tablespoonful is enough for forty quarts of milk, and one teaspoonful for twelve or thirteen quarts. Too much rennet will make the curd hard; and as this kind of cheese should be soft, rennet should be used sparingly. About four quarts of milk will make a pound of cheese. The curd should be used fresh and before it has cooled. If it has cooled it should be warmed up to ninety degrees. The curd of twelve or fifteen quarts may be made in a large tin pan. The rennet is stirred in the milk and the milk is left in a warm place for an hour, when the curd is set. A convenient method of setting the curd is to lay a square of fine muslin in the pan, securing the ends on the edge and pouring the milk into the muslin, when the curd is set the corners and edges of this are drawn together and tied, and the whole lifted out and hung up to drain. As soon as the whey is drained off the curd is put into the molds. These are made of thin veneers of some sweet wood, as maple or beech, or of tin. They may be round, or any shape to suit the taste, and without bottom or top, about three inches by two, and one and one-half deep, or larger if desired. Mats made of rushes, or clean rye or wheat straw sewn together (figure 80), are used to rest the molds upon while the cheese is making, and the mats are placed upon a towel which absorbs the moisture. The molds and their contents are turned daily for three days, and, if desired, are sprinkled with salt at each turning.

The cheeses are ready for eating fresh in three days; or, they may be taken to an airy dairy-house or cellar and kept for curing for six weeks or two months, being turned every day and laid upon a layer of sweet straw upon a lattice shelf. The curing process may be so managed as to give a great variety of flavors to the cheese. If mold gathers upon them it is scraped off occasionally. Cloths dipped in vinegar may be wrapped around the cheeses, or these may be covered with pulverized sweet herbs. Much ingenuity may be exercised in this way to vary the character of the cheese, and doubtless in time some discoveries may be made through which one may hit upon a desirable market product that will furnish a profitable industry for the family. This is an undeveloped possibility with us. In other countries millions of cheeses of this kind, but in great variety, are made and sold yearly, and some persons have made in past years a wide reputation which has descended with its comfortable profits to their children.

A very rich cheese is made of pure cream, and eaten

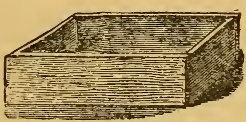

Fig. 79.—MOLD FOR SMALL CHEESE.

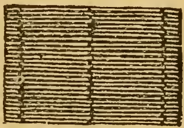

Fig. 80.—MAT.

while fresh. This is sold in the English and French markets at a high price, and is also made for domestic use. The cream is taken from the milk as soon as it is thick, but while yet sweet, placed in a muslin cloth, and hung up to drain over a pan in which the drippings are caught. After hanging in this way in an airy, clean dairy-room for twenty hours, it becomes firm enough to be placed in the molds. The mold is a small wooden box or frame about five inches long, three wide, and one and a half thick, without bottom or top (figure 79). This is placed upon a layer of clean, smooth straw, and a mat of rushes, made as shown in figure 80, is put under it. The cream is then placed in the mold, which is lined with a neatly fitting square piece of muslin folded at the corners; this is turned down over the cream and a second mat of rushes, which fits the mold, is laid upon it. A block of wood and a light weight are placed

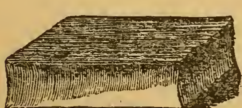

Fig. 81.—A CREAM CHEESE.

on the mat to press the cream into the shape of the mold, where it remains until it has become set to the shape, which is in two or three hours. The cheese is marked on the top and bottom by the rushes of the mats, which give it a corrugated appearance (figure 81). It is fit for use as soon as it is set. When sent to market it is not removed from the molds until it is sold for use. No salt is used in the preparation; this is added as it is eaten. The ordinary price of this cheese is the same as that of the best butter. When made for home use, and eaten fresh, it is a choice delicacy. It is sparingly made in the vicinity of New York, and sent to market wrapped

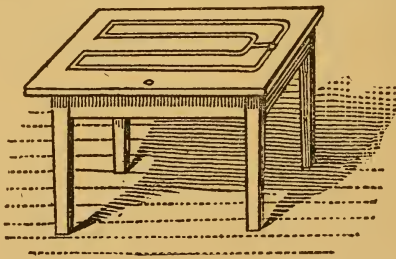

Fig. 82.—DRAINING TABLE.

in tinfoil. In making these cheeses it is best to thicken the cream by scalding the milk after it has stood in the pans for twelve hours. The pans are set on a stove until the cream "crinkles," when they are returned to the shelves. In twelve hours more the cream is quite thick and is ready to go into the molds.

POT CHEESE.—The simplest form of domestic cheese is the "pot cheese." This is made of curd from sour skimmed milk gradually heated to 100 degrees, when the whey separates. The curd is dipped into a square of thin muslin gathered into a loose bag and hung up on a convenient hook or to a peg purposely placed in a hole made for it near the edge of the draining table (figure

82). This is a common table with a white-wood or maple top, in which a few grooves are cut leading to a drain hole, as shown ; a pail placed under the drain will serve to catch the drip from the table. The cloth containing the curd hangs from the edge of the table and drains into the pail. The curd may be pressed slightly in small hoops and sprinkled with salt on both sides ; then placed on a mat made of green rushes sewn together, as shown at figure 80, and turned three or four times a day for four days and salted slightly once a day on each side. These cheeses may be kept for some weeks to cure, and will acquire a very fine flavor. The curd may be kept in the cloth for two or three days and each day an additional quantity may be made until sufficient is gathered to make a cheese of several pounds, when the whole of the curd may be placed for a few minutes in a vessel of warm whey and then put to press together. Curd may be made in the cloth by laying this in the pan before the milk is curdled, and when the curd is formed gathering the edges together and tying them and lifting the whole out of the pan and hanging it to drain. The curd is not then disturbed or broken, and when whole milk is used, as for better cheese, there is no risk of losing any of the cream with the whey as it drains off.

A Fine Cheese.—A remarkably fine small cheese is made as follows : The newly-drawn milk is set away to cool after having been strained twice and poured from one pail to another to air it thoroughly. After three hours it is slowly heated until the usual pellicle forms upon its surface. When the pellicle is firm enough to be lifted, the milk is removed and one teaspoonful of rennet is added and stirred in to twenty quarts of milk. The evening's milk may be skimmed and warmed in a separate vessel, to the right point, and then mixed with the morning's milk, and the rennet added. Or, by keeping the milk in ice water in deep pails, it may be preserved sweet for two or three days and then made into cheese; or the curd may be kept as above mentioned and added to the new curd, in which case the rich quality of the cheese may be preserved. The milk may be curdled in a large jar or tin pail, or in several of them, and the curd may be carefully lifted with a common dipper or ladle, and placed at once in small cylindrical molds of tin (figure 83). Empty fruit cans, from which the top and bottom have been melted, and which have been cut down to four inches in length, will serve the purpose very well. From five to six hours are required to form the curd. The molds are filled with the curd as they stand on the rush mats on the draining table before de-

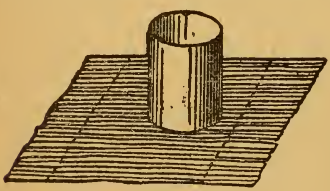

Fig. 83.
TIN MOLD AND STRAW MAT.

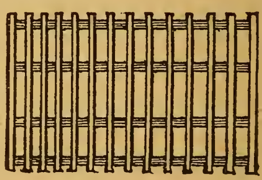

Fig. 84.
FRAME FOR DRAINING CHEESE.

scribed; the whey gradually flows away, and in two days the cheeses will have become firm enough for the mold to be lifted off from them. The cheeses are sprinkled with salt and left on the mats for three or four days, when they will be ready for the curing. This may be done on a shelf of narrow laths placed six inches apart. The cheeses are placed on a frame of laths shown at figure 84, the frame being kept on the shelf, but removed to the table when it is necessary to salt and turn the cheeses. The cheese during the curing should be exposed to abundant currents of air, for it is on this airing that the effect of the curing depends. It is this system of curing which gives the exquisite flavor to the small foreign cheeses, as the Roquefort, the Camembert, and others, and these are precisely the kinds that can be made very well in family dairies, or in other small dairies where a dozen cows are kept.

The cheeses in such a process of curing require to be turned every second day for three or four weeks. If mold gathers on them it is wiped or scraped off, and when moisture is perceived upon the surface this stage of curing is completed. The cheeses and the frame are then removed to a dry, close cellar, where they are kept for one month, being turned every second day. The cheeses at this period will have shrunk to one inch in thickness and three in diameter. If they are kept after this they should be wrapped in paraffine paper or tin-foil. The delicious English Stilton cheeses, weighing from eight to twelve pounds, and six or seven inches in diameter by nine or ten in hight, are made in this manner, but with the addition of cream to the new milk. The milk of Jersey cows having twenty per cent of cream would make a very rich cheese, and if the curing were as well done it would equal this famed English cheese.

THE STILTON CHEESE is one specially suited to a small dairy. It is made in the following manner, to which all its peculiarity is due: A strong brine is made of salt and cold water, and a number of sweet herbs, thyme, hyssop, sweet briar, marjoram, dill and savory, tied in bunches, are steeped in it, with a few whole pepper-corns, for four days, when the clear liquor is racked off. The calves' stomachs are steeped in this brine for five days, when the rennet is kept for use. The morning's new milk is mixed with the cream of the previous evening's milk in a narrow deep pail. The milk is heated to ninety degrees and the rennet added. The pail is lined with a cloth, so that when the curd is formed it can be lifted out without breaking and placed in the mold. The curd is set in a warm, airy room. The mold is pierced with small holes to permit the whey to drain off without pressure; after a short time a light pressure is made upon the curd. When the cheese has sufficient consistence it is removed from the hoop and bound with a cloth, which is changed and tightened every day as the cheese shrinks. It is turned and wiped daily. When the crust is firm the cloth is removed and the surface of the cheese is brushed twice a day for three months. It is then placed in the curing-room, where it is kept to ripen for a year or eighteen months. No salt is used in making this cheese. Veins of green and blue mold are formed in the cheese by thrusting into it thin skewers which have been rubbed with some old cheese in which the mold has been developed; the mold spreads from these places through the body of the cheese, giving it a peculiar marbled appearance.

SAGE CHEESE is another kind that may be made in a small dairy. This is also known as green cheese. For a cheese of eight pounds two large handfuls of green sage and half as much parsley and marigold leaves are bruised and infused over-night in a portion of new milk. The colored milk is added to one-third of the milk to be curdled, and this and the rest of the milk are curdled separately. The curds are drained, scalded and broken in the usual manner of the Cheddar system, and the colored curd is then mixed, either evenly or in various shapes and devices, with the other curd as it is placed in the hoop. Much ingenuity is sometimes exercised in forming these devices by means of appropriate cutters and molds, and incorporating them with the white curd. The cheese is pressed and cured in the usual manner. Small green cheeses are made by bruising young sage leaves and spinach leaves in equal parts in a mortar and squeezing out the juice. The juice is added to the milk before the rennet is mixed, and the curd being formed, it is carefully broken very evenly, and put to press with gentle pressure for five or six hours. It is salted twice a day for five days and turned daily for forty days, when it is ready for use. This is a delicious cheese when made of rich milk and skillfully handled. It is made of small size, weighing less than one pound.

THE EDAM CHEESE is one of the most excellent and therefore popular of all the small kinds.

Edam is a town of Holland, near the well-known Zuyder Zee, and about twelve miles northeast of Amsterdam. This town is the center of the manufacture of those nearly globular reddish-colored cheeses, which are largely imported into this country, and sold in all large cities at from twenty to thirty cents a pound. Edam cheese, designed specially for exportation to foreign countries, is carefully made and will keep several years. It is, therefore, a favorite cheese for use upon ships while making long voyages, and is almost the only cheese which is exported to India, China, and Australia. There is a demand for small cheeses of high flavor, and the Edam cheese to some extent fills this demand. It is a cheese of three or four pounds weight, with a sharp, almost pungent, yet agreeable flavor, and, as we have already said, will keep for years. The process of manufacture, as described by M. Le Senechal, director of the dairy of St. Angeau, in Holland, is as follows: As the peculiar purposes for which this cheese is destined forbid the use of too rich a milk, and the presence of too much cream or butter in the curd, it is usual at the hight of the season—that is, from the middle of August to the middle of October—to skim from one-third to a half of the milk; at other times the whole milk is used. The milk, brought to a proper condition as to richness, is placed in the vat, and raised to a temperature of about ninety to ninety-two degrees in summer, and ninety-two to ninety-five degrees in winter, when the rennet is added in the proportion of a quarter of a pint to 100 quarts of milk, or somewhat less, according to circumstances. The desired color, a light yellow, is produced by the admixture of a portion of annatto, the quantity depending upon the season, the richness of the milk, the quality of the pasture, and other incidental circumstances, which the skilled dairyman so well understands. The usual quantity is a teaspoonful of a liquid preparation of annatto to a quarter of a pint of rennet. The liquid annatto used in Holland is about the same as that used in the

Fig. 85.—PRESSING INTO MOLDS.

New York factories. The rennet and coloring matter having been added to the milk, it is stirred for one minute and left to rest.

As soon as the curd is thoroughly set, it is cut into small fragments with a curd-knife made of a number of fine wires fixed in a frame. This is done very carefully, lest the cream in the curd might escape into the whey and be lost. The curd is then gathered into a mass and freed from the whey, after which it is pressed by the hands into the molds, as shown in figure 85. In this process the workman fills each hand with curd and presses it together, reducing it to a soft cake, which he

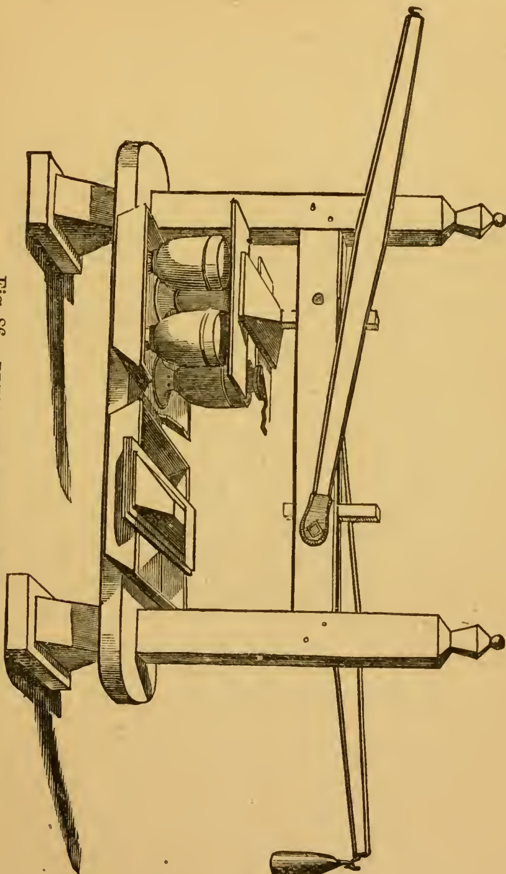

Fig. 86.—PRESS FOR EDAM CHEESE.

throws with force into the bottom of the mold. He repeats this process until the mold is filled, when the mass of curd is pressed together and taken out, and reversed three or four times until it is compact. The small holes at the bottom of the mold are kept clean to permit the whey to drain off. As soon as the cheese is sufficiently pressed with the hands it is taken from the mold and plunged into a bath of hot whey (122°) for two minutes. It is then again pressed in the mold and shaped, wrapped in a cloth, replaced in the mold and pressed (figure 86). The cheese remains in the press for one or two hours in the winter, six or seven hours in the spring, and twelve hours in the summer. After coming from the press the cheese is put in the salting mold (figure 87). This gives the cheese its final shape. The cheeses are sprinkled with salt daily for ten days while in these molds, and are frequently turned to drain, the whey passing off to the draining table through a hole in the mold.

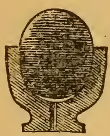

Fig. 87.
SALTING MOLD.

After this stage the cheeses are dipped in moist salt, wiped dry, and placed upon the drying shelves to cure. The shelves are arranged as seen in figure 88, and the cheeses are placed upon them in regular order, according to their age. Here they remain three months, being turned every day the first month, every second day the second month, and once a week during the third month. At the end of twenty-four to thirty days they are dipped in a bath of tepid water (about sixty-six to seventy degrees), washed, brushed, and set to dry in an open place. When perfectly dry they are replaced upon the shelves. Fifteen days afterwards they are again washed, dried, and greased with linseed oil, when they are returned to the shelves, where they remain until sold for home consumption. When prepared for exportation, they undergo some further processes, to give them a lighter color upon the outside, and also to preserve them for a longer period. They are first scraped smooth with a sharp knife, then, for the English and American markets, they are rubbed with a mixture of linseed oil and annatto, which gives them a deep orange color. These cheeses are now largely made in this country and are sold for about one dollar each at retail. They are made in precisely the manner

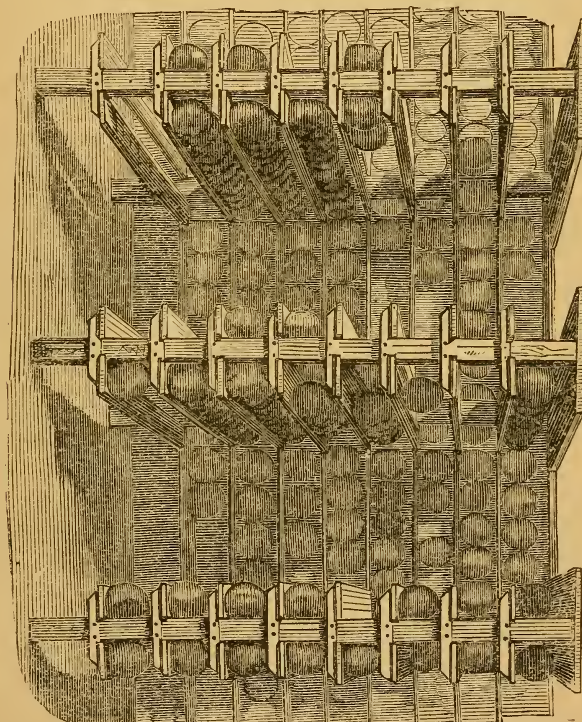

Fig. 88.—DRYING SHELVES.

described, and are not to be distinguished from the Holland made cheeses in flavor or appearance.

THE NEUFCHATEL CHEESE is an exceedingly popular small cheese in the markets of our large cities. It is the American imitation of the French Neufchatel. The best of these cheeses are made and ripened with great care. They are usually made from whole milk, which immediately after being drawn is strained into crocks and treated with rennet. The crocks are then placed in boxes, which are covered with woolen cloth. After having stood forty-eight hours the crocks are emptied into a basket lined with a clean white cloth, and standing over a trough to drain. After twelve hours the corners of the cloth are folded closely over the curds, which thus enveloped are placed within a press and left for twelve hours. They are then put into a strong linen cloth, in which they are thoroughly kneaded and rubbed in every part until the caseous and buttery parts are perfectly mixed and made into a homogeneous paste. If this paste is too soft the cloth is changed until the surplus moisture is withdrawn. If it is too hard and dry more curds are added from that of the next milking (which is now draining). The mold, which is open at both ends, is then rather more than filled with the paste. It is held upright over a table with the left hand, while the top is patted down with the palm of the right hand so as to completely fill the whole mold. The surplus is then cut away, and the little cheese is pushed out from the mold.

The cheese, after molding, is dusted on the two ends with very fine and dry salt, that accidentally remaining on the hands being sufficient for salting the sides. It is then stood on a board, not touching its neighbors, and left to drain for twenty-four hours. The cheeses of this making are then carried to the store-room, where they are laid on their beds of clean straw (on shelves), being placed in uniform rows crosswise of the straw, and lying about the distance of their diameter from each other. Two days later they are turned, each one being rolled half way over; this brings them on to dry places in the straw. Three days later they are turned up on end and stood on the space between the original rows. After five days they are reversed and placed on their other ends, and here they stand five days longer. They are now sixteen days old, and have become somewhat dry, a skin being formed over them. If they are not now coated with a slight blue mold they are again reversed and allowed to stand longer. When this mold has appeared they are taken to a *dry*,-cool room, where they are turned (end for end) every five days, and they are watched (with much care as to atmospheric conditions) until they are well coated with a reddish globular mold. If the processes have all been well managed this mold will appear uniformly on all sides, and the ripening will be equal throughout. After this they are turned less frequently, first once in ten days and then once a fortnight. At the end of three months they should be sold, as soon after this time they will begin to run.

Well-made Neufchatel cheese should be a homogeneous paste, free from granulation, and spreading smoothly like butter.

The care and close attention which the manufacture demands justifies the high price that the well-made article brings in the European markets—a price which the more simply made American imitation can not command.

In the manufacture of this class of cheeses quality should be made the first consideration. The French call this class of cheeses "*fromages de consistance molle,*" or simply "soft cheeses." They should be of a buttery consistence, with a pleasant sharp flavor and an ammoniacal odor, but not so pronounced as that of the Limburger. The rich buttery consistence is procured by the addition of some of the cream of other milk of the previous evening, and a little more rennet is then used. The low temperature, the small quantity of rennet, and the long slow curing, with the effect of the mold, all aid in procuring this desirable quality. American imitators of the French cheese would do well to imitate equally well the careful French methods.

Brie Cheese, another excellent soft French cheese, is made in three or four factories at least in the United States. One of these is in Orange County, New York, and the product is equal to that of the French dairies. There are the fine, the half cream, and the skim Brie cheeses. The fine is the only kind made here. The process is at first precisely like that of the Neufchatel cheese. The new warm milk is treated with rennet as soon as drawn, sufficient rennet being used to get the curd in an hour or a little more. The mold is about a foot in diameter and three inches in depth. The mold rests on a mat of rushes placed on a plank form. As soon as the curd is formed it is dipped out of the vat with a strainer dish, without breaking it, and the mold is moved to a draining table for the whey to run off. As soon as the curd has become firm enough, it is taken from the mold, smoothed with a knife, and put on the salting table, where it is sprinkled with fine salt. The next day it is turned and salted on the other side. If the cheese gives way it is strengthened by a band of zinc placed around it until it becomes firmer, and to turn them easily they are laid upon a frame of osiers with another on top. They are turned daily from ten to fourteen days. They are cured in a dry airy room, where they become covered with blue mold with which the red spores are mingled, and after six weeks they are ready for sale.

The best cheeses are refined in the following manner. They are packed in casks in layers with oat straw between them, in moist cellars or damp stone rooms, at a temperature of not more than fifty-five to sixty degrees, where they remain until they become soft, mellow, and exceedingly unctuous in texture, and submit easily to the pressure of the finger. They are then in the right condition for consumption, possessing a rich piquant flavor and soft creamy consistence much liked by a certain class of consumers of cheese.

The Roquefort Cheese is an example of a mode of curing by which a most exquisite flavor is developed in an ordinary curd by means of fungous growth both within and without the cheese. The manufacture has been for many years under a sort of associated system much similar to our factory system, and takes precedence in point of time to ours by a good many years, the milk being sold to the company—which owns the caves where the curing is carried on—by some of the farmers, others sell the curd, and still others the new cheese; the curing, being the most important part of the manufacture, is carried on by a few individuals or companies.

The milk used is taken from ewes—a race of sheep being bred in the locality having extraordinary milking qualities—as well as from cows; but the quality of the cheese seems to be quite independent of the milk used. The evening's milk is strained into a copper cauldron and heated slowly to a point never equal to boiling heat, but varying according to the judgment of the operator in regard to the season, the weather, the pasture, and the quality of the milk. The richer the milk the less heat is applied. The heated milk is put into widely flaring pots for the cream to rise and is skimmed in the morning. The morning's milk is put directly into the cauldron with the evening's milk and heated to the same temperature as the evening's milk was. The rennet is then added in the proportion of one tablespoonful for 120 pounds of milk—a little more than fifty quarts. The curd is cut and broken in the usual manner and the whey is separated. The whey is dipped out of the vat with a flat dish-shaped dipper, which is pressed into the curd until no more can be taken up, when the curd is broken up with the hands and put into the molds.

The molds are of glazed earthenware of a flat cylindrical shape, pierced with holes, and are about eight and a half inches in diameter and three and a half in hight, so as to make a cheese of about seven pounds in weight green, and five to six pounds when cured. The whey drains off through these holes and from the bottom of the mold. About one-third of the depth of the molds is filled in with the curd and this is pressed down. The surface is then lightly sprinkled with a preparation of blue mold made in this way: A bread is made of equal parts of flour of wheat and barley, leavened strongly with one part of yeast for twenty-three parts of the bread, and one quart of vinegar. The bread is then raised and baked crisply. It is kept in a warm place until it is covered with green mold (*Penicillium glaucum*) which is suffered to spread all through the bread, the soft part of which is then dried and crushed to a fine powder. The incorporation of this powder sows the seed (the spores) of the mold, and this spreads during the curing all through the mass of the cheese in numerous veins. When this mold assumes a blue color it is taken as an indication that the cheese is of superior quality. The mold is thus filled with curd in three layers, with the fungus spores sown between them, the last layer projecting considerably above the level of the mold, so that when the pressure is applied the mold may be exactly filled to an even level.

A second mold is filled in the same manner and placed upon the surface of the first one; a leaden plate is then laid upon the second mold to furnish the pressure, which gradually forces out the whey and fills the molds even with the curd. The filled molds are then placed on benches having channels cut in them to drain off the whey, and the cheeses remain until no more whey escapes from them, which is during three or four days, being turned twice daily. The air of this apartment is kept moist by means of pans of hot water frequently renewed. When ready for the change the cheeses are taken out of the molds and moved to the drying house. This house is dry and airy, and the windows are covered with wire or cloth gauze to keep out flies. The tables are covered with linen cloths, upon which the cheeses are laid to dry, and are turned evening and morning. In three days they are taken to the curing cellars or caves.

The village of Roquefort is built upon an elevated plain 2,700 feet above the general level, and is underlaid with limestone rock which is honeycombed with caves and fissures. A constant current of cold moist air passes through these caves, and it is in these that the curing cellars are made. No light of day enters them, and by means of cross-walls and apertures the air currents are directed through the corridors where the cheeses are stored. At this point the cheeses amount in weight to eighteen per cent of the milk used. The temperature of these caves ranges from forty-five to fifty-five degrees and the moisture is sixty degrees, on a scale of which a hundred degrees is saturation.

The first apartment in the caves is the weighing-room, where green cheeses are received from the farmers (patrons), for the purpose of curing, by the owners of the caves, who purchase them and cure them with their own product. The cheeses are carefully tested and are then placed on the ground, which is covered with straw, and remain twelve hours to cool down to the low temperature of the caves. They are then removed to the salting-room. A handful of salt is spread over one face of the cheese and this is placed on the ground; another is salted on one face and placed on the first, and a third is treated in the same way and set upon the second one. In twenty-four hours the cheeses are reversed and salted as before on the other faces. Forty-eight hours afterwards the cheeses are well rubbed with a coarse cloth to make the salt penetrate and are replaced in piles of three. They are then left for two days, when they are returned to the weighing-room and are passed through two operations which are called the "*raclage*" (trimming). The first of these operations is to scrape off from the cheese with a knife a certain adhesive glutinous matter which forms upon it during the salting; the second is to remove a

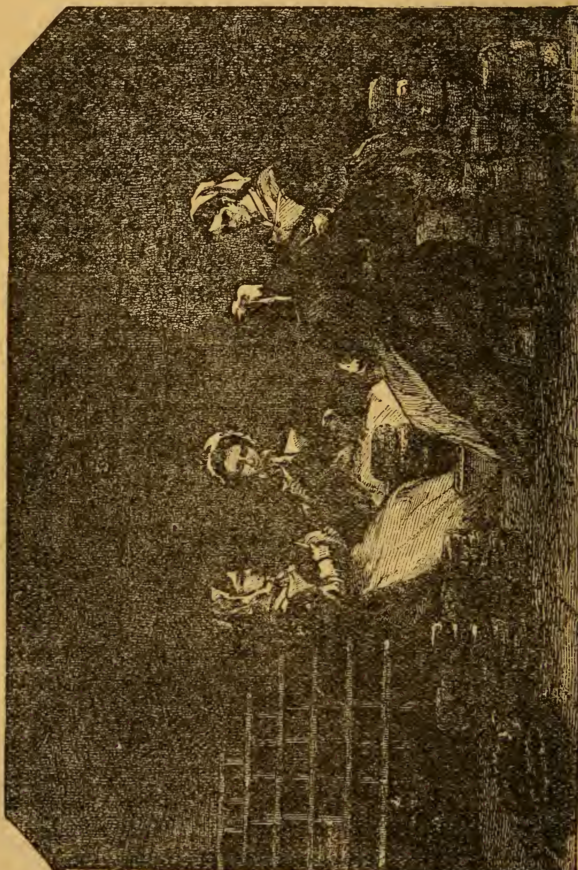

Fig. 89.—RACLAGE OF THE CHEESE.

thin slice of the crust of the cheese, which is preserved for sale as an article of food for poorer consumers. This sells at about five cents per pound (figure 89). The cheeses are now sorted into three qualities, having so far progressed in the curing as to enable the operators to class them in this way. After this sorting the cheeses

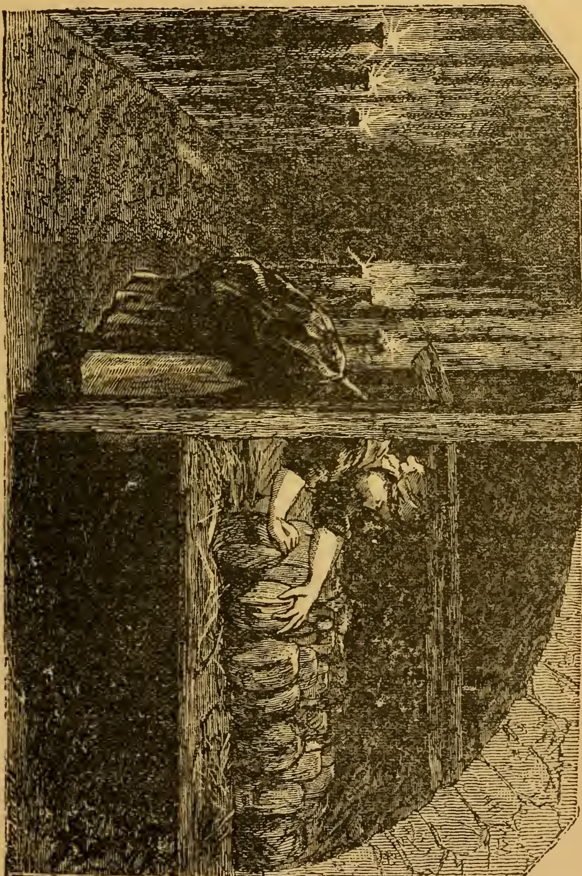

Fig. 90.—ROQUEFORT CURING-ROOM.

are returned to the curing cellars and put up in piles of three as before, the most solid on the straw-covered floor and the softer ones on these. In this state they remain for eight days. They are then taken down and laid out singly without touching each other (figure 90). At this stage they become yellowish or reddish in color. When they become covered with a white mold an inch or two thick they undergo a second "raclage." The moldy substance is sold for feeding to pigs. In ten or twelve days after, this operation is repeated; the finer the cheeses the more quickly they are covered with the mold and prepared for it. In thirty or forty days more, the first made cheeses are ready for sale, as they are not considered suitable for long keeping. The later made cheeses are selected for the most thorough curing. These are made in May and June and are not finally disposed of until September to December. These cheeses undergo the operation of "raclage" several times and develop first a red mold and finally a dense blue mold. During the curing the cheeses lose twenty-five per cent of their weight. When the curing is completed the best cheeses are wrapped in tinfoil; the second quality are packed naked in baskets, each cheese being surrounded with a thin wooden band. Only the finest, wrapped in tinfoil, are imported to this country, where they retail for fifty to sixty cents a pound.

CAMEMBERT is one of the finest flavored and richest of the small French cheeses. It was first made by a dairyman named Paynel in 1791, soon became popular, and his family are to-day engaged in making this same cheese, along with several neighbors, the annual sales amounting to very near two million cheeses. Two quarts of milk are used to make a cheese, which weighs a little over three ounces when it is cured and ready for sale. The wholesale price is about one dollar and eighty cents per dozen, and they retail at twenty cents each. The method of manufacture is as follows: The milk,

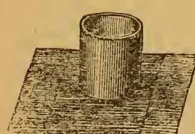

Fig. 91.

drawn with extreme care to preserve perfect purity all through the feeding and care of the cows, is taken at once to the dairy, where it is set aside in jars for three hours. The thin cream which has risen is skimmed off and

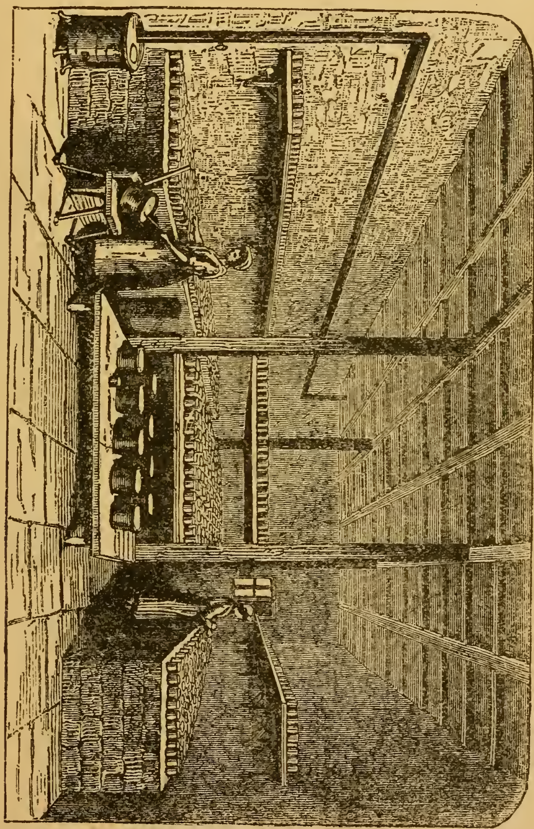

Fig. 92.—CAMEMBERT CHEESE FACTORY.

used for making an extremely delicately-flavored butter, which sells by the confectioners in Paris at a high price. One hundred quarts of milk furnish only one pound of butter. The milk is then heated until a skin forms on the surface, and when this begins to shrink or "crinkle" the rennet is added to the milk at the rate of one spoonful to twenty quarts of milk. After six hours the curd is dipped out of the jar—which is of glazed earthenware, holding about three gallons—into small, tin molds, which are about four and three-quarter inches (twelve centimeters) in width and hight, open at both ends, and resting each on a small mat of rushes sewed together

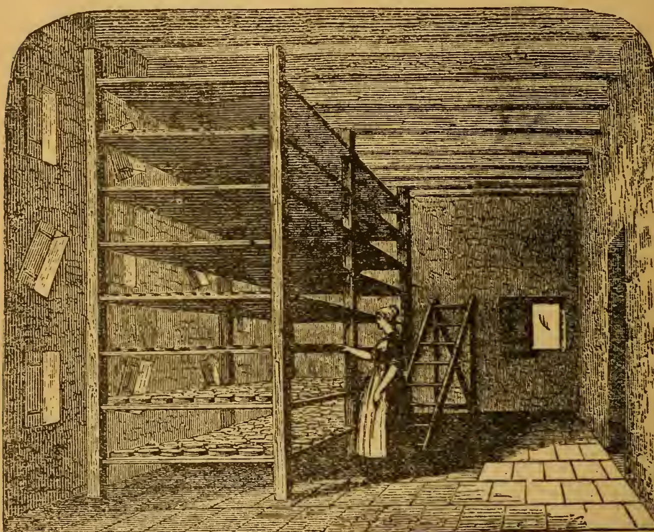

Fig. 93.—DRYING ROOM.

(figure 91). This work is done, in Mons. Paynel's dairy, in a stone building, furnished as represented at figure 92. In two days the curd becomes firm enough to be taken from the molds; no pressure is used. Then they are sprinkled with salt, and placed on the tables for three or four days. They are next carried in baskets, upon tin gratings or frames which fit the baskets, to the drying-room, where the frames with the cheeses on them are placed on the shelves (figure 93). Here they are turned every two days for three weeks, and exposed to currents of air, which are made to flow in various directions by

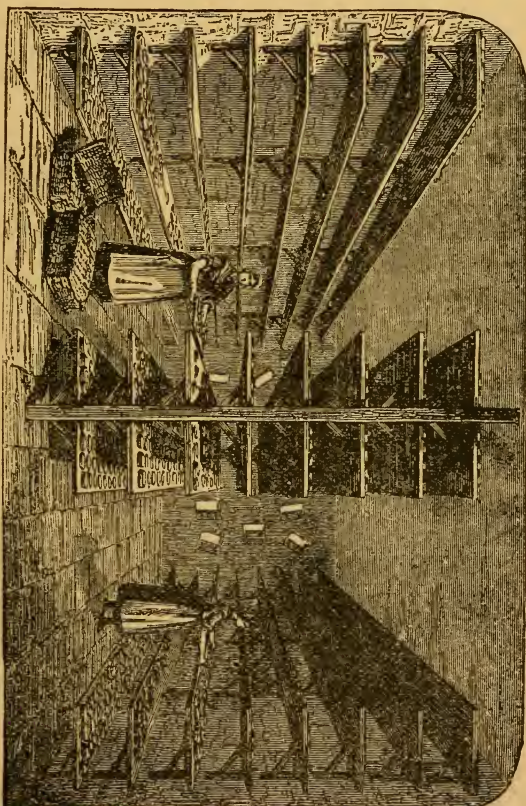

Fig. 94.—FINISHING CELLAR.

means of movable window frames, seen in the engraving. The cheeses are thus aired in turn, until all have been equally exposed to the currents. They are then removed to a second dry house (*sechoir*), where they are more exposed to the air, and in time begin to sweat and become moist. When this occurs, they are removed on trays to the finishing cellar (*cave de perfection*), (figure 94), which is furnished with shelves and glazed windows, the air being rigidly excluded. They remain here twenty to thirty days, and are turned every two days as before. After this they are finished, and appear as shown at figure 95, being then wrapped in paper, and packed in baskets containing ninety cheeses, for shipment to market. They are now about four inches in diameter, and one and one-fourth in hight. An unusually fine quality sells in Paris for twenty-five cents each. The largest consumption is in that city, which annually takes over a million of these cheeses.

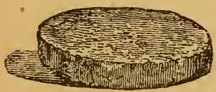

Fig. 95.

One Hundred Hints to Cheese Makers, which include the whole art of conducting a factory successfully, are here given, not for the instruction of experienced dairymen, but rather as reminders of what is so apt to be forgotten, and as a code of rules for younger practitioners who have not yet mastered all the secrets of their art.

1. Teach your patrons how to produce milk of the best quality by asking them questions and giving them advice.

2. Print the following "*Ten Points for the Instruction of Dairymen*," and furnish each of your patrons with a copy every three months.

3. Feed your cows on clean food only. Never use sour food.

4. Be sure to give only clean pure water.

5. Clean the cows before milking.

6. Strain the milk carefully immediately after milking.

7. Air the milk well while straining, holding the strainer above the pails.

8. Never use a greasy cloth, brush or utensil.

9. Empty whey from the cans immediately on arriving at home, and clean the cans without delay.

10. Never dog, or run, your cows.

11. Never use the milk of a sick or gargety cow.

12. Scour the cans with a hard brush, rinse them thoroughly and air them well.

13. Examine the milk cans once at least every week.

14. Look closely to the opening of the can into the milk conductor and examine the conductor every day.

15. When tainted milk is received, lose no time in visiting the dairy and finding the cause and removing it.

16. Clean out the water pans every week.

17. One day in the week have a general examination and cleaning.

18. Use brushes for cleaning, and keep cloths perfectly clean and sweet.

19. Air the brushes and cloths thoroughly, and dry them once a day.

20. Milk in good condition is set at eighty-four to eighty-six degrees.

21. When milk is slightly acid set it at ninety to ninety-six degrees, according to degree of acid.

22. Use only rennet of known strength.

23. Never use impure rennet.

24. Dilute the coloring to one gallon for every vat of milk. Stir the coloring in thoroughiy.

25. Carefully gauge the rennet to the condition of the milk.

26. Early in the season, when cows are fresh, more rennet is required than later.

27. The more rennet is used the moister will be the cheese.

28. The moister the cheese the more quickly it cures.

29. The first action of rennet is to bring the curd ; the second is the curing of the cheese.

30. As much rennet as will bring the curd at eighty-six degrees in twenty-five to thirty minutes will make a quick curing cheese.

31. Forty-five minutes should be allowed for bringing the curd in summer and fall chesse, with good milk.

32. Higher temperature than eighty-six degrees promotes the action of the rennet.

33. Sour milk should have more rennet, proportionate to the acidity.

34. Dilute the rennet to one gallon for a vat of milk.

35. Thorough stirring in of the rennet is required to cause even coagulation.

36. Let the curd become fairly firm before cutting.

37. Use the horizontal knife first, lengthwise; when the whey has separated use the perpendicular knife crosswise.

38. A quick curd is to be cut very fine.

39. Cut quick, so as not to push the curd.

40. After cutting stir gently and slow.

41. Clear the sides and bottom of the vat from adhering curd.

42. Do not use heat until fifteen minutes after beginning to stir.

43. Use hot water for heating, lest you scorch the curd.

44. Heat gradually; rise one degree in not less than four minutes.

45. Heat a quick curd as soon as it is stirred, and as fast as possible.

46. Stir until the curd is firm.

47. Draw off the whey when the hot iron shows fine hairs one-quarter of an inch long.

48. Keep dry curd at a temperature above ninety-two degrees.

49. Let the curd become solid only when it is sufficiently dry and firm.

50. Turn and pack close until the curd is in layers four or five deep.

51. At this stage permit no whey to remain on the curd.

52. Test the curd frequently, by touch, smell, taste and appearance.

53. Curd is ready for cutting and salting when it feels mellow, soft and unctuous;

54. When it smells slightly acid;

55. When it has a brisk, sharp, but not sour, taste;

56. And when it appears somewhat fibrous in texture instead of flaky.

57. A porous open curd should be soured more before it is cut and salted.

58. A moist or soft curd should be cut earlier.

59. Stir a soft moist curd some time before adding salt.

60. A soft moist curd, and a porous open one, should both be well aired by stirring before salting.

61. Air and stir curd, as a rule, five or ten minutes after grinding before salting.

62. Use the salt which you have proved to be the best.

63. Use a small mill and grind the salt extremely fine.

64. April and May cheese requires one and three-quarter pounds of salt per 1,000 pounds of milk.

65. Summer cheese requires two to two and three-quarter pounds of salt per 1,000 pounds of milk.

66. An increase of salt is required when the milk was sour, or an excess of rennet has been used.

67. Salt retards curing and corrects acidity.

68. Twenty to forty-five minutes should elapse after salting before going to press.

69. Undue delay at this stage causes loss of flavor.

70. Press continuously; at first light, then gradually heavier.

71. Clean the curd mill every day.

72. A foul curd mill inevitably produces bad flavors.

73. Use loose-fitting followers and canvas rings.

74. Pure water only should be used when bandaging cheese.

75. The cheese most easily acquires bad flavors at this stage.

76. Thoroughly clean curd sinks every day; air racks at night.

77. Use racks with slats having both edges beveled.

78. Be sure to use perfectly clean cloths in the sink. Soak in a strong alkaline solution to clean from grease.

79. Scrub hoops and press tables frequently; wash with hot water daily.

80. Turn the cheese daily.

81. Do not remove press cloths for two weeks.

82. Finish the cheese to a perfect shape before removing it to the curing-room.

83. Curing is the result of digestive fermentation; seventy degrees is the most favorable temperature for it.

84. The higher the temperature the more rapid the curing.

85. Spring cheese requires seventy to seventy-five degrees.

86. Summer cheese requires sixty-five to seventy degrees only.

87. Keep three accurate thermometers in different parts of the curing-room and consult them frequently.

88. Keep the curing-room clean, the air pure, and the tables free from grease.

89. Keep the flies out of the curing-room by every possible precaution.

90. Turn the cheese on the tables every day for three weeks.

91. Use warm pure grease when the cheese is stripped of the press cloths and carefully fill every crack smoothly.

92. Grease summer cheese before boxing them; use scale boards before the grease dries.

93. Use two scale boards on each end of the cheese.

94. Weigh each cheese carefully. Mark the weight on the inside of the box.

95. Use strong boxes to fit the cheese tight and level, and with close-fitting covers.

96. Avoid unclean wagons or cars in shipping cheese.

97. Avoid the very least uncleanliness in every detail about the factory, especially in the disposal of the whey.

98. Keep an exact record of each day's work.

99. Finish every day's work completely, leave none of it for the next day.

100. Discipline yourself to observe all these rules, and consider the breach of any one a damage and a loss to be avoided by the most scrupulous exactness.

CHAPTER XXV.

MILK DAIRYING.

THE production of milk for sale is a business of very large extent. The quantity of milk sold and used for domestic purposes by others than farmers is unquestionably equal to one-tenth as much as that used in butter and cheese making. With six million farmers who produce milk in our whole population, and whose families comprise thirty million persons, there are as many more in the United States who use milk. Estimating one quart as the daily consumption of each family of five persons, there must be at least a million cows kept for the production of milk for sale. This business is always increasing with the growth of cities and towns which require systematic supply. Moreover, the business is somewhat intricate, and it is quite difficult to keep the milk in good condition under the unfavorable methods of transportation and distribution, which are very much against the interests of the producer and in favor of the distributor. There is great need for persons engaged in this branch of dairying to fully understand the best system of producing milk, the methods of caring for it until it reaches the consumers, and of the disposal of it. These three considerations are of the greatest importance and deserve the closest study and most careful practice, because the success of the business depends upon it.

The cows most desired for this business are the half bred Shorthorns, or grade Holstein-Friesians. Many breeders of fine pure bred Holsteins—which are large milkers and whose milk is excellent for this purpose—devote their herds to the production of milk for sale, finding a good demand for the calves, which sell at prices which repay the cost of rearing them. Some Ayrshire breeders do the same with equal profit. But, as a rule, it is best to attend to one thing at a time in business, and the milk dairyman will find the best cows for his use to be the grade Shorthorns, Holsteins, or Ayrshires—the first being the best cattle for beef, fattening very easily and rapidly when the yield of milk is falling below a profitable point, which is from eight to ten quarts a day; the second making fair beef, and the third being fairly good beef cattle for local consumption. Each kind is a good milking cow and produces a heavy, well-flavored and dense milk.

The feeding of cows for this purpose is especially important, because as competition reduces the price of milk to the lowest point, the feeding must be both cheap and productive. A study of the characters and kinds of foods, and the methods of growing the most productive feeding crops, is of great use in this respect, and a reference to preceding chapters in which these subjects are treated will be instructive. The practice of large milk dairymen who have long experience in this business near the city of New York, is given in the following description of a milk-barn and business in which 200 cows are kept. The farm is located about thirty miles from the city of New York and the owner procures his cows from Ohio chiefly, where he can obtain good grade Shorthorns. These cows are kept in a barn of

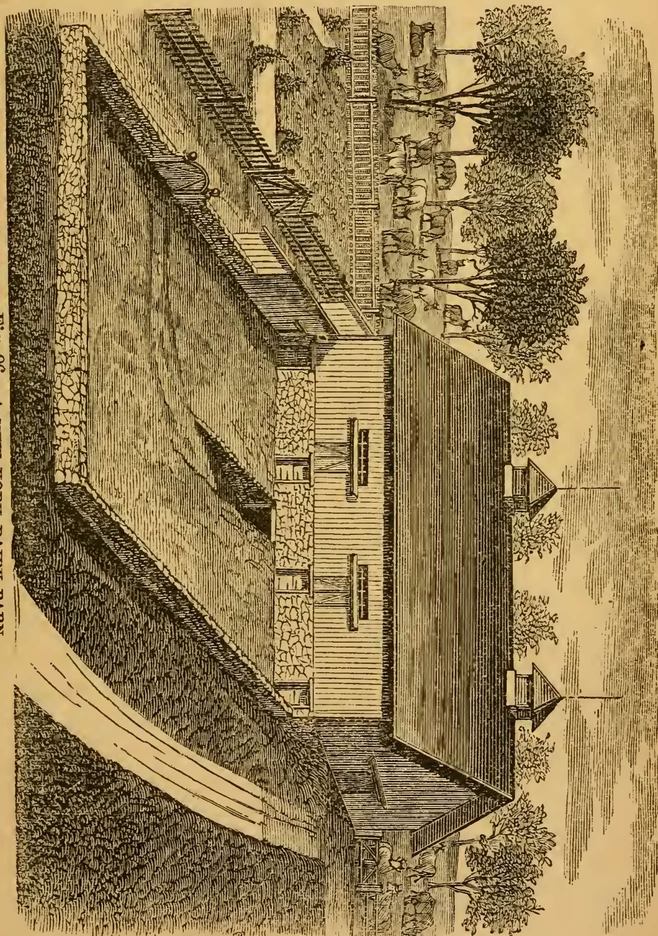

Fig. 96.—A NEW YORK DAIRY BARN.

which figure 96 was engraved from a drawing made by the author on a visit to the farm. It is situated upon the side of a hill, in an excavation of which the basement stable is placed. The basement is of stone, and nine feet high. The barn is twenty feet high above the basement, eighty feet long and twenty-eight feet wide. The yard is surrounded with a stone wall, and a manure pit is dug under the center of the building, large enough to back a wagon into. No manure is kept in the yard, which is thus always clean and neat; but it is raked into a wagon, which is backed into the pit to receive it every morning, and carted away. Nothing is thus left to taint the air around the stable, and to vitiate the purity of the milk. At the left of the yard, adjoining the stable, is a spring-house, in which the milk is rapidly cooled, and kept cool until the time for shipment. Behind the spring-house, and immediately at one end of the barn, is the pit for storing brewers' grains, of which a portion of the feed consists. These grains, purchased from the breweries, contain a large portion of corn meal, which is now extensively used in brewing, and are both nutritious and wholesome food. It is a mistake to suppose that fresh brewers' grains are unhealthful or improper food, or tend to produce any but the best of milk. Grains are simply crushed malt which has been deprived of a part of its sugar by the process of mashing, and contain, when in a dry condition, only very little less milk-producing nutriment than the barley from which they were made, the loss, besides the sugar, being chiefly starch or carbonaceous matter. The daily ration given to the cows upon these milk farms is usually half a bushel of grains, in which there is a considerable portion of corn meal, and six to eight quarts of dry corn meal, with as much hay as they care to eat. Where no grains are fed the ration is eight to twelve quarts of corn meal with hay. The pit in which the grains are stored is a deep cellar walled with stone and cement and covered with a roof. A door from the bottom of the pit opens into the stable, and permits the removal of the grains as may be needed. In this pit several thousand bushels of grains can be stored, and being packed down closely, and kept from access of air, may be preserved in good order for months. It is upon a similar plan to this that farmers are now preserving their corn fodder in a green state in silos until the new crop comes in. The basement has four doors and is amply lighted and ventilated. The floor is divided in the center by a wide feed-passage, upon each side of which are stanchions to hold the cows. There are no feed troughs, but the feed is placed upon the floor before each cow. The stanchions are made of oak, are self-fastening by means of an iron loop, which is lifted as the stanchion is closed, by its beveled end, and falls over it, holding it securely. The space between the stanchions for the cow's neck is six inches. Each cow has a space of three feet, and there are no stalls or partitions between them. The floor upon which the cows stand is four and a half feet wide, behind this is a manure gutter eighteen inches wide and six inches deep, and behind the gutter a passage of three feet and six inches; in all giving a space of fourteen feet from the center of the feed passage to the walls upon either side. Hay-chutes are made in the floors, by which hay is thrown down into the feed-passage. These also serve for ventilation, in connection with the cupolas upon the roof.

In the summer the cows are pastured, but get their usual ration of corn meal, and when the grass begins to fail are fed green crops cut and carried to the yard, or into feeding lots, where they are kept. The principal crop fed is corn fodder, grown in drills and cultivated as well as if planted for grain. The main crop on these farms is grass for pasture and hay, and Western corn is purchased for feeding. The reason for this is that corn is thus procured more cheaply and easily than it can be grown here, while hay is bulky to transport and cannot be bought profitably. Coarse feed should always be grown in preference to grain food, as this can be procured outside of the farm, while the other cannot.

Partial soiling is indispensable for feeding the cows on a milk farm, for a regular supply of milk must be had every day, and this can only be kept up by liberal feeding of succulent fodder after the grass fails. Ensilage is also a most useful resource, as it provides succulent food in winter. Where a satisfactory supply of brewers' grains, glucose meal, and malt sprouts can be procured cheaply these will take the place of ensilage and can be preserved in the same way. With these foods hay must be fed as a complementary fodder and the two kinds will be sufficient for all purposes without ensilage. As to the rest, reference may be made to previous chapters for special information in regard to the exigencies of the business.

The management of the milk is of the greatest importance, and this is the point in the conduct of the business where most of the losses and failures are made. Every attention should be given to insure the most perfect cleanliness, the comfort of the cows in hot weather, and to cooling the milk as soon as it has been drawn from the cow. The last-mentioned subject is worthy of special consideration. It has been previously stated that when milk is cooled to a low temperature and then warmed it sours very quickly. The sugar of the milk changes to lactic acid by an internal decomposition in which the atoms merely change their combination without any change of elements. This souring can go on in sealed bottles, when it is supposed to be quite safe from change, and the dairyman is much disappointed to find his agent complaining of the milk souring when he felt sure it was beyond all danger; the very security he depended upon being the source from which the unexpected mischief arises.

The cooling of the milk then becomes a matter of paramount importance. Ice water is too cold, and produces the very mischief it is intended to prevent. Fifty-five degrees is low enough, and sixty will do very well if the milk is not exposed to unusual risks in the transportation. There are various methods of cooling milk. The most usual one is to put the cans, as soon as the milk has been strained into them, into a tank or pool of cool water, or into a well from which water is drawn for use and is so kept fresh and cool. An iron frame, in which the cans are placed, is lowered into the well by an ordinary windlass, and the cans are kept there from early morning, when the cows are milked, until night, when the milk is shipped. The evening's milk is treated in the same way, but is not mixed with the morning's milk. Milk is always shipped in the evening, so as to be ready for the early morning's delivery. As the cans often remain on the platform of the railroad depot for a considerable time before they are put on the cars, it is advisable to have a dry, clean blanket, conspicuously marked with the shipper's name, thrown over his cans; and by making a suitable arrangement with the conductor of the milk train the cans may also be protected in the same way in the car, and thus arrive at their destination several degrees cooler than if they had been unprotected.

The great point to observe is not to cool the milk too low, and to cool it as soon as possible after it is strained, airing it well by pouring it through the strainer raised above the pail. The deep-setting milk pails, eight or eight and a half inches in diameter, are convenient for cooling the milk in, and if the temperature is not lower than fifty-five degrees there will not be much cream rise during the day. To prevent the cream rising the milk should be stirred gently two or three times during the day. A tank of water, such as is described in a previous chapter, cooled to the right point by ice, is very suitable and convenient; but a thermometer should be used to be sure the cooling is not below the safe point.

The distribution of the milk by dairymen who have a route, or a number of customers, may be eased very much by simple methods of avoiding difficulties which cause much trouble at times. Souring of the milk prematurely is the principal difficulty. This may be avoided by thorough cleanliness in the utensils, which should be scrubbed with a stiff brush and cold water; soap should not be used, but a small quantity of a weak solution of

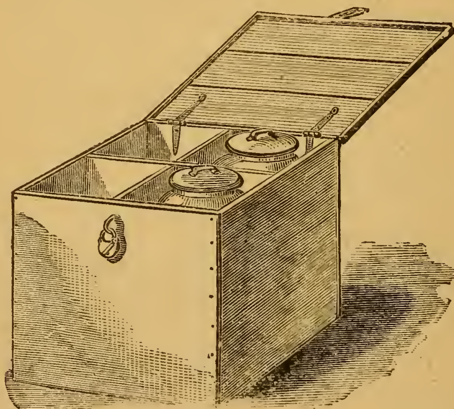

Fig. 97.—BOX FOR MILK CANS.

concentrated lye; this will remove all remnants of sour milk, grease, or other impurities from the cans. Boiling water should then be used, and, finally, clear cold water to finish, after which the pails and cans should be inverted on a bench in the open air, in a sunny airy place, and tilted so that the air can enter freely.

The routine of a milk route, as has been found satisfactory by the author, is as follows. The cows are milked at five o'clock in the morning, and the milk is immediately strained into the cans; twenty-quart ones are better than the larger ones, as the milk keeps in better condition in very hot or very cold weather. In very hot weather a glass jar or bottle filled with pounded ice may be hung in the cans to keep the milk cool; in cold weather the cans may be put in a box lined with woolen, felt, or quilting of wool, and a hot brick in each corner in a sheet-iron receptacle will prevent freezing of the milk (figure 97). When the weather in the hot season is very close and sultry, and there is danger of the milk souring, a teaspoonful of carbonate of soda, or more as the case may be thought to need, may be dis-

Fig. 98.

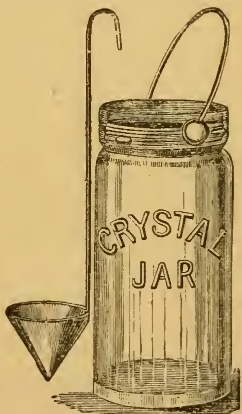

Fig. 99.

solved in a quart of the milk and the solution poured into the can.

It will help the business very much if each customer is given a card on which is printed a few simple directions for caring for the milk ; for the most frequent complaints arise from want of judgment in taking care of the milk and to undue exposure to heat and impure air. These directions should be to the effect that the milk should be kept in a perfectly clean vessel and as soon as received should be heated to nearly boiling and then kept in a cool place.

The business of bottling milk for sale is one that should be encouraged as far as possible. The milk should be cooled, as above mentioned, before it is put in the bottles, and then sealed up tightly, using rubber rings under the stoppers. The Warren bottle (figure 98) is the kind most used and holds a quart. Another very useful bottle is shown at figure 99. As there is a loss of fully ten per cent in measuring milk out of the large cans in single pints and quarts, this is saved when bottles are used, and the loss of bottles will not be as much as this. Our method of distributing milk in bottles has been to pack them in nests of two dozen, in boxes, filling the interstices with dry sawdust, or clean fresh grass in the summer. If the boxes are shipped and pass through several hands they should be locked and duplicate keys kept, to prevent any meddling with the milk.

To avoid loss or complaints by souring of the milk, and to keep the bottles in good condition, the plan followed in the author's dairy has been to give each customer a card with the following directions upon it:

"Keep this bottle in a cool place.

"Or, loosen the cover and set the bottle in a pot of cold water and heat to nearly boiling; then close the cover and set the bottle in a clean closet as cool as possible.

"When the bottle is emptied rinse it out with cold water and leave it filled with fresh cold water until taken away."

When the driver receives the emptied bottles he pours out the water and sets the bottle in a rack in the wagon. The large majority of consumers on a milk route will readily pay a cent a quart more for milk put up in this way, and this extra cent, with half a cent a quart saved in the measuring, will pay for a bottle in the sale of sixteen quarts. The bottles are not only paid for but the extra labor of handling them is also compensated for.

There have been found some serious difficulties in the way of distributing milk by dealers in large towns and cities, and milk producers have complained very much of loss of milk, excessively low price, and loss of cans. A most effective remedy for these evils, which reduced the profits of the business very much, has been found in association of the producers. The dairymen combine and form an Association, which makes contracts with the railroad companies, hires an agent in the city to receive and dispose of the milk and to look after the return and shipment of the cans. On the other side the milk dealers have also combined and formed what are called "Milk Exchanges." The two associations naturally become antagonistic, and when the expense of delivering milk in a large city is greater than the cost of producing it, there seems to be some necessity for this antagonism on the part of the producers, who find, in their own associations, freedom from dictation and extortion and a better service in every way.

CHAPTER XXVI.

WINTER DAIRYING.

THE author's special proclivity has been for winter dairying. He has learned, from many years' experience, that there are several very great advantages in pursuing a special business in which few persons are willing to engage, because it may be some little way out of their regular line of work. The most profit is made from special industries and products. The reason is that those persons who have the enterprise, energy, and skill to engage in any unusual industry meet with less competition than those who employ themselves in any ordinary occupation. It is true that they have more difficulties to encounter and overcome, but this is the very reason why they get a better price for their products and better pay for their labor. The winter dairy is one of the most profitable of these special industries. There are several reasons for this. One is that few dairymen or farmers are making butter in the winter, and consequently the supply of the fresh article is limited. Another is that those persons who are able to manage a winter dairy are experienced and skillful and consequently produce a better quality of butter than others. Other reasons are that the management of a dairy in the winter is really easier and more certain than that of a summer dairy, because it is not so difficult to maintain the requisite temperature by the use of heat as by the use of ice; there is no trouble from premature souring of the milk; the cows are in better condition when they are properly cared for; the food can be more perfectly regulated, and the whole of the dairyman's attention can be given to his special business without the interference of the ordinary farm work of the summer.

There are some special requisites needed for this business in addition to the unusual capabilities of the dairyman. A near market is needed, a snug and well-arranged stable and yard, a properly constructed dairy-house, the best furniture and apparatus, a herd of cows kept specially for this use and coming in fresh in the right season, a proper preparation for feeding both as regards the crops and the use of them, and a rigid and strict regularity and consistence in every process and operation.

The dairyman himself is the first necessity. He must be thoroughly experienced in the management of the herd, and sufficiently well versed in the science and practice of his art to be equal to all emergencies which may arise through the changeable weather and the varying temperature, which affect the cows as well as the milk and cream, and every operation from the beginning to the end of the business. He must be thoughtful, observant, free from all prejudices, apt of perception, and quick to take advantage of every occurrence, favorable or otherwise, which may arise. He must also be a good business man and know how to dispose of his product in the best manner, for there is quite as much in this as in the preparation of it. He must be a good judge of cows, able to provide himself with a first-class herd, for it costs no more, and often not so much, to feed a good cow as a poor one; neat, and having a thorough sense of cleanliness; a good and careful milker; regular in his habits, and withal kind and considerate to his cows. He must be a good farmer, and, while a winter dairy may be operated without a supply of roots, yet he should be careful to grow a crop of these for his cows, because they are the balance weight, as it were, of the feeding, preserving uniformity in the quantity and quality of the product, and producing a well-flavored and well-colored butter. He must also be able to produce maximum crops of whatever kind he grows, because, necessarily having high-priced land near a large and good market, it is indispensable for profit that he must keep the largest number of cows upon the least possible number of acres, and therefore he must raise a large supply of fodder. Green crops and roots, being bulky and not purchasable, must be grown on the farm, while grain food may be purchased more cheaply than it can be grown. A winter dairy farm should have only enough pasture to keep the cows during their unproductive season, helped out by some green fodder crops. The crops grown should be mainly clover, fodder corn, and roots. The clover is kept in the ground two years only, when it is turned under and sown to rye, which is cut for the cows to help out the pasture, and is then turned down for the fodder corn. Two crops of sweet corn are raised in one season —one of some early variety, as Narragansett, followed by

Evergreen, and these two will yield, or should be made to yield, at least eight tons of cured fodder, or eighteen tons of ensilage, per acre. The next crop on the corn stubble will be roots, and this crop is followed by rye seeded with clover in the spring and cut green if necessary for the cows in the summer. Where fine butter can be sold, sweet corn is also readily salable; and as the dairyman needs the fodder, this vegetable can be grown for market with great advantage in conjunction with winter dairying. Musk-melons are another excellent crop for this business, and some skillful growers make from $300 to $500 per acre from it upon a rye stubble, leaving the land clear for sowing rye again for seeding with clover in the spring. Early potatoes, peas, and summer cabbages and turnips are also profitable crops for this business, and they leave the land in time for a crop of sweet corn or millet for winter feeding. It is these summer crops, taken in connection with the fodder crops for winter use, and which afford some feed for the cows while on the restricted pasture during the summer, that present a subject for close study and methodical arrangement by the winter dairyman. Another important part of the business is the rearing of calves upon the sweet skim milk, warmed to a right temperature (eighty to ninety degrees). The heifer calves from a herd of well bred cows, or of good grades served by a pure bred Jersey, Holstein, or Ayrshire bull, afford a considerable profit to the dairyman, and we know from personal experience that the progeny of a good cow may be made to bring in to her owner in the course of her useful life no less than $500 without any difficulty.

The cows for winter dairying should be of some breed which is largely productive of butter. The best strains of Ayrshire cows are excellent, but we have found the butter to be too hard under the heavy grain feeding and the low temperature, and consequently an equal number of pure Jerseys of good butter stock and some cross bred Jerseys and Ayrshires—which made the very best cows, yielding from ten to twelve pounds of butter weekly—were used in the dairy. When butter sells for fifty cents a pound, it will pay to get the best cows, even at a cost of $100 to $150 each. It will even pay when butter sells for no more than thirty or thirty-five cents a pound to have cows that yield ten pounds of butter weekly. The cost of feeding cows in the winter is less than in the summer; the labor is less, and other expenses of the dairy are not so much as in summer. A cow then that yields ten pounds of butter in winter at thirty cents a pound, as compared with one that yields seven pounds at twenty cents in summer, is 100 per cent in favor of the winter dairy, and equal to $1.50 weekly. For the thirty or forty weeks of the season this difference amounts to forty-five or sixty dollars, which in one year pays the difference in the value of the cow, leaving still a calf worth fifty dollars as a bonus. It is an example of the truism that "the best always pays the best," and this is most especially true in dairying, and more than ever in winter butter making.

The arrangement of the barn and yard should be such as to reduce the labor as much as possible, and the system adopted by the author, as described in previous chapters, has been found convenient and economical in every respect. There are no foolish whims about it, no coddling or fussing over the cows, and nothing but what is indispensable in a working dairy carried on for profit and not for show. Excessive warmth is not conducive to robustness, health or profit. One may learn how this is himself. If a man's house is kept closed up and heated with stoves to a temperature of eighty degrees, and his food and drink are all taken hot with a view to preventing the effects of the cold and to insure more comfort, the dwellers in that house will become sick or diseased—

the impure air will poison the blood, the warmth will relax the skin, dry it and open the pores, and the slightest draft will cause a fit of shivering and induce dangerous colds. It is in precisely such houses that sore throats, diphtheria, scarlet fever and other diseases are so frequent; while in the house where the windows are thrown open to the breezes, and the cold, brisk, pure air is welcomed, and exercise and health give warmth, fed by the abundant oxygen of the fresh air coursing through the blood, there is health and vigor and comfort. It is the same in the dairy. Pleuro-pneumonia invades those herds which are kept in close, warm, unwholesome stables, and the dreaded tuberculosis finds there its prey; while from the wide airy stable, well ventilated and filled with pure cool air, the well fed cows will emerge to frolic in the snow and enjoy the bright sunshine and the crisp air. Excepting in stormy weather, the cows should spend at least three or four hours every day in the yard.

To preserve a healthful condition, maintain the vital warmth, and keep the skin in proper action, thorough carding and brushing should not be neglected in a winter dairy, and the utmost cleanliness in every respect should be observed. Abundant supplies of absorbents, of which dried swamp muck is the best, and hard wood sawdust and fresh leaves next, and in place of these cut straw or any other fine waste material, should be procured. The winter dairy affords a grand opportunity for making manure.

The feeding must be liberal and of the best food. It must be regular in quality, quantity, and time. The drinking water should always be warmed sufficiently to take off the chill. Giving the cows ice-cold water will diminish the aggregate butter yield several pounds a week.

The management of the milk and cream in a winter dairy is the most critical part of the business. The ever-varying temperature has to be guarded against and regulated so as to be kept even and up to the point required for the largest quantity and the best quality of the butter. This, however, is by no means so difficult as it might seem, and our experience goes to show that it is not so troublesome or costly as to keep an even temperature through the summer, and avoid all those interferences of the weather which affect the cows, the milk, the cream, and the churning in the hot season. Fuel is cheaper than ice, and by proper construction and management of the dairy-house very little fuel is required, in some cases none. There are two methods of constructing and arranging milk-houses, and we have used both with very satisfactory results. In one case a permanent spring is required, and one which does not freezé, but will maintain a regular temperature of forty-five degrees. This is brought in pipes laid three feet below the surface, with a cistern or vat sunk in the ground and lined with cement or brick. A tank of this kind in the author's dairy was lined with white bricks, and floored with white quartz pebbles upon which the deep pails stood in eighteen inches of water always flowing in at the bottom and out at the top. The water came from a bubbling spring in the ground, and never varied more than five degrees the year round. A house with double walls was built over the spring, and had three apartments—one for the tank, one for churning and washing utensils in, and an upper one for storing pails, wrappers, etc. The top of the tank was raised four inches above the level of the cemented floor, and was covered in by two falling doors, so that in the severest weather the temperature in the tank did not vary one degree. The furniture in this room consisted solely of a low bench for skimming the pails upon, a rug to preserve the feet from the coldness of the floor, and an oaken table for the butter until it was finished and for the pails until they were shipped.

The other apartment had a pump connected with the spring, a stove with a hot water reservoir, a low sink for washing utensils in and connected with a drain which emptied into a stream near by, a table, a hot box, churn, and butter-worker. The stove was heated only upon the days when churning was done or in very cold weather to make work in the tank-room more comfortable. The milk strained in the barn was again strained before it was put in the tank. The tank was provided with cross-bars of galvanized iron set in the bricks, and making a number of spaces in which the pails were set so that they could not overturn when plunged to nearly their entire depth in the water. The cream, skimmed every twenty-four hours, was kept in the tank until the evening before it was to be churned, when it was put in the hot box to be ripened. This box had double sides, bottom, and cover, and was lined with sheet cork inside to retain the heat. Two deep pails of hot water—not so hot as to make steam—and closely covered, were put in the box, and the cream cans with them. Eighteen hours in this box thus warmed with water at one hundred and twenty degrees brought the cream up to seventy degrees, and when put into the churn, warmed by a dash of hot water, was never less than sixty-five degrees when the churning began. The room was heated to sixty-five or seventy degrees during the churning. The churn used was the rectangular or the Blanchard, both kinds being used during the numerous experiments made on the action and effects of churning. The former has no dasher, the latter has a most convenient one, and this is practically all the difference between them. Both make the granular butter, if the churning is stopped at the right time, and the butter can be washed free from the buttermilk in either of them.

The other milk-room, a basement cellar, opening into a room heated by a stove, was furnished with shelves arranged on three sides of it. It was lighted and ventilated by a window near the ceiling on the north side; the walls were of stone and quite thick—one foot above the ground, where the slope was highest, and four feet lower down. It was furred and lathed and plastered; the floor was cement; the room over it was a parlor of the house and was constantly heated. Thus the temperature was very uniform, and sixty-five degrees was maintained in it quite easily by opening the door of the adjoining room, which was used for churning and washing utensils. The shelves were in three tiers and made of four strips one and one-quarter inches thick and three wide, set on edge so that the air could circulate all around the pans without impediment; to aid this the strips were beveled on the top to an edge. The shelves were fourteen inches wide and ten inches apart; the top shelf was covered with a wide board to prevent any dust from settling down upon the milk. The pans were of pressed tin, fourteen inches in diameter and four inches deep, and were filled three inches deep with milk, making eight quarts. The milk, after setting in the usual way, was skimmed at the end of thirty-six hours by floating off the film of cream into a suitable jar with as small a quantity of milk as possible. The cream, kept thirty-six hours longer and stirred when new cream was put in with it, was but slightly acid at the end of this period, and was in just the right condition for churning. When it was not churned alone for experiment this cream was put in the churn with that from the deep pails; being already at a right temperature and ripe for use.

All through this work every attention was paid to preserve perfect purity of the air and cleanliness of the utensils—a drop of spilled cream or milk was at once wiped and washed off the floor, no smoking or chewing tobacco was permitted in or about the milk-houses, ventilation was given when the air was dry and pure, and moisture was moderated, when in excess in damp and foggy weather, by the use of fresh quick-lime, which quickly absorbed the moisture and kept the air pure and fresh. Wood was used for fuel in the stoves, and the thermometers were frequently consulted to keep the temperature even and steady. All these precautions cost nothing but thought and a little—a very little—time, but they go far to making the business of winter dairying profitable and pleasant.

Most of the troubles incident to winter dairying arise from neglect to keep the temperature even, and in over-warming the cream. Sometimes a farrow cow may do much mischief, because her milk contains a large proportion of albumen, which coagulates on the first appearance of acid in the cream and forms white flakes which cannot be separated from the butter. Overfeeding, by producing disorder of the udder and ropiness or thick clots in the milk, which may pass through the strainer into the churn, also produces these troublesome white specks. Keeping the milk at too low a temperature and for too long a time, when there is not enough of it for a churning two or three times a week, is also a source of trouble. Then the excess of acid curdles the milk in the cream and the whey separates. This neglect of the right temperature then makes it necessary to warm the cream for churning, and this is usually done by setting the jar near the stove or in a pan of hot water, by which a portion of the cream is made too warm and the curd becomes hardened in small flakes. The too acid cream often foams in the churn and the butter does not come, or if the cream is too cold the butter will not gather.

Temperature is the active agent for good or bad in winter dairying, and the neglect of it is the cause of nearly every trouble which arises. The strict observance of the principles set forth in treating of the various subjects in this and previous chapters, is essential to success at any time in dairy operations, but much more in the winter. When everything has gone right up to this point there will be no trouble in churning and the butter will come in the right form and condition in a regular time, which will scarcely exceed from twenty to thirty minutes, according to the rapidity of churning. Eighty turns a minute will invariably bring the butter in the winter, when everything is right, in twenty minutes.

With winter dairying it is possible to rear calves on the sweet skimmed milk, for all the milk will be sweet when skimmed. This is warmed up to eighty degrees and given to the calves, which are kept in snug, warm, comfortable pens, deeply littered with leaves or straw over a deep bed of dry swamp muck. The calves are fed until the grass comes in the spring, when they are weaned; the cow's business soon ends, the crops occupy all the time. The demand for fresh butter is met by the general supply of cheap creamery or farm dairy butter; and the winter dairyman's harvest is over. He is then occupied in raising food crops for another season, the cows gambol in the pastures, or doze lazily under the shady trees in the wood lot, and there is rest and peace in the household, unknown where the summer dairy is carried on amid the plagues of flies, the heats and drouths of the season, and all the cares of farm work, sowing and reaping and gathering into barns, and the low prices caused by excessive supply.

CHAPTER XXVII.

THE FAMILY DAIRY.

There are probably more than a million of the six million families in this country who do not live upon farms that keep one or two cows for milk and butter. The statistics given in the agricultural reports regarding the number of cows kept we think very defective and incorrect. Ten million cows are far too few to be distributed among six million farmers, and the very numerous class of dwellers in villages and small towns, or upon small plots too modest in area to be dignified by the name of farms. These small family dairies are often badly managed and too expensively kept, because the owners do not know how to avail themselves of all the advantages which accrue from experience and skill in making the most of a small plot of land, or in feeding the best cows to be procured, so as to secure the largest product at the least cost. It is in these modest family dairies that cows are subject to more accidents arising out of neglect or want of accurate knowledge in their management. Hence, all through this work, a prevailing idea has been to incorporate with the fuller information desired by farmers and business dairymen, such plain and simple facts as may serve to guide the owner of a family dairy of a single cow in the way he should go to secure the most milk and butter for the least cost of money and work.

The family cow should be the best that can be afforded. A copious milker and a good butter producer should be chosen, because a surplus of butter should be packed away in the time of plenty to supply the family through the period in which the cow is taking a rest. This time will be from two to three months, and as an ordinary family will use from three to four pounds of butter weekly, the cow should be able to produce at least 200 pounds of butter during her milking period, besides furnishing milk and cream for the table. This would make up the required yield to an equivalent of 250 pounds of butter yearly. This is nearly a pound a day for the entire nine months of the milking period. There are not many ordinary cows able to do this, and yet there are at least one million of them wanted. This suggests to the breeders of cows an exceedingly remunerative business in rearing grades of Jersey or Guernsey stock which will be able to supply the wants of this large class of small dairies.

The best cow for this purpose is a cross bred of two breeds, one capable of giving a large quantity of milk and the other of making a large quantity of butter. A small cow is also required, because of the restricted pasture and the moderate means at command for feeding the cow. The Ayrshire and Jersey or Guernsey breeds crossed supply this demand in a more nearly perfect manner than any others. A cross of Dutch and Jersey or Guernsey also makes an excellent family cow; but as there are not enough of these pure breeds to go around, the largest part of these family dairies must be supplied with the best of the native cows, or good grades. Thousands of farmers who have good native cows might procure a good bull of any of these breeds and cross it upon their cows and rear calves for sale to supply this large demand.

The stable for a cow may be a very simple affair, and plans for such will be found in Chapter IX. If a horse is kept there should be a separate entrance for the cow, or one of the animals should be kept in a closed stall, so there could be no danger of one injuring the other. If a pig is kept it should never be permitted to become a source of ill odors in the cow stable, and by all means the pig should not be kept in the manure yard. If a cow needs to be kept clean for the sake of the sweetness and purity of the milk and butter, a pig should be kept equally clean for the sake of the meat; for a pig is subject to all the conditions in this respect that a cow is, and pure wholesome pork is as desirable as pure wholesome milk and butter can be.

For preparing the feed for the cow a small-sized fodder cutter should be procured, one of the copper-strip roller kind is perhaps the most desirable and easily kept in order, and the fodder should be cut and fed with the meal. In the summer the feeding should be pasture or grass cut and carried to a small yard, and the daily allowance of meal may be given mixed with the fresh grass or some of the waste of the garden and the house. Parings of potatoes, turnips, pea pods, pea vines, and the clippings of the lawn, will all afford useful food for a cow. In country places where half the roadway belongs to the owner of the lot, and the public have only a right of way and passage over the road, the roadsides may be kept in clover and grass and afford a large amount of feeding. The author's residence comprised three acres of land with roads on three sides, in all taking up nearly 1,000 feet in length and twenty-five in width of useful land not required for the use of the public. This made up more than half an acre of land, from which sufficient grass and hay were cut to feed a cow for half the year. The clippings of the lawn of three-quarters of an acre furnished quite an equal quantity of the best of fodder, young grass of the most nutritious kind. The mowing of an acre or more of orchard, the fodder of sweet corn, and the spare apples, pears, beets, peas, carrots and potatoes from the garden, with the grass and hay, all provided sufficient feeding, with the half bushel of corn meal and bran weekly, to feed two Jersey cows which yielded over twenty pounds of butter every week in addition to a liberal supply of milk and cream for the family during the whole summer. Four-fifths of this butter was eagerly bought by neighbors at fifty cents and upwards per pound, giving a very handsome interest upon the value of the cows.

The farm, a few miles distant, had half a mile of road through it, which was kept in good order, without help from the perfunctory road master and his able assistants, in the same way, and excepting the road track was plowed, manured, and seeded with grass and clover and was mowed as regularly as the fields were. An envious

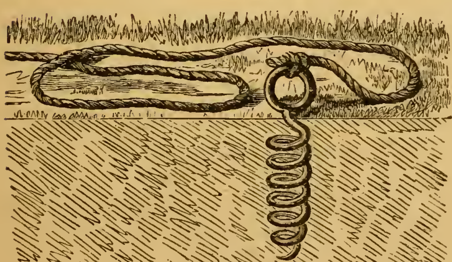

Fig. 100.

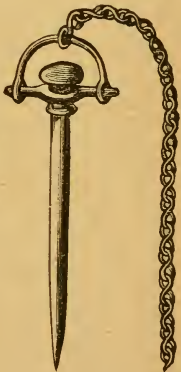

Fig. 101.

neighbor, who wished to enforce his rights to do as he pleased on the road and who drove maliciously through the grass, breaking and tearing it down, was promptly prosecuted and fined for trespass, and taught that the road was owned by the owner of the land adjoining, and the public had only a right of passage over it, and only on the beaten track, and that the owner of the land could use it for any purpose he wished provided it did not interfere with this public easement. Thus one may turn this valuable land to good purpose in growing grass for the family cow and making it into hay or cutting and feeding it in a fresh state. This will be a great help in such a dairy, and as an improvement upon the usual roadside weeds and general waste of the land, will commend itself to the good sense and thrift of all civilized and orderly people as well as to the sense of right and justice.

In feeding cows upon lawns and small plots the tethering system will be found very convenient. We have used the two kinds of tethering pins shown in figures 100 and 101; one has the advantage of being forced into the ground—when it is soft—without a mallet, but when the ground is dry and hard it is difficult to make it penetrate; the other needs a mallet to drive it down, but as the mallet may be left near the pin, there will be no inconvenience in this respect. This pin has a swivel head which prevents twisting and entangling of the chain. A swivel should always be put into tethering chains to prevent twisting. These chains should always be made of steel for strength and lightness; for if a cow in her playful moods once breaks her chain, she will always try the same trick by running at full speed the length of her tether in the effort to snap it again, and will generally succeed through one weak link. This is a troublesome habit and should be prevented, for with this method of feeding cows one may do a great deal of damage in her playfulness if she gets loose in a garden or on the lawn among ornamental trees and flower borders.

The milk for a family dairy will be usually kept in the cellar as the most convenient place. If so, a part of the cellar should be divided off tightly to exclude dust, and the remainder should be kept free from all disagreeable odors. The whole cellar should be whitewashed with hot lime to destroy mold, and every decayed part of the floor should be removed. No cellar should have a wooden floor, the earth is better; but the best is a floor of cement, or flagstone laid in cement, both of which are indestructible and clean. If there is a spring conveniently situated, a small house may be built over it and the water used to keep the milk cool in some of the ways previously described. An outside cellar, built in sloping ground, with a basement in front of it and a building over it which can be used for various purposes not inconsistent with a milk-house, will make an excellent place for keeping milk. In default of any other convenient arrangement milk may be kept in a clean roomy closet in the coolest part of the house, and many a good housewife makes excellent butter from milk kept in such a place. Pure air and regular temperature, even if it should go up to sixty-five or seventy degrees—provided the cream is skimmed before the milk is actually sour and never thick, and the cream is not left to stand longer than until it is moderately sour, and is stirred when fresh cream is added—will secure good butter, although only a closet in the house is all that can be afforded to keep the milk in.

In the winter, a closet in the house, where the temperature is kept even by the warmth of a chimney passing through it, is an excellent place for the milk and cream, and better than a cellar where the temperature will go down to fifty degrees or less, for this is too high and too low for the best separation of the cream. When milk is kept in a cellar in the winter and the cellar becomes too cold in the coldest part of the season, it is not difficult to raise the temperature to a right point by having a block of iron heated red hot in the fire, carried down and set upon a few bricks on the floor. A sheet-iron pail filled with hot coals from a wood fire will also serve the purpose of warming a cellar. In the coldest weather it will hurry up the rising of the cream if the pans of milk are set upon the stove and warmed up to about eighty degrees before being put away for the cream to rise. This will bring up the cream in twenty-four hours, making it thick and easily removed from the milk.

When the churning is about to be done, the cream should be brought to a temperature of sixty degrees in the summer, by setting the jar in ice water not cooler than forty-five degrees. If the thermometer shows that the temperature is seventy degrees in the place where the churning is to be done, the cream may be cooled to fifty-five or fifty-six degrees, as it will become warmed up a few degrees during the churning. In the winter the cream may be raised to sixty-five or even seventy degrees, if the churning-room is as cool as fifty degrees. The temperature of the place where the churning is done should always be taken into account, so that the effect of it upon the cream may be equalized.

In warming the cream by means of hot water care must be taken not to overheat any part of the cream. The cream is a thick adhesive fluid through which heat circulates very slowly, and if the heat of the water is 100 or 120 degrees the sour milk and any albumen that may be contained in it will be partly coagulated and will form curds in the churn which cannot be separated from the butter, thus giving much trouble, disappointment and worry to the butter maker. The same evil will happen if the cream jar is set near a hot stove, unless the cream is constantly stirred. To avoid the necessity for warming the cream, it is advisable in the winter to skim the cream as close as possible, taking no more milk with it than can be avoided, and when the cream is prepared for the churn to bring it to the right temperature by stirring in, very gradually, water not warmer than ninety degrees, by which the cream will be thinned and warmed at the same time. In the summer the churn should be cooled by means of ice water before the cream is turned in, and in winter it should be warmed by a dash of hot water and a few turns to distribute the heat evenly.

When butter which is put away for winter use is closely pressed down in the package it should be covered with a wet cloth and then with salt, and the edges of the cloth turned back and pressed down closely to the edge of the jar. Some air-tight covering is then put over the jar, which is put away in a cool place for safe keeping. Good butter, well packed and kept in a sweet place, will go on improving in quality for six months, when it will be in the best condition for use.

The family cow should be docile, easily handled, and free from vices and tricks. Such a cow is more easily reared than purchased. Hence it is desirable to rear one's cow from a calf, either by breeding the calf or by purchasing one when weaned and raising it. In this way a gentle and most serviceable cow can be procured and trained to her special life and purpose through all the gradations of calf and heifer up to the point of usefulness. In breeding cows it is well to know that the ninth day after calving is the surest time to breed the cow for the next calf; after this, the cow will go for six weeks without becoming in breeding condition, and after this the periods recur at intervals of twenty and twenty-one days. Thus the time of the arrival of the next calf can be arranged to suit the convenience of the owner. In general, the cow which is fresh in September or October will be the most useful in a family dairy, as the supply of butter can be saved for use in the late summer, and the troubles incident to dairying in the hottest months of the year are avoided. If two cows are kept one should come in in March and the other in September.

CHAPTER XXVIII.

DISEASES OF COWS.

"PREVENTION is better than cure." And in treating of the diseases which commonly occur in the dairy we would emphatically enforce this ancient adage as the rule of conduct in every herd, whether it consist of one cow or a hundred. The dairyman should be always on his guard to avoid causes of disease—those too common errors of management and feeding which disturb the natural functions of the animal, and by causing disorder of the system produce what we term disease.

Cows are usually healthy and robust. The exceptions are the high-bred and high-fed animals kept by breeders who force their stock by every possible means to undue production. Life and vigor cannot be drawn upon so excessively and last to the end of the common period of usefulness. The stock of these is something like a fixed quantity from which one may take small or large drafts; the larger these are the sooner will the supply be exhausted; and this is very much the case with high-kept dairy stock. The common dairy cow, moderately fed, never pushed beyond the natural period and capability for milking, lasts for twenty years without an ailment or an accident, except as the result of some carelessness or neglect. On the other hand, the high-bred Jersey cow, valued at thousands of dollars because she responds liberally to a system of forcing and makes a remarkable product of butter from high-feeding, is constantly suffering from garget or threatened with serious disease, and finally dies of milk fever. And yet the Jersey cow, notwithstanding her occasional want of constitution, will always be the favorite family cow and the "butter-machine" of the dairyman. It is therefore necessary that precautions should be used both to avoid accidental disturbances with common cows and to avert threatened dangers from those which are more subject to disorder.

The owner of a cow should know when his animal is doing well and be able to recognize at once the first approach of trouble. A healthy animal exhibits certain unmistakable signs of its condition: the appetite is regular and vigorous, the muzzle is moist and covered with drops of perspiration, the eye is bright and active, the coat is smooth, the horns are moderately warm, the milk is given in full quantity, the respiration is easy, the pulse is regular, and the process of rumination is constant soon after eating. When an animal is ailing, the first effect of the disturbance is more or less of fever, and this is indicated by the dryness and heat of the muzzle, uneasy or rapid breathing, coldness or excessive heat of the horns, falling-off of the appetite, rise of temperature and increase of the pulse. The frequency of the respiration and of the pulse varies in different animals, but in health the respiration is always easy and the pulse never more than fifty in a minute in adult cows. The pulse may be felt most conveniently on the cheek, near the large, flat muscle which closes the jaws. Here the sub-maxillary artery comes from the inside and passes over the edge of the bone and up the side of the face in front of this large muscle. The artery may be felt by placing the first and second fingers of the right hand on the left jaw towards the inner side of the bone, and the thumb on the outside to keep a steady pressure. The brachial artery may be felt on the inner side of the fore-arm, below the shoulder, level with the elbow joint, and in advance of it. A little practice with moderate pressure of the fingers will soon fix the places where these arteries can be found and the pulse examined.

The next usual symptom of disorder is the suspension of rumination, or "loss of cud." This is generally accompanied by roughness of the skin, dullness of the eyes, and apparent lassitude, the cow moping and standing apart with the head down and occasionally grinding the teeth. When these symptoms are noticed it is time to be on the alert to discover the cause of the trouble and apply an immediate remedy. Usually some circumstance may be recalled which will account for the disturbance—some over-feeding, some exposure, or neglect, or even some change of feeding, which is often sufficient to disarrange the system and cause sickness. Neglect of timely precautions may in such cases bring on serious disease of the blood and a general inflammatory condition which will subject the animal to danger of infection by means of germs of disease which are always present in the atmosphere, waiting for a favorable opportunity of becoming sown in a suitable soil, so to speak, where all the requisite conditions for their immediate growth may be presented. The first approaches of disease are usually silent and inconspicuous. Some little changes may be noted, but these seem so insignificant that they are passed over without any serious thought, and are forgotten. Here is the greatest mistake that is made. It is far easier to prevent mischief than to cure or avert it when it has arrived. The lower animals, with dull nervous systems, patient and uncomplaining, exhibit no signals of distress until the strength fails and disease has taken a strong hold upon them. In many cases remedies are then too late which at the outset might have successfully prevented a serious attack.

A dose of some simple purgative medicine, as a pint or a quart of raw linseed oil when the digestive organs are disturbed, or a pound or twenty-four ounces of Epsom salts when there are inflammatory or febrile symptoms, or one-ounce doses of hyposulphite of soda when the blood is out of order, will usually quickly restore the animal to better health. The exercise of precaution, however, in feeding, watering, securing pure air, and protection against the rigors of the weather, such as have been suggested in previous chapters, will generally be sufficient to keep a herd in such good health that an occasional dose of the simple medicines above mentioned will be all that may be needed, except on unusual occasions, when, from unforeseen circumstances, more serious disorders may invade the herd. In the dairy these disorders will be chiefly those which appertain to calving and which occur immediately before or subsequent to this interesting event, which consequently calls for more than usual foresight and preparatory precautions.

Usually the common diseases of this class are inflammatory in their character, and are due to a too high or a too low condition; in either case the natural functions are interfered with, and a disturbance of the circulation results. They are usually serious, and some, as milk fever, are often fatal, consequently the utmost precautions should be taken for a month or two before the period of calving arrives. During this time the feeding should be simple but nutritious; no stimulating food should be given; grass or green fodder in the summer and good hay and roots in the winter, but no grain food, should be the fare, and every possible care should be exercised to avoid fatigue, nervous excitement, worry or violent usage. The management of the cow previous to calving should be such as is recommended in Chapter XIII. It is to the observance of this careful management that the author attributes his exemption from all trouble in his dairy for over twenty years, in which he has never had a sick cow, or an abnormal calving, or lost a calf, or had any animal injured in the slightest degree.

ABORTION.

This disease is one of the most injurious of those which affect dairy cattle. It has been considered a mysterious disorder and much investigation has been devoted to its causes and progress without any very certain result until the present time. It is called abortion in the cow when the fœtus is expelled before the seventh month and before it has been sufficiently developed to maintain an existence separately from the dam. After this period the expulsion of the fœtus, whether it be living or dead, is called premature birth. This period has been fixed by veterinarians, as well as by physicians, as the connecting limit between these two forms of accidents of pregnancy, because after the 200th day the fœtus becomes capable of a separate existence, and may live and thrive, under exceptionally favorable circumstances, although at first weakly or immature.

Premature birth, too, can scarcely be considered a disease, but rather in the light of an accidental occurrence due to various causes, while abortion is undoubtedly a disease originating in certain disordered conditions of the animal, which can be traced to a specific cause or result of causes. It may be classed as of two kinds, *sporadic* or *enzoötic*, and *epizoötic*, *infectious*, or *contagious*. The former may be due to several causes, external and internal; the latter is always due to infection by a specific germ introduced into the system and developed by favorable circumstances.

Sporadic or Accidental Abortion.—The causes of accidental abortion are very numerous, acting either directly or indirectly, and produce their effects in an evident or obscure manner.

The External Causes are physical injuries arising from falls, blows, severe exercise, as being chased by dogs or other cattle, continued bad weather and exposure to cold rains which are especially injurious, squeezing or crowding through narrow doorways, nervous excitement, fear, and offensive odors. The results of these injuries are mechanical, and are so obvious to an intelligent reader that no comment upon them is required.

The Internal Causes arise from bad or unwholesome feeding, contributing disorders of other organs and febrile diseases, and least frequently uterine diseases which result in the death of the fœtus. Unwholesome feeding, including watering, very frequently produces abortion. The use of frozen roots which chill the stomach and so reduce the temperature of the adjacent uterus as to kill the fœtus ; the use of ice-cold water, which has the same effect; feeding cotton-seed meal, smutty corn fodder, or ergoted grasses or straw, or rye bran from ergoted grain; innutritious food, or excessively rich food, the former starving the animal, the latter causing too great plethora. All these and other closely related circumstances are most effective causes of this disorder. Acute fevers so increase the internal heat of the dam as to destroy the fœtus. Pleuro-pneumonia causes its death by affecting the condition of the blood ; anæmia, anasarca, tuberculosis, anthrax, apththæ, and other serious diseases of the dam, lowering her vital forces, have the same fatal effect upon the immature young creature *in utero*. The only refuge from these forms of this disease is prevention.

Epizoötic or Contagious Abortion is a disorder of very frequent occurrence which has caused much dispute and discussion among the veterinary profession. Professor Saint Cyr, the eminent French veterinarian, after a long and exhaustive discussion concludes that the principal if not the only cause of this form of the disease is contagion; but he has not as yet been able to explain or describe the nature of the medium by which the disease is communicated or spread, or its mode of action in the infected cows. Without entering into any discussion of the apparent causes of this disease—which enters into a herd without previous notice or any premonition of disaster, and goes through it, causing one cow after another to lose her calf after periods of gestation of three to seven or eight months, and which, having desolated the farm for this year, reappears in the same herd or an entirely new one, if the same stable and yards are used—it will be sufficient to mention that none or all of the alleged causes of this disease will explain satisfactorily any hypothesis or belief that any other conditions than the introduction of a specific germ into an animal, or a herd or stable, will reasonably account for the peculiar circumstances under which this malady makes its sudden appearance in localities where it has never been heard of previously. These circumstances are as follows:

1. Abortion usually follows the introduction into a stable or herd of some strange cow which is in calf and which loses its calf without any apparent cause or provocation. Then one of the other cows loses its calf, a second and a third follow, and the disease goes through the whole herd. In a case known to the author of a herd of seventy-two valuable Jersey cows, only seven live calves were born in one year, and these were of cows which had nearly completed their terms of gestation before the disease appeared. This infection followed the introduction of a cow purchased at a public sale in New York City, and this cow had lost her calf by abortion the previous year.

2. It is usually the cows nearest to the newly introduced one which become affected, and the disease spreads by the closest contact.

3. When cows from healthy herds are brought into infected herds or stables, those of them calving soon after pass through their period safely, but those whose time is more distant usually lose their calves. It thus appears

that a period of incubation is required for the development of the disease.

4. When by accident infected stables have been destroyed by fire, and with the infected herd have been totally consumed, the disease has disappeared from the farm.

5. Abortion usually occurs during the fourth month, although it may happen at any period of gestation.

6. It appears to be a rule that the time of occurrence of this disease arrives later in the period of gestation of the infected cows in succeeding years; thus a cow which loses her calf one year in the fourth month, will not abort the next year until the fifth, and the year after until the sixth, and so on until the full time be passed, when the calf will appear to be full grown and healthy, but after a short time will be stricken with disease and perish apparently of inanition and weakness.

7. The condition of the cow does not seem to have any effect upon the progress of the disease, and heifers with their first calf are as likely to be affected as older cows.

8. A cow under the influence of the infection gives no indication of suffering—eats, drinks, and milks as usual. But by close observation a changed appearance of the visible organs is to be noticed, a looseness of the parts and sinking of the muscles which always appear before calving become plainly apparent, and heifers "spring" and exhibit the full udder as if about to calve naturally. One who has become experienced in the behavior of the diseased cows knows beforehand that the animal infected is about to abort.

9. The expulsion of the fœtus is so easily and quickly accomplished, and the cow shows so little concern or injury, that unless the owner is forewarned the accident might pass without notice, excepting when the fœtal membranes are retained; these being then removed with much difficulty, and on their appearance they show in-

dications of being diseased at the points of adherence to the walls of the uterus, commonly known as the cotyledons.

10. A cow which has once lost her calf will usually fail to breed, but become a "buller," and be very troublesome or useless, and if she be bred successfully the calf will almost invariably be lost as the previous one was.

11. When a cow which has lost her calf is kept from breeding for a considerable time there is a fair chance that she may be bred successfully; several months, or a whole year, should elapse.

12. When the calf survives a premature birth it is invariably weak and unthrifty; usually it dies after a few hours or days, bellowing incessantly, as if in suffering, and if it should survive it will never be profitable to its owner.

These circumstances all tend to show that the disease is contagious and affects only one organ—viz., the uterus—of the cow; the animal otherwise appearing in usual health, unless through the persistent retention of the fœtal envelopes, which by their decomposition and absorption may produce blood poisoning, the animal succumbs to the ultimate and secondary results of the disease. Recent careful investigations undertaken by the French Minister of Agriculture, through Prof. E. Nocard of the Alfort Veterinary College, have confirmed the belief in the contagiousness of the disease and its communication by a special germ which exists in diseased organs, and whose presence in hitherto healthy animals invariably produces all the results which happen through infection.

Prof. Nocard, as the results of his investigation, concludes as follows :

1. In cows that have aborted, even in those that were pregnant for the first time, there exists in the interior of the uterus, between the mucous lining and the mem-

branes covering the fœtus, especially in the crypts of the cotyledons, various microscopic organisms which are not to be found in pregnant cows, or in cows that have already calved, belonging to districts in which abortion does not prevail.

2. These microscopic organisms do not appear to exert any injurious action upon the mucous membrane of the uterus, whether during the period of the gestation destined to be suddenly terminated, or after abortion has taken place.

3. The recurrence of abortion in the same subject is satisfactorily accounted for, if we admit the pathogenic influence of the microbes, by their remaining in the interior of the uterus up to the time when they can act as before upon a new fœtus, or upon its envelopes.

4. In like manner, cases of barrenness, following abortion, may be explained by the acid reaction of the uterine fluid in which the microbes maintain themselves; the spermatozoa cannot retain their vitality except in an alkaline medium.

The careful study of the foregoing facts will easily enable those concerned to take the needed precautions for avoiding the occurrence of the simpler accidental form of this injurious disease, as well as of that of the still more serious or ruinous contagious form of it. Care to prevent accidents which so often occur through neglect or oversight; to avoid the use of unwholesome food, and exposure to the vigors of the season, in the one case, and in the other to exercise the strictest precautions in bringing in strange cattle to the herd; to put the new-comers into a close quarantine until their healthfulness is proved will prevent the disease, and to exact from the sellers a full guarantee of health before purchase and removal of any animal will prevent the serious losses which occur to the purchaser, if it does not evade the danger. Just here it may be usefully suggested that as losses by contagious disease among valuable dairy herds have been very numerous and exceedingly costly of late, purchasers of valuable cattle should always exact of the sellers security against this risk, and should insist upon a full warranty of soundness and freedom from disease, with acknowledged liability for any damage that might happen from any breach of such warranty. With such precautions the onus and risk would fall where it naturally belongs, viz., upon the seller, who would then be very careful that the animals he disposes of are free from fault and would be most anxious to keep his stock in a perfectly healthful condition.

When abortion appears in any herd, immediate treatment should be adopted. The cow should be instantly removed from the herd upon the first indication that she is about to lose her calf or has lost it, and kept isolated in a distant part of the farm, where she should be disinfected within and without in a thorough manner. Her treatment there should be as follows: The stable should be kept filled with vapor of carbolic acid, and solutions of sulphate of copper should be liberally spread over the floor and painted or sprayed upon the walls and furniture. Injections of solution of one dram of hyposulphite of soda in a quart of warm water should be made into the uterus, three times daily. Every evacuation of the cow should be covered with fresh made carbolate of lime or solution of sulphate of copper, and the cow should be given daily one ounce of hyposulphite of soda dissolved and mixed with some food.

The stable itself may also be disinfected by burning in it a pound of sulphur and keeping the doors and windows tightly closed while the sulphurous acid fumes are distributed in every part of it. Of course no cows are to remain during the disinfection. The solution of sulphate of copper with which the floor, stalls and furniture is to be drenched is made by dissolving four ounces to the gallon of water, and carbolic acid should be kept exposed abundantly in the stable by spraying it on the floor. Each cow should receive the hyposulphite of soda, given daily in the food for two or three weeks, and the disinfecting process should not be discontinued during this interval.

Medicine may be available if given in the first stages of the disease. When the condition of the animal is depressed tonics are called for. The ordinary tonic mixture of sulphate of iron, gentian and ginger in equal quantities, one dram of each for one dose, has been given with benefit. Tincture of Peruvian bark, made by infusing four ounces of the bark in a quart of whiskey, is also useful, given in four-ounce doses three times daily. Antiseptics are useful in the first stage of the infectious form of the disease. One-half-ounce doses of chlorate of potassa, or one-ounce doses of hyposulphite of soda, given daily until the symptoms disappear, have been given with benefit; as have four-dram doses of asafœtida, given twice daily for three days. A pint of infusion of black haw (*viburnum prunifolium*), or an equivalent of the tincture, has been found exceedingly effective in arresting the disease when in its early stages, and when given on the first premonition of the disorder. This infusion was in common use on Southern plantations in time of slavery, when the negroes had used cotton root for procuring abortion, and was found most effective in averting the effects of the root. This fact has a double significance in this regard.

Epizoötic abortion has been known from the earliest times. An old work upon Animal Plagues, printed 200 years ago, describes several outbreaks of this disease which occurred previous to A. D. 800. A very destructive outbreak happened in Germany in 1777 among cows and pigs; another in France seven years later affected most of the cows and mares. Medical works mention a great many instances of a similar kind, but without specifying any particular cause beyond the supposed influence of unfavorable weather and the presence of abundant ergot in the grain and grass crops.

DISEASES OF THE MAMMARY GLANDS.

MAMMITIS or GARGET is one of the most frequent and troublesome diseases in the dairy. "Caked bag" is the dread of the dairyman, who finds his supply of milk suddenly cut off and a sick cow upon his hands requiring care and treatment. The technical name, mammitis, or

Fig. 102.—DIAGRAM OF A COW'S UDDER.

inflammation of the mammæ or milk glands, includes a number of affections of this organ; garget, ropy milk, bloody milk, diseased or impure milk, and whatever may cause disorder of the milk secretions.

A description of the construction of the udder, or rather the mammary glands, of which the cow has four inclosed in one common envelope, all of which we call the udder, will explain more clearly the nature and effect of the various disorders which are commonly included in the term garget. At figure 102 is a representation of a supposed section of the udder made lengthwise through it, from front to rear. At *a* is the milk vein, so-called, but really the abdominal subcutaneous vein, which in some cows has an enormous volume. The capillary or ultimate branches of this vein are very numerous, and connect and anastomose, or form a continuous net-work, with the capillary or ultimate branches of the subcutaneous abdominal artery which supplies the mammæ with blood. These capillaries surround and envelop the gland vesicles, shown at figure 103. These gland vesicles here figured appear as magnified four times. Each one of these minute vesicles has the office or function of secreting the milk from the blood supplied to it by the arteries, and

Fig. 103.

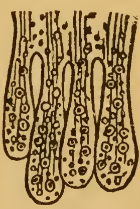

Fig. 104.

forming cell tissue, and the blood which has parted with its quota of cell matter and fat then passes to its veins on its way to the lungs and heart for purification and a fresh supply of nutriment from the great thoracic vein which pours into the heart the blood newly formed from the digested food. Thus the milk is as direct a product of the blood as are the muscular tisue and fat, which are deposited in their proper places from the proper vessels of supply. These gland vesicles are clustered in groups around the lactiferous or milk-conveying ducts, much as a bunch of grapes is clustered around the stem upon which they hang from the vine-stalk. They are about 1-200th of an inch in diameter. Each vesicle contains a number of cells and each cell has a nucleus or central mass; this is shown at figure 104, in which the gland vesicles are highly magnified. These gland cells become infiltrated with fat during the period of milk production, and this fat supplies the cream of the milk. The milk ducts converge and run into two, three, and sometimes four large channels, which in their turn empty into a larger reservoir situated at the base of the teat. These milk ducts are lined with a fine mucous membrane, and this itself secretes some portion of the milk which always contains more or less mucus. The teat is formed of, first, this fine mucous membrane, which is very delicate and sensitive, then a thick layer of tissue over which the mucous membrane is doubled, and this tissue is again covered by the skin. Among this tissue are numerous bundles (fasciculi) of muscular fiber, arranged in a circular and a longitudinal manner around the duct or orifice of the teat. At the base of the teat is the sphincter muscle, which operates as an elastic band or ring to close the duct; below this are several other bands of concentric muscular fiber, and around the duct, lengthwise of the teat, are arranged numerous other fibers. The whole of the structure of the glands is supplied abundantly with nerves.

From this description of the milk glands and the further account of the functions and character of the ultimate cells of the gland vesicles or lobules given in a previous chapter, their delicate and sensitive nature can be readily understood. The large supply of blood which passes through the glandular substance from the important artery which supplies the whole reproductive system, renders it remarkably sensitive to any disturbances of the circulation, or any accidental local derangement. Inflammation arising from excessive circulation and supply of blood is accompanied by engorgement of the fine capillary vessels and blood may then pass directly into the secretory glands, and thence with the cell matter into the ducts and become mingled with the milk. This explains the cause of bloody milk which is sometimes given by cows, or at times becomes a permanent product of young cows whose mammary glands are in an abnormal or undeveloped condition. It also explains how the sensitive mucous membrane, abundantly supplied with blood in the minute circulating vessels, when in an inflammatory condition from any cause, secretes an excessive quantity of mucus, and hence we may have ropy milk; which is milk containing so excessive a mixture of mucus as to become adherent and stringy. Or when this ropy, glutinous, adherent mass fills the ducts, and no milk can pass through them, the lobular masses become engorged and tumefied, the udder becomes swollen and hard and painful from the tension upon the sensitive tissue, the gathered matter is absorbed into the connective tissue and the capillary vessels, and we have a development of garget or inflamed and tumefied udder in its worst form.

Unless speedily relieved, the fine secretory cells become obliterated in a growth of hardened fibrous tissue, and the gland, so far as this may occur, loses permanently its power of yielding milk, and a part of the udder may, as we sometimes find, become spoiled for future use and permanently dried up. In bad cases the cellular matter breaks down into pus which burrows through the gland, forming an abscess, or several of them, by which the products of the inflammation escape. This involves destruction of the glandular substance, the lobular masses are destroyed, and the productive ability of the udder is in greater or less part lost beyond restoration. The structure of the teat and of the fibrous bands enveloping the glands explains how the cow is able to retain the milk or let it down, as is done in the operation of milking. The whole muscular part of the udder is under the control of a system of voluntary nerves. The cow can draw tight the sphincter muscle which closes the outlet of the main lactiferous reservoir at the base of the teat. She can contract the muscular bands which support the whole udder, and so compress the whole arrangement of the ducts as to prevent the flow of milk. Or when, by reason of weakness of the sphincter muscle or by the will of the cow, it is loosened, the passage is opened for the escape of the milk, and it leaks away and is lost. Sometimes, on the other hand, when the fine membrane lining the teat is injured, and tumors or lumps are produced and the duct is obstructed, the cause may be easily understood. Or when the skin at the outer orifice of the teat scales off, as it is apt to do, and the milk spatters and spreads instead of flowing with an even stream, we may recognize the cause of the trouble from knowing the precise method in which the teat is constructed.

TREATMENT OF MAMMITIS OR GARGET.

An attack of garget requires instant treatment; neglect may cause serious results, while immediate care may soon overcome the trouble. The treatment varies somewhat according to the peculiar character of the attack; and this differs greatly as the causes differ. The causes of garget, in which may be included all the forms of the disease, are constitutional tendency to inflammatory disease; overfeeding with stimulating food, such as cotton-seed meal, which readily provokes it; inflammation resulting from cold, as exposure to cold rains soon after calving or by lying upon damp cold ground; excessive muscular strain, as by chasing around when the udder is filled; retention of milk, either purposely done by the owner, or by the cow withholding the milk; and lastly, by a sort of reflex action upon the milk glands produced by a generally diseased condition of the cow which disturbs the circulation and forces it excessively in this direction, or which produces a diseased and irritant condition of the blood.

It is readily seen that each of these conditions may call for a different treatment, and that it would not be difficult for the owner of a cow to do mischief by adopting the advice of a neighbor or friend, who might have, at one time, procured relief in a case having an entirely different origin, by the use of some particular treatment or remedial agent. In some cases it is very clear that medicine might be required. For instance, when the trouble is caused by some disease of the blood and this is removed the secondary effects may disappear. In some cases mechanical treatment only may be needed, as when the vessels and ducts have become engorged and the milk has clotted in them, and an alkaline injection would dissolve the solid caseous matter and enable it to be drawn away. In other cases both this treatment and medicine would be needed, as when the blood is in an acid condition during a feverish state of the system, and alkaline salts may be given internally and injected into the udder as well.

Sometimes soothing outward applications may be requisite, as when muscular strains or accidental blows have caused the trouble; and at other times when suppuration is probable some absorbent agent, such as iodine, may be applied, and an antiseptic medicine given internally. In this case warm fomentations would be useful, and it may even be advisable to apply hot poultices and to support the udder by a broad bandage carried under it and over the loins. When it is necessary to draw the milk from a disordered udder, a silver milking tube may be used, which is inserted in the teat and through it the milk flows by its own gravity. This treatment overcomes any obstinate interference by the cow with the flow of milk, and brings it down in spite of her objections.

When the milk is too ropy and clotted to be drawn in this way, an injection of one teaspoonful of carbonate of soda (common baking soda) or saleratus, dissolved in a pint or half a pint of warm water, may be injected into the udder through the teats. This will dissolve the thickened milk and enable it to be drawn either by the milking tube or by the hands or fingers. These methods will be applicable whenever the udder requires to be relieved of its contents, unduly retained from whatever cause.

When the cow is in a fevered condition, or the udder is greatly inflamed, tender and hot, a cooling saline medicine will be useful; this may be a pound of Epsom or Glauber salts, and if the fever is very considerable, one ounce of saltpeter may be added. A saline diuretic, such as saltpeter, will always relieve an inflamed udder, as it increases the action of the kidneys and so reduces the activity of the milk-secreting glands.

When the udder is in a suppurative condition, and the matter drawn from the teats is mixed with pus, hyposulphite of soda will be beneficial; this is an effective antiseptic and prevents danger from the absorption of pus into the blood. This salt is given in one-ounce doses daily and should be continued until all danger is removed. A mixture of four ounces of glycerine, with one dram of iodide of potassium, dissolved in as little water as is necessary to make the solution, will be useful to disperse a threatened abscess, or to soften the udder when it is very hard from an obstinately congested condition. The iodine is an active absorbent and has been used in such cases with the best effect. A portion of this mixture is well rubbed into the skin of the udder after it has been fomented with hot water, and wiped dry with a soft towel. The udder is gently pressed and kneaded with the hands during the rubbing. Camphorated soap liniment, well rubbed into the udder after fomentation, is also useful in mild cases. To draw the milk from the udder is indispensable, and the milking tube should be used if necessary. When a portion of the udder becomes tumefied, fomentations of hot water, or a hot poultice of linseed meal applied to the part by means of a broad bandage covering the udder and brought up over the back and securely fastened there and behind the buttocks, will be advisable. These remedies are only suggested for use with such cows as may be affected with garget. It is impossible to mention particularly the right treatment for every special case. Ordinary judgment and reason must be used to meet each particular case when treatment is found necessary.

VACCINE VARIOLA—COW POX.

One of the most annoying diseases to which cows are subject is pox, or variola. It would be trifling in its effect upon the cow were it not that it affects the teats and renders milking difficult or almost impossible, and that when it appears in a herd it goes through the whole of it. This disease is an eruptive, contagious fever, communicated by a special virus or germ reproduced by the disease. The history of the disease is as follows:

When the owner of a cow is milking the animal, he discovers that she is uneasy and restless, and on searching for the cause may find one or more hard nodules in the skin of the teat, which are painful to the cow when pressed. The milk also falls off somewhat in quantity. In a few days these nodules appear at the surface in the form of round, inflamed spots, somewhat raised above the skin, and depressed or pitted in the center. The form and position of these spots are similar to that shown in the engraving, figure 105, and they usually appear upon the teats in the position shown. In three or four days the spots are found to contain liquid matter, and, if care is not taken, are broken and may become raw sores which are difficult to heal, which, in fact, sometimes result very disastrously and even fatally.

By and by the contained liquid becomes a thick yellowish pus which dries into a scab, and this in time becomes loose and falls off, being replaced by newly-formed skin. When one case is out of the way another appears, and in a herd of twenty or more it may continue the whole summer in its passage through the herd, giving constant annoyance. During the progress of the disease the udder is inflamed and tender, and the teats are quite painful when pressed; so much so that milking

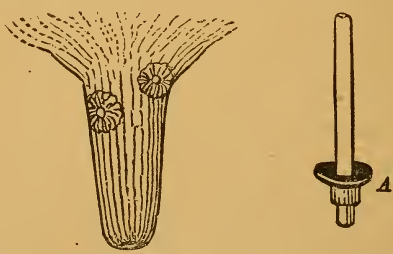

Fig. 105.—APPEARANCE OF COW POX. *A*.—MILKING TUBE.

in the usual manner is impossible. Recourse is then had to milking tubes.

This disease is readily communicated to mankind and to horses, and spreads from cow to cow, being usually conveyed by the milker, whose hands and clothing soon become infected with the virus. The matter contained in the vesicles is the true vaccine virus used for inoculating persons as an antidote to the more dreaded and virulent small-pox, and in its effect upon mankind occasions no worse disturbance than the slight fever and sometimes glandular swellings incident to the operation of vaccination. The virus will often remain permanently in a stable, and will cause every heifer which comes to milk in it to contract the disease. When this is found to be the case the stable should be thoroughly disinfected by burning sulphur in it very liberally, sprinkling carbolic acid freely over the floors, and thoroughly whitewashing the walls and the stall and other furniture.

The treatment of the disease is very simple, if precautions are used to prevent the rupture or forcible removal of the vesicles or scabs before the contained matter has dried and hardened. This is best done by the use of the milking tubes and by softening the teats and allaying the irritation by cooling, emollient applications, such as the simple cerate of the druggists or the prepared cosmoline or vaseline jelly which is both emollient and antiseptic, being a preparation from petroleum. The only medicine required is a daily dose of one ounce of hyposulphite of soda in the feed, given as long as the eruption lasts. The same may be given to the other cows or heifers in the dairy or stable as a preventive or as a means of very much lightening the results of an attack upon them. During the continuance of the disease the effect upon the milk is either imperceptible or very light. When at the first inception the udder becomes hard and inflamed the milk curdles prematurely and will often thicken if brought to a heat of 150 degrees. There will sometimes be white specks in the butter caused by the coagulation of portions of the milk, and perhaps by the presence of secreted matter in it; but in general there is nothing in the milk that would indicate that the cow was ailing in any way. Nevertheless, as the ailment is a blood disease, and the blood has been subjected to the action of a special virus by which the disease has been produced, and as the milk is a direct product from the blood, it is at least subject to suspicion and should not be used by persons who are particular as to the purity and wholesome character of their food, which they are wise in demanding should be above suspicion.

The duration of the disease is from ten to twenty days, and if the cow is kept warm and free from exposure to rain or inclement weather, no complication is likely to occur. In some cases the disease passes off with a very slight eruption, a mere pustule followed by a scab upon one teat only, and that of a very inconsiderable character, being observable, and the owner of the cow never suspecting the nature of the slight trouble, even should he give it a passing thought. But as cases are by no means rare in which the disease has spread very quickly to other cows, and these have experienced a more serious indisposition, it is wise for the dairyman to be on his guard and use all necessary precautions as soon as he perceives the first indications of the disease in the herd. Then the sick animal should be isolated. She should be milked after all the others, or the person who milks her should not approach the other cows, and the precautionary dose of hyposulphite of soda above mentioned should be given daily for at least ten days, gradually reducing it after that down to one-fourth the quantity mentioned.

OBSTRUCTED TEATS.

Small tumors occasionally form in the milk ducts along the teats and interfere with the milking, or at times quite close the passage. These usually come to a head and break and give no more trouble, but sometimes they form a permanent enlargement and become a serious impediment to the milking. The use of a milking tube serves to remove the obstruction temporarily, but when a permanent obstacle forms it is removed by means of a blunt-end steel probe, having, an inch below the end, triangular sharp edges projecting slightly so as to cut the obstacle and form a passage, which is kept open during the healing by means of a wooden plug which is inserted into the duct between the milkings; the milking being done by means of a tube. This plug is provided with a head to prevent its slipping wholly into the teat.

FISTULA OF TEAT.

When an opening forms in the side of the teat, through which the milk escapes during the milking, it is known as fistula. It is removed by carefully dissecting the skin around the opening, and into it, as far as possible, when the opening is enlarged by a slight cut at each side; the edges of the wound are drawn together by stitches, one safe one being put through the part where the fistula existed. When the wound heals the opening is closed. This must be done when the cow is dry.

DISEASED MILK.

Milk is subject to several imperfections resulting from various diseases of the udder or from constitutional and blood disorders. The most common of these imperfections is

Bloody Milk.—This is caused mostly by physical injuries to the udder, as violent exercise, blows, stepping upon it by other cows while the one is lying down, etc., etc. In such cases the trouble is temporary and disappears upon fomentation with hot water and the application of a stimulating liniment. It is sometimes due to defective action of the secretory glands, which may be temporary or permanent, but is usually temporary and is quickly remedied by giving a cooling laxative and alterative, as a pound of Epsom salts with one ounce of hyposulphite of soda, following, for a week or ten days.

Blue and Watery Milk is an indication of the serious disease known as tuberculosis. As this disease is infectious and generally fatal in course of a few months, and the milk is quite unfit for food in some cases, a careful investigation should be made to discover if this disease is present. If it is so found, the animal should be at once slaughtered and buried deeply as a means of safety from its spread among the herd or from worse effects upon persons who might use the milk. Other indications of the disease are emaciation, dullness, dry harsh skin, swollen glands under the jaws, paleness of the membranes, sunken dull eyes, and a mawkish or fetid breath. Sometimes cows give a bluish-colored watery milk as a natural peculiarity, but such animals, although free from disease, are unprofitable and should be quickly weeded out of the herd.

MILK FEVER.

This disease is one of the most serious that affect dairy cows and has been a subject of study and discussion among veterinarians for fully a century. It occurs mostly among the best class of cows and the most productive milkers, and usually appears from twelve or twenty-four hours after calving up to the third day. There are no premonitory symptoms, excepting a diminished flow of milk or a total and sudden cessation of it. The first apparent symptoms are drooping of the head, whisking of the tail, general uneasiness, striking at the belly with the feet, loss of appetite, and cessation of rumination. A shivering fit commonly occurs. Sometimes the cow stands with the head pressed against the front of the stall and exhibits all the attitudes of intense stupor—the mouth is hot, the eyes red, and there is an unconscious treading motion of the hind feet. Breathing becomes rapid, the animal is unable to stand and falls to the floor, or lies down heavily. Quite often the cow is supposed to be all right until she is found down, lying on the side or resting on the brisket, with the head turned around to the flank and lying stiffly with the nose close to the belly. The muscles of the neck are contracted and the neck is rigidly bent so that the head cannot be moved from this position. This symptom is typical of the disease, and gives rise to one popular name for it, viz.: "Dropping after Calving." Stupor becomes more and more intense and the animal falls into a comatose condition from which it rarely recovers. There is no fever, and the temperature falls below the normal; the feet, ears and horns are exceedingly cold, and the movements of the bowels are suspended. If the animal recovers, these symptoms may be continued for as long as four days; if death does not ensue in two days recovery may be hoped for. In this case the cow seems to suddenly awake from its stupor, raises its head, and after some struggles rises upon its feet and stands. When the movement of the bowels returns recovery is assured. When, on the other hand, death is approaching, the coma becomes more intense, the head sinks and rests upon the ground or it sways from side to side, the eye is glassy and insensible to the touch, the belly becomes swollen with gas, the breathing is hard, and the animal dies easily or with some slight convulsions. In this disease the deaths are about forty-five to fifty per cent; the largest proportion being those cases which occur the soonest after calving. When two days elapse before the attack, recovery may be looked for.

The causes of the disease being known one may exercise precautions against it. As it is chiefly the highly bred, heavy milking, or large bodied plethoric cows which are attacked, great caution should be observed with these to avoid high feeding for a few weeks before calving. Or when cows have been permitted to fall off in condition for months previous to the calving, the feeding should be very carefully increased up to the period when calving is looked for. Close confinement is to be avoided, and abundant exercise should be given to incoming cows. Generally whatever will lower the condition of vitality or excite the circulation in internal organs, checking the action in the skin and extremities, should be carefully avoided.

The treatment is chiefly mechanical. Every effort should be used to increase the action of the skin and the circulation in the limbs by the application of ammonia liniment, or of mustard to the back along the spine, a wet sheet wrapped around the body and covered with blankets, and the application over the blanket of hot flat-irons along the spine and loins, with brisk rubbing of the limbs and applications of turpentine, or hot water by means of flannel cloths steeped in it, wrapped around the limbs. If the bloating is severe the paunch should be opened with a small-bladed knife or a trocar (fig. 106, p. 462) inserted on the left side, at a point equidistant from the point of the hip bone, the last rib and the backbone, and penetrating downwards to avoid the kidney and lumbar muscles. Injections of warm soapsuds after the bowel has been emptied manurally are to be given, and half a pint of whisky with one ounce of tincture of camphor has been serviceable when medicines by the mouth have failed. In short, the treatment of this disease must include relief to the brain from the prevailing congestion, stimulating the functions of the skin, promoting the action of the intestines, stimulating the lower nervous system, the spine and the lumbar nerves, removing the milk and stimulating the action of the udder. When the disorder is relieved the animal should be nursed back to strength by means of mild tonics and small but frequent rations of easily digested and nutritious food.

MILK SICKNESS.

"Milk sick" is a mysterious disease, a peculiar characteristic of it being that the infected cows escape, while the calves and persons who use the milk suffer, and in frequent cases perish, by the poisoning. Male cattle take the disease, which poisons the flesh and renders it unwholesome for food, while cows enjoy impunity in the escape of the poison through the milk.

Half a century ago, when there were far more undrained swamp, impure water, and malaria than there are now, there were many more cases of the disorder than there have been of recent years. Then the very buzzards, the hogs, the turkeys, and the dogs and cats that ate of the carcasses of animals which had died of the disease themselves died of milk sickness. Cats, dogs, calves, and chickens that drank the milk or ate the flesh of cows suffering from the malady staggered around weakly for days and died. Many people died of the disease, induced by eating butter or drinking milk from diseased cows.

Then the theory was held that the ailment was caused by eating some plant that appeared late in the season. Others believed that the cause might be found in the earth licked up by the stock at what are known as salt-licks. Still others believed that cattle were poisoned by eating grass on which some mineral, carried up with moisture from the earth during the warm hours of the day, settled with the dew in the cool evening and night; and yet others were of the opinion that the disease was induced by the drinking of water from stagnant pools or from impure streams. The early settler sometimes fenced about the spots where observation taught him the germs of the malady lurked. In time the land around these spots was plowed and seeded, water was drained off, and the fences rotted and fell, the plow completed the work of purification, and the previous existence of the disease was forgotten.

Milk sickness is known in many of the States lying east of the Mississippi River; it also exists on the north side of the Blue Ridge and among its foothills in Western North Carolina and Georgia. In the great valley of

East Tennessee it is also found in the foothills, where the pastures are rich and moist and the growth of grass vigorous. There is no doubt that the malady has prevailed longer and more extensively in the southern parts of Indiana and Illinois than in any other part of the land. It appeared regularly each year, usually, if not invariably, in the dry, warm weeks of the closing summer, when the streams were low and the water supply was generally stagnant and festering with noxious germs. Human beings and stock besides neat cattle have received the germs of the malady from sources other than the milk or the butter of affected cows. Indeed, people who did not use milk or butter have died of the disorder, and swine and dogs that had no access to such food have done the same. In view of these facts the theory may be entertained that the cause is not found in noxious weeds, as has been held by some, nor can it be grass or a mineral poison like arsenic, as has been believed.

In the second annual report of the Bureau of Animal Industry an account is given of the discoveries made by Dr. Joseph Gardner, of Lawrence County, Indiana, in his investigations of milk sickness. Describing the results of a microscopic examination of the blood from a heifer suffering from the malady, Dr. Gardner said: "I was startled but not surprised to see that in the small space embraced in the field, and which could be covered by a transverse section of a fine cambric needle, there were countless multitudes of actively moving, writhing, twisting bacteria that bore, in size and behavior, a striking resemblance to that form of bacteria called by naturalists *Bacteria subtillissima.* They seemed to cling to the blood disks, to be between them, to be within some of them, and to be in such an innumerable multitude as to fairly fill the observer with horror at the bare thought that the blood of even a domesticated animal should have such terrible inmates. Some dogs ate of the dead cow, and they too were attacked by the 'slows' and their blood showed the same form of bacteria."

Knowing that some of the family owning the sick cow had not partaken of milk or butter, but had nevertheless suffered from the disease, Dr. Gardner examined with his microscope the water taken from the springs from which the family drank, and found that it appeared clear and pure to the unaided eye, but was filled by the same forms of bacteria that swarmed in the blood of the cow. In another family a case of milk sickness had occurred. Dr. Gardner examined some of the milk he took from a cow whose milk was used by the patients, and found in it just such living organisms as he discovered in the blood and water. Afterward he found the same bacteria, but in smaller numbers, in the blood of two persons not severely attacked. In giving his account of his studies of this malady, Dr. Gardner said that milk sickness never prevails in wet seasons, when springs are flush and streams are full. He was not willing to assert that water is the only medium outside of animals in which the bacteria may propagate in sufficient quantities to cause the disease to manifest itself, "but," said he, "we may rest assured that if the cattle and the families have water of unquestioned purity the other sources and uses will not be prominent factors in its production." He added that gastritis and bilious fever are the only diseases the physician will be likely to confound with milk sickness. The treatment he adopted consisted of the administration, each two hours, of full doses of brandy and honey, or sirup, with sulphur and magnesia. The patients quickly recovered. This treatment is the same as that used in the Blue Ridge localities of west North Carolina and Georgia where the disease prevails.

It seems to be important that consumers shall be warned of the danger that may lie in consuming milk, butter or meats from districts in which milk sickness appears, and that physicians, even in places remote from spots where that disorder originates, shall be ready to recognize it whenever it may appear, and understand its nature and proper treatment. There is certainly some danger, although it may be doubted whether there is sufficient warrant for the assertion which has been made to the effect that each year hundreds die in places far from the localities where the cause of their death originates, from the use of meats, butter or cheese containing the germs of the disease; for the meats and dairy products from localities infected by the scourge have to seek a market away from home, and consequently find their way to the larger towns. Nevertheless, the author, who has had an opportunity of observing and studying this disease in the rich valleys of the Southern mountain region, has found it exceedingly prevalent there, and the resident physicians and even the people themselves look for it as a matter of course in the summer and fall months. Deaths frequently occur from the use of infected milk and many persons are to be seen whose systems have been permanently weakened by the poison. From its peculiarity there is no means of prevention except avoiding places known to be subject to it, or of avoiding the use of milk and butter from cows pastured where the disease may be suspected to exist.

EVERSION OF THE UTERUS.

A rather common disorder in dairies is the *prolapsus* or eversion of the womb. Sometimes this disorder goes no further than the ejection of the vagina; but in any case it is apt to be troublesome, as the nature of it is not understood. The disturbance is first noticed by the appearance of a red soft tumor between the lips of the vulva as the animal is lying, or the whole organ may be found protruded and dragging in the filth of the gutter or stable floor. By an easily recognized corruption of terms this accident is popularly known as "falling of the withers." It occurs mostly after calving, when the *os uteri* or opening of the organ is dilated. The malady has been known for ages and an ancient Roman veterinarian (Vegetius), writing of it, made the useful suggestion to use an inflated pig's bladder as a means of pressure to retain the organ after its return to its position.

The treatment is as follows. The organ is to be carefully washed with warm water and returned through the orifice gradually by the fingers—the nails having been closely pared to avoid injury. The organ is to be held and supported meanwhile on a sheet held by assistants, and when in a proper position the extremity of it is pushed into the opening by the closed fist; the uterus folding in upon itself by the pressure as it is carried into its place. When the uterus has been returned to its position it is held there by means of a bandage across the hind parts, so arranged as to support it without interfering with the evacuations. To repress spasmodic efforts to expel the organ, laudanum is given in doses of two ounces each, repeated at intervals of two hours if necessary. As the trouble is almost sure to occur with the next calf, cows subject to it should be fattened off as soon as may be.

RETENTION OF FŒTAL MEMBRANES OR AFTER-BIRTH.

This is a very common trouble in dairies and occurs more frequently with cows than with any other animals. The reason for this is that the fœtal membranes of the cow are attached to the surface of the uterus, for their support, by a large number of broad attachments called cotyledons, varying from forty to a hundred; these at times adhere quite firmly, and some of them do not separate until after the *os uteri* has closed and holds the membranes partly ejected and partly retained. The trouble, however, is not serious, unless through some complication, and generally disappears by the slow decomposition and discharge or absorption of the membranes. But it is disagreeable and at times injurious to the cows, because of the absorption of the fetid matter, and the effect of this upon the milk, as well as upon the health of the cow. The cause of this defect is supposed to be the earliness of the calving and the immaturity of the preparatory condition of the uterus. When the birth is a few days after the average time there is rarely any trouble of this kind. It has also been found that when a cow retains the membranes with the first calf, it is apt to do so always afterwards. The use of moldy fodder is believed to promote this retention, and there are many other popular opinions in this regard which have no foundation in fact.

The treatment proper under the special circumstances varies with the nature of the case. If there are no complications and the cow performs her functions satisfactorily, the membranes may be left for a week or ten days until they part naturally; but if fever or other disturbance of the system occurs, and the animal is suffering, then assistance is called for. This may be afforded by giving one of the following infusions:

4 ounces of laurel berries,
2 " " anise seed,
4 " " bicarbonate of soda,

steeped in four quarts of water and given in two doses, with twelve hours between. If necessary it is repeated, but usually it is effective within twenty-four hours. Or,

1 ounce of savin leaves,
½ " " carbonate of potassa,

in one pint of water. The decoction is strained and given lukewarm; the dose is repeated every six hours. Or,

8 ounces of powdered savin,
6 " " molasses,
4 " " powdered cumin,
2½ " " essence of rue,
2½ " " " " savin,
2 quarts of alcohol.

This tincture, well infused, is given in doses of three ounces, in two quarts of infusion of savin leaves.

The removal of the membranes by manual force is recommended when they are wholly or in greater part retained, and are causing serious injury. This is done as follows: A person with a small hand and arm, which are well oiled, takes hold of the exposed portion of the membranes with the left hand and follows them into the uterus with the right hand. Feeling cautiously for the attachments, each one is carefully separated until all are loosened, when they come away immediately without any further trouble. In case of partial retention of the membranes one ounce of hyposulphite of soda may be given daily as an antiseptic to prevent harm by the absorption of the retained matter.

TUMORS OF THE JAW.

The frequently occurring hard swellings on the jaw are caused by a disease of the jawbone which is contagious, and is produced by a special germ which lives and grows at the expense of the bony substance. It is known as *actino mykosis*, or "lump-jaw." It is constitutional and descends by heredity. It first appears as a small nodule upon the side of the face or on the jawbone. This grows gradually into a large tumor which discharges extremely fetid pus, known by its odor to come from the decaying bone. The progress of the disease is slow but sure. The jaw is gradually eaten away and the animal perishes from inability to eat. The disease, however, is not always fatal, as it has been known to succumb to antiseptic treatment when in its early stages. Some valuable animals, treated by advice of the author with hyposulphite of soda in one-ounce doses daily, continued for three months, have gradually recovered, without any permanent injury or blemish.

Sometimes the disease attacks the tongue, which becomes swollen and sloughs away until the animal perishes. In this form of the disorder the antiseptic treatment undertaken at the outset is the only hope of saving the animal. Animals having this constitutional taint should never be used for breeding purposes.

APHTHA.

This disorder affects the lips and tongue, producing painful blisters which break and form raw sores; the tip of the tongue may also be affected so that the animal cannot eat and falls off in condition and milk very rapidly. The disease readily yields to simple treatment. A pound of Epsom salts, followed twenty-four hours afterwards by two-dram doses of chlorate of potash, daily for a few days, usually brings about a cure. The sores are washed twice daily with a solution of two drams of the chlorate in a quart of water. While under treatment the animal should be fed soft nutritious food.

An epizoötic form of this disease is quite common in England, but so far no case of it has been known to occur in America. It is known as "foot and mouth disease," the feet also being affected in a similar manner as the lips and tongue; blisters and raw sores breaking out around the coronet and in the cleft of the feet. As this disease may be imported at any time, it will be well to describe the nature and treatment of it. It appears first by a shivering fit, followed by fever, hot inflamed mouth and lips, lameness of the feet, and tenderness of the udder and teats. In two days large blisters appear on the lips, feet and teats, and the animal suffers greatly. The disease has a period of about two weeks, when the symptoms abate and finally disappear, leaving, however, its germs of contagion hidden in the building and the fields, for the infection of fresh victims. Death rarely ensues; but the cows are often rendered useless for the dairy. The only treatment is palliative. A dose of Epsom salts, the chlorate of potash mentioned above, with the chlorate wash for the mouth. A solution of borax—two ounces in a quart of water—with two ounces of honey and one dram of carbolic acid added, may be applied to the feet, which should be kept bandaged.

ERGOTISM.

This disorder is produced by feeding smutty corn fodder or ergoted grass, and in some cases by means of musty hay or other food. The result is vesicular eruptions of the mouth and gangrene of the feet. Outbreaks of this disease have been mistaken for foot and mouth disease; but no intelligent person, much less a veterinarian, should be led into this error. For the gangrene of the feet is entirely different from the watery blisters in epizoötic aphtha, and appears as a ring of dead tissue which gradually becomes deeper and deeper until the hoof falls off and finally the feet separate, leaving the animals entirely helpless. There is no cure for this disorder when it takes on this serious form, but in its early stages cure is possible by means of cooling purgatives to clear the system of the poison and soothing, healing applications to the diseased surfaces. A mixture of tincture of myrrh and glycerine painted on the sores will relieve the pain and lead to recovery.

BLOATING (INDIGESTION).

When cattle are fed to repletion upon wet green fodder fermentation takes place in the paunch with the evolution of a large quantity of carbonic acid gas, which distends the stomach and causes it to press dangerously upon the lungs and interfere with the breathing. Unless relieved, the animal quickly dies of suffocation. As an immediate and safe cure is possible, it is useless to waste time in trying questionable remedies. This cure is to perforate the paunch at the point of its greatest distension with an instrument known as a trocar, which is contained in a separate tube called a canula (figure 106). This instrument is plunged into the paunch at a point equidistant from the point of the hip, the last rib and the loin ; being the center of a triangle drawn from these points to each other. The trocar should be pointed downwards to escape the kidneys and the muscles of the loin. It is then drawn out, leaving the canula in the wound. It will help to relieve the animal to pour through the canula into the paunch a quart of a solution of carbonate of ammonia, or a solution of two ounces of hyposulphite of soda in a pint of water ; either of which will stop the fermentation and relieve the bloating. Food should be given sparingly for a few days after this until the stomach recovers its tone. As has been observed, "prevention is better than cure," and this accident or mistake is most easily prevented by ordinary caution and care in feeding or pasturing green fodder.

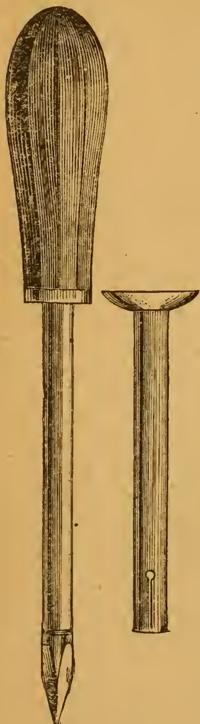

Fig. 106.

CHOKING.

When feeding roots or apples, carelessness, so common among hired help, may lead to the accidental stoppage of the gullet by a piece of the food which has been swallowed whole. This is easily prevented by chopping such food finely in a box by means of a spade with the edge sharpened and feeding it with a little ground meal, or finely cut hay or grass. When an accident of this kind does happen it is repaired very quickly by crushing the obstacle in the throat in this manner: A block of smooth thin board is placed upon each side of the gullet over the obstacle, one person holds a heavy block to one side of the throat and another person gives the opposite block a smart blow with a mallet. This crushes the soft piece of root without injuring the gullet; if it is slightly bruised, it will heal in a few days, and the injury will be less than that resulting from the use of a probang by which the obstacle is violently forced downwards into the stomach.

DIARRHEA.

Nature always makes efforts for its own relief, and diarrhea is the result of an effort of this kind to relieve the bowels from some offensive matter. It may, however, be the effect of a diseased condition of the bowels, as in tuberculosis, when the functions of the bowels are disturbed and the food passes through in an undigested state. But in the great majority of cases it is caused by overfeeding and consequent indigestion. Calves gorged with milk, or given cold or sour milk when used to warm and sweet milk, or under other sudden change in the feeding, suffer seriously from this disorder. Cows that are gorged with grain or immature fodder, or supplied with impure water, become diseased in the same manner.

The remedy is to give a gentle purgative, soft and emollient and soothing to the irritated membranes. A pint of raw linseed oil is useful, and should be followed by well boiled oatmeal or linseed gruel, with soft easily digested food given in small quantities. After the diarrhea is reduced, a tonic should be given: as one dram each of powdered sulphate of iron, gentian, and ginger root, given in a bran mash or cut feed once a day. For calves three months old or less, a quart, and no more, of new milk warmed to 100 degrees may be given twice a day. If the diarrhea is accompanied by spasms, twenty drops of a mixture of two drams of tincture of rhubarb, one dram of tincture of opium, and one dram of tincture of camphor, may be given in a little hot new milk and repeated every two hours until the spasms cease. If this cessation does not ensue after three doses, double the quantity. For calves over three months old the above doses may be trebled.

IMPACTION OF THE STOMACH. INDIGESTION.

When food is not digested it remains in the stomach, usually in the third compartment or "manifolds," where it causes inflammation of the lining membrane, and, drying by the heat, forms a hard mass or cakes between the folds of the stomach. This arrest of the digestive functions and the consequent disturbance of the nervous system give rise to serious disorder, popularly termed "dry murrain." Suspended rumination (loss of cud) follows first, distress from the pain, and finally stupor or frenzy from the resulting congestion of the brain. When stupor occurs the animal rests in a state of drowsiness, with the head pressed against a wall, fence or other support; if frenzy, the animal bellows, dashes itself about, breaking the horns and bruising the head madly, until death ensues in a few hours. Over-feeding upon wet grass, rank fodder, smutty cornstalks, dry stalks in a corn stubble, or any other food that is not digestible is the most frequent cause of this disorder.

Active purgatives with copious doses of thin gruels and stimulants are required. Two pounds of Epsom or Glauber salts dissolved in two quarts of warm water is to be given. Molasses added freely has been found useful. Copious injections of warm soapy water are given soon after. Two-ounce doses of carbonate of ammonia follow the purgative at intervals of three hours, with abundance of thin linseed gruel. If the later stages occur, thirty grains of nux vomica should be given and repeated every half hour and the injections continued. When the animal becomes violent it should be secured where it can do no harm, and if need be, sheaves of straw should be so disposed as to protect it from injury. On recovery the feeding should be gradually restored and a course of tonics followed for two or three weeks. Bran and linseed meal mashes with gentian and ginger will be found useful.

TUBERCULOSIS.

The best bred and fed cows are subject to an insidious but most serious disorder which becomes constitutional, and is contagious under certain favoring conditions and disposition of the exposed animals. This disease consists of the disorganization of the tissue of various important organs and the formation of tubercles or cysts which are filled with solid grayish matter which in time changes to a soft, yellowish cheesy mass. These cells rupture and discharge this soft matter, leaving cavities of considerable size, which sometimes destroy the greater part of some important organ, as the lungs, liver, spleen, kidneys, etc. This disease is communicated by inoculation and by eating the diseased meat, or the milk, if the udder is diseased; but it is more often produced as the result of some local inflammation which seems to offer a favorable opportunity for the development of the specific germ which accompanies this disease and which is abundantly scattered in the atmosphere waiting to find a resting place where it may serve its destructive purpose in nature.

The symptoms vary considerably according to the seat of the disease, but under all circumstances there is considerable fever, with loss of activity, harsh skin, nauseous breath, stiffness and weakness of the limbs, dry cough, thin blue milk, swellings of the glands of the throat or of the joints, constant desire for the company of the bull, and unusual feverish brightness of the eyes, which are sunk in the orbits. If the bowels are affected there is a profuse and obstinate diarrhea. As the disease progresses the symptoms become more intense and in time the animal perishes from impaired respiration or the fetid and profuse diarrhea. At times the bones are affected, and these gradually crumble and slough away.

Recovery is very rare, and when it occurs the animal is left in impaired health and too much weakened to be of any value in the dairy, more especially as the taint in the blood is surely transmitted to the progeny. Prevention includes the removal of infection, healthful breeding—avoiding the physical deterioration caused by too close inbreeding—and the use of only robust and vigorous parents, wholesome feeding, avoiding undue stimulus of the milking capacity, and the maintenance of vigorous condition by all the best hygienic methods. Drainage of fields and pure water are greatly helpful in this direction.

VERMINOUS BRONCHITIS IN CALVES.

Cattle are infested by a slender thread worm which inhabits the bowels, lungs and bronchial tubes. Mature animals are not seriously affected by these parasites, but calves are often attacked by them and suffer greatly, frequently dying of the interference with the respiration. These worms are commonly known as *Strongylus filaria*, and they are the same kind as those which produce "pining," "paper skin," or anœmia in young lambs, and "gapes" in young chickens, and infest many species of small animals, as rabbits, pheasants, etc. Consequently the eggs are widely distributed in meadows and pastures. They gain access to the lungs and air passages of the calves from the stomach, to which they are carried in the egg form, with grass or hay from fields which have been pastured by older cattle. The young worms crawl up the gullet to the throat and pass downwards to the bronchial tubes, where they live upon the mucus secreted by the irritated membranes. When they become numerous they produce such irritation as to cause a constant hacking husky cough, whence the disease has taken the common name of "husk." In time they gather into masses and obstruct the passages so much as to cause suffocation, and the calf falls into convulsions and dies. Prevention is obviously difficult, but cure is easy. This consists in saturating the system with the fumes of turpentine, by giving long continued doses of half an ounce every morning one hour before feeding. This may be given in a teacupful of milk or some sweetened oatmeal gruel, and should be continued for ten days and then repeated after an interval of three or four days.

DEPRAVED APPETITE.

At times cows and other cattle are found eating rotten wood, old bones, manure, and other coarse rubbish. This unnatural appetite is due to some irritation of the stomach which deranges the digestion and causes a morbid craving for these substances. There are various causes for this irritation. The condition of pregnancy, disease of the liver, tuberculosis, and the presence of foreign matters in the stomach; as balls of hair and other concretions of indigestible matter, stones, nails, and pieces of wire, will produce this result. The disorder should be treated as ordinary indigestion, by giving pint doses of raw linseed oil and dilute nitro-muriatic acid as a solvent of the concretions and a tonic. Two drams of the acid is given in one pint of water daily just before feeding. This disorder is almost always associated with hide-bound, dry rough coat, and other evidences of unthrift for want of proper nutrition. The most nutritious food is, therefore, to be given in moderation to secure perfect digestion. Bran and linseed mashes, cut roots with corn meal, and other good wholesome food should be provided, but given in light rations. Sometimes this habit is caused by the presence of sand in the stomach taken in with grass which has been washed by floods, or from light sandy soils. In such cases, feeding fine middlings with moistened cut hay or green fodder will help to relieve the stomach by carrying off the adhering sand.

RED-WATER.

This is a disease of badly-fed cows which suffer from indigestion; the result of which is to disturb the functions of the liver and change the condition of the blood. The blood is thin and watery from a deficiency of fibrine and red globules, which are lost through the kidneys, and communicate a dark brown, red, or black color to the urine. Cattle, feeding in woods or swamps and forced to eat coarse unwholesome herbage, are usually affected in this manner. The method of prevention is obvious. The mode of cure is to give an active purgative to relieve the liver; a pint of raw linseed or olive oil, with two drams of podophyllin, may be given, after which copious drinks of linseed tea, with two-dram doses of chlorate of potassa, and two drams of powdered ginger, should be continued for several days. Nutritious and easily digested food, as bran mashes, cut feed with ground corn and oats, or chopped roots are required.

VICES OF COWS.

Cows are given to few vices, and all that appertain to them are caused by faults of management. The most troublesome are the habits of kicking, holding up the milk, and sucking themselves. Cows are caused to kick by fear; and the act is one of defense. Some young heifers kick when first handled in the effort to miik them and from nervousness ; but if they are gently used this trouble is easily got over and nothing more of it may be seen. If the young animal is then mismanaged a vicious habit may be formed ; if she is punished by beating, or is whipped, especailly if this is cruelly done, as is usual in such a case, the association of the punishment with the act becomes fixed upon the memory, and ever afterward the cow may be a kicker, because it natûrally expects the punishment at milking time and tries to defend itself from it. The frequent change of ownership also greatly helps to produce this habit, because some cows will resent the approach of a stranger ; but this only happens with very fretful cows or those which have been habitually ill-used.

This habit may be prevented by the cautious and kindly treatment of the calf and heifer before she becomes a cow. A young calf will usually make an attempt to kick when the udder and teats are handled, but the objection is soon removed by gentle persistence in the treatment previously recommended both for calves and heifers, in regard to handling, brushing, and other familiar attentions. A cow that has been thus reared and trained will never become a kicker except by very brutal treatment. To cure this vice is sometimes, if not always, easy. There has never been found any difficulty about it when using patience and kind and gentle treatment, notwithstanding some occasional relapses and annoying accidents. The author's method of treatment has been as follows:—First, to secure the confidence and friendship of the animal ; second, to approach her cautiously, both to avoid alarming her and to secure oneself against an attack ; lastly, never to strike or punish the cow for an attempt to kick, but, instead, to soothe her and so remove the fear of danger which has given occasion for the kicking. All this may be done by gently patting and stroking the cow, speaking to her when approaching her, and familiarizing her to the handling. Arter this milk her in a small pail, which can be held so that it cannot be upset, and with the left arm pressing upon the cow's leg so that a kick can be warded off as much as possible. While milking, the cow is spoken to to attract her attention, and every movement about her should be slow and deliberate, so as to avoid anything to cause her to suspect that a blow might follow the movement. When the milking is safely over the cow is petted and spoken to, and a handful of meal or oats may be given to her. If a kick is made or threatened, the cow is never to be beaten for it, but spoken to kindly. No other person than the milker should approach the cow during the milking. Having entirely cured some cows by this treatment that had been in the habit of kicking badly, wholly dispensing with sticks and ropes, which only irritate the cow, we have confidence that there are few cows that have been so utterly spoiled that they may not yet be made quite gentle by it.

Some cows kick because their sight is defective and they cannot distinguish the person approaching them. The author has had one such cow that was perfectly gentle and kind and free from all vice whatever, that would yet lash out the foot when approached from behind without being spoken to, and especially when the udder was touched on the wrong side suddenly and without notice. Nevertheless, when spoken to she would turn her head and lick the hand stretched out to her. This cow's sight was not good, and the defect was shown in other ways. Such cows should be approached and handled always with gentleness, or they may be very easily startled, when it is instinctive with them to kick.

Holding up the milk occurs chiefly when the cow is fresh. A cow that has been used to suckle her calf will naturally prefer that way of being milked. It is most frequent with cows that are so habituated, and for this reason it is rare among those cows whose calves are not permitted to suck them. It is a fault more easily prevented than cured, and at the same time one that is very troublesome and mischievous in its results. A fresh cow that holds up her milk nearly always provokes thereby an attack of garget and future loss of milk all through the season, so that the dairyman or owner of a family cow should be on the watch to avert the trouble. When the calf is habitually taken from the cow before it has had time to suck, the cow will come to her milk naturally and without resistance, and this practice cannot be too strongly recommended as a constant rule in the dairy. When, however, the trouble has occurred and a remedy is sought, we find how powerless we are to strive with the natural instincts of an animal excited to stubborn resistance. Many devices have been tried and recommended to overcome this vicious propensity, but none of them is of much value. One of these is to hang a heavy chain across the loins; another is to press upon the loins forcibly with the hands while efforts are being made to draw the milk. Others are to give some feed at milking time, or to distract in some way the attention of the cow from her supposed grievance. Soothing measures and perseverance, or the use of milking tubes, are the only effective remedies. To give some feed or salt, and to sit down and rub the udder and manipulate the teats as in milking, and to persevere with gentleness, is often effective; but the only successful method of getting the milk is by the use of milking tubes (more particularly described elsewhere), by which the milk flows by force of gravity in spite of any unwillingness of the cow. The tubes are inserted gently into the teats and the milk runs in a stream until all is drawn off. This method, or any other, is only temporary, and to be used only in the special emergency, because of the danger of injuring the lining membranes of the teats and producing inflammation of the udder.

Self-sucking is the worst vice which a cow can contract. It totally destroys her usefulness and is a constant source of loss and disappointment. It is contracted by old cows as well as young ones, and cases occur in which ten or twelve-year old animals begin to practice the vice. How it is learned seems to be unknown, but it is more frequent than might be suspected. The remedies proposed have been numerous, but all fail excepting that of slitting the tongue, by which the act of suction is made impossible. It may seem that this is a cruel and unusual punishment, but it it not so severe an operation as castration, and we do not hesitate at that to increase the value of our male animals. Even a kind owner need not hesitate to recommend the operation of slitting the tongue when the cow is a valuable one, the division being made two inches in length. The operation should be performed when the cow is dry, and the wound heals very soon. It is necessary to give soft food or slop until the healing is well advanced.

Recently, having been consulted by the owner of some valuable cows which had contracted this vice, the author designed the following harness which wholly prevented the trouble. A surcingle was buckled around the cow behind the forelegs, and a halter was made for the head. Both of these were provided with rings to which a stiff rod of tough wood was fastened by snap-hooks at the ends; the rod being passed between the forelegs. This necessarily prevents the cow from bringing her head into the position required to reach the teats.

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