PROFITABLE DAIRYING

A MANUAL

FOR

FARMERS AND DAIRYMEN

BY

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FOREWORD

THIS little book is not a text book for the student of dairying, but a manual for farmers and dairymen. While the information contained herein is believed to be as reliable as that of scientific publications, it is set down in a form adapted to the general reader. No apologies are made for the use of everyday language, as the writers believe it best adapted to the needs of those for whom this work is intended. Neither are they convinced that the same simplicity of style is not better adapted to the student of scientific agriculture.

¶ Acknowledgment is made to those who have assisted us in any way in the production of this work, and especially to the breeders who have permitted us to use photographs of famous dairy animals for illustrations.

BENKENDORF & HATCH

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INTRODUCTION

CHAPTER I.

There is no branch of agriculture which yields so handsome and so satisfactory returns to the farmer as the dairy industry, if properly pursued. To be sure there are other branches which yield larger returns, but these large profits are more than compensated for by the loss to the soil and the uncertainty of a safe return each year. Tobacco may be grown successfully for a number of years on the same piece of ground, but the soil must be diligently worked and extensively fertilized. In the end the overtaxed soil refuses to respond and finally lies exhausted. So it is with grain farming. One cannot draw continually on a bank account without renewing his deposits there. Neither can the farmer draw continually from the storehouse of plant food which he possesses, that is, from the soil of his farm, without putting back the same amount of fertility that he takes off with his crop, unless he wishes to wear out and ruin his farm.

Now, in dairy farming the larger portion of all that is raised on the farm is fed there and ultimately finds its way back to the soil in the form of barnyard manure. The butter and cheese which are sold from the farm contain so small a portion of soil matter that the loss to the soil is scarcely perceptible. This is the chief reason why dairy farming is proving so profitable and is coming so rapidly into popular favor.

But this is not all. Dairy farming promotes crop rotation and encourages the production of clover, alfalfa and other leguminous crops which if fed on the farm do not wear out the soil, but may positively add to its fertility. The progressive dairy farmer not only finds himself placed, through his industry, in a position of competence and ease, but under his wise management he finds the soil of his farm growing richer and more productive. All of these surprising assertions admit of absolute proof and will be fully discussed in the chapters which follow.

But the farmer who reads this must neither think it an overdrawn case for dairy farming on the one hand, nor imagine on the other hand that all he has to do is to get a few cows and that they will take care of him for the rest of his days. Both positions are equally erroneous. No man can permanently succeed in any undertaking without putting intelligent thought and energy into his work. Neither can the dairy farmer.

The ability to secure profits from dairying lies in a thorough knowledge of its fundamental principles. It is hoped that the information contained in this little book will be of value to the farmers who may chance to read it, in that it endeavors to set these principles forth in a simple and practical way. The authors have avoided the use of scientific terms so far as it is possible for them to do so, and have tried to use language and illustrations easily within the grasp of men not trained in scientific work. Wherever it has been necessary to resort to unusual terms, these terms are fully explained in ordinary every-day language. If the farmer, into whose hands this little book may happen to fall, will follow its teachings, exercise due industry, patience and perseverance, he cannot go far wrong in branching out into dairy farming, if he is not already engaged therein. If he is already a dairyman, it is hoped that it will render him service by assisting him to improve his methods, thereby increasing his profits.

CHAPTER II.

DEVELOPMENT OF THE INDUSTRY.

Dairying as an agricultural industry is very old, but as a "commercial" industry placed on a firm and sure scientific basis, it is very new—less than a quarter of a century of age. This fact is largely due to the invention of two machines which have completely revolutionized the whole industry. These two machines are the Babcock tester and the centrifugal separator.

Previous to 1879 the only method in common use for the separation of fat from the milk was by setting the milk either in pans or cans and allowing the cream to rise naturally, but in that year two machines were invented, one in Denmark and the other in Sweden, which made use of the principle of centrifugal force for this separation, and were so constructed that the process was continuous. Since that time other inventors have placed modifications of these machines on the market, but the principle employed is always the same, until today there are a dozen or more styles of thoroughly reliable centrifugal separators in every day use.

This method of separation effected so large a saving of butter fat to the farmers that creameries rapidly sprang up, particularly in the north central states, accompanied by cheese factories, only to be defeated of their mission by dissatisfaction and fraud, because there was no quick and satisfactory method for determining the richness of the milk delivered by the patrons, and no way by which a factoryman could determine the losses in skim milk, etc. In these early creameries and cheese factories an unprincipled patron could water his milk in order to get the lion's share of the profits, as it was then the custom to pay for milk by the pound. Of course such fraud was certain to cause dissatisfaction, besides being manifestly unjust.

Another thing well known even in those days, is that all cows are not equally good fat producers, that is, all cows do not give milk equally rich in fat, and the "pooling system," as it is called, where all farmers are paid the same price per hundred pounds of milk without regard to its fat content, is plainly not equitable.

These two facts, viz.: that a patron could adulterate his milk and thereby increase his profits, and that a patron, although not adulterating his milk, could deliver milk from herds testing low in fat, and receive the same amount of money per hundred pounds of milk at the factory, led Dr. Babcock in an effort to solve the vexed problem of providing the dairy world with a quick and easy method for determining the fat content of milk. His labors resulted in the invention of the Babcock test in the year 1890, which date marks the beginning of active progress in the dairy industry. This invention is such a simple and practical method for the determination of fat in milk, cream, butter and cheese that it has never been improved upon, and it is doubtful if a better method will ever be discovered. Dr. Babcock's name is known the world over, and it is certain that no other man has ever contributed such a rich legacy to agriculture as has Dr. Babcock by the invention of this test. He did not patent it but gave it free to a great agricultural population where it found immediate adoption and widespread use.

As an illustration of the rapid development of the dairy industry, it is only necessary to call attention to the census reports of the United States, which show but five creameries and cheese factories within its domains in the year 1860. In 1890 this number had increased to 4,712, and in 1905 statistics collected in the one state of Wisconsin show a grand total of nearly 3,000 in that great dairy state. The total value of all butter and cheese produced by the factories within the United States in 1860 was but $23,500; in 1890 this value had increased to nearly $63,000,000, and in 1905 there was $45,000,000 worth of dairy products produced in the state of Wisconsin alone. While the progress is more marked in Wisconsin than in most of her sister states, yet her dairy development may be regarded as typical. It is estimated that for 1907 the value of the dairy products in the United States was over $700,000,000. And the end is not yet.

Notwithstanding the high prices paid for milk, butter and cheese, milk and its products are among the very cheapest, most wholesome and most nutritious articles of human food. There are more digestible nutrients contained in twenty-five cents worth of milk at six cents per quart than can be obtained from the same amount of money expended for meat, fish, fruits or vegetables at ordinary market prices. This fact will always operate to keep up the prices of dairy products. The cow is the most economical food producer extant. No one need fear an overproduction of dairy products. Whatever may have been the ups and downs of the past, certain it is that the future of the dairy industry looks exceedingly bright.

CHAPTER III.

COMPOSITION OF MILK.

Milk as secreted is opaque and white in color. Normally it usually has a slightly yellowish appearance, due to the fat globules it contains. The white color is due to suspended particles reflecting the light. Skim milk, or milk from which the fat has been removed, has a bluish tinge due to the light reflecting on the casein and calcium phosphates of the milk. It has a sweetish taste when drawn owing to the presence of the milk sugar.

Milk is heavier than water, having a specific gravity of about 1.029 to 1.033. This means that if we had a vessel that would hold exactly 1,000 pounds of water, this same vessel would hold 1,029 to 1,033 pounds of milk.

Milk may be considered as consisting of two parts, viz.: the fat and the serum. One hundred pounds of milk ordinarily contains about 3.7 pounds of fat, the serum being all of the constituents of the milk except the fat, or 96.3 pounds.

There is no chemical combination between the fat and the serum, but the fat floats in the serum in the form of very small particles varying in size and number in different kinds of milk. The number of fat globules in a cubic millimeter, which is about the size of a pinhead, is from one to five million, depending, of course, upon the kind of milk. Ordinary milk contains about two million fat globules to the drop, and it is estimated by the Agricultural Department at Washington that it would take a man ten years to count this number at the rate of one hundred per minute, counting ten hours per day.

When first drawn the fat globules are uniformly distributed, but after standing a few minutes these globules gather into groups of ten to one hundred, although we find throughout the milk small, isolated, individual globules. Their average diameter is about one five-thousandth of an inch; some are as large as one one-thousandth of an inch, while others are so small that they appear under a microscope like very tiny specks, too small to be measured.

The number of fat globules increases as the period of lactation advances, there being from two to three times as many in the same volume at the end as at the beginning; the size, however, greatly diminishes. The fat globules in milk of different breeds vary in size, the largest ones being found in Jersey milk. The Ayrshire and Holstein-Friesian cows have the smallest; the Shorthorn ranking between the Jersey and Ayrshire, although certain strains of Shorthorn cows produce milk with very large fat globules. It may be interesting to note that the largest fat globules on record were found in Shorthorn milk.

The serum is composed of water and solids (usually designated as solids not fat). These embrace such solids as casein, albumen, sugar and ash, varying in amounts with different individual cows, and with the fat comprise what are known as total solids. Below is a table showing the average composition of milk:

Water	87.4 per cent
Fat	3.7 per cent
Albumen	.5 per cent
Casein	2.7 per cent
Milk Sugar	5.0 per cent
Ash	.7 per cent
	100.0

The most variable of these constituents is the fat; the casein, albumen, sugar and ash being quite constant. The fat content varies a great deal according to the breed. It is well known that the milks of Jersey and Guernsey breeds are rich in fat. To show these breed variations we append the following table compiled by the agricultural experiment stations of America:

Jersey	5.35 per cent
Guernsey	5.16 per cent
Shorthorn	4.5 per cent
Ayrshire	3.66 per cent
Holstein-Friesian	3.42 per cent

It must not be inferred from this that all Jersey cows produce milk of such richness as given in this table. As a matter of fact there is a great difference with the individuals of each breed. Certain Holstein-Friesian cows have been known to produce milk as low as 2.8 per cent fat, and even lower, while other individual Holstein-Friesian cows may produce milk containing 4.0 per cent fat. But this table shows the average from a large number of cows.

The per cent of fat in milk changes somewhat with the period of lactation. Professor Van Slyke of the Geneva Station, New York, gives a table showing a gradual increase as the period of lactation advances. It will be noticed that for the first five months the milk did not increase in richness, but remained practically the same; after that the fat of the milk gradually became richer as the period advanced.

Month of Lactation	Per cent of Fat in Milk
1	4.54
2	4.33
3	4.28
4	4.39
5	4.38
6	4.53
7	4.56
8	4.66
9	4.79
10	5.00

The time between milkings has a great influence on the fat content of the milk. It is quite generally known that morning milk is richer than evening milk. This is not always true, but in general we find that when a cow is milked three or four times a day she will produce richer milk than when she is only milked twice. As a rule the richer milk follows the shorter period between milkings. This is an important fact to bear in mind when the milk of a cow is tested for its fat content.

Milk will vary a great deal in richness from day to day. The health of the animal also has an influence on the variation of the percentage of fat. Excitement may very materially reduce the quantity of milk as well as the quality. It is therefore poor policy for a dairyman to abuse his cows by beating them or by allowing them to be chased by dogs.

The first milk after a cow freshens is termed colostrum milk. Instead of having a solid not fat content of 9.0 per cent, it seldom falls belows 18.0 per cent. The great increase in the solids not fat is due to the increase in those substances which are very essential as a food for the calf during the first three or four days after birth, viz.: casein and albumen. The following table gives the composition of this milk, showing that the fat content is quite normal but that the solids not fat differ greatly from the solids not fat in normal milk.

Water	74.6 per cent
Fat	3.6 per cent
Casein	4.0 per cent
Albumen	13.6 per cent
Milk Sugar	2.6 per cent
Ash	1.6 per cent
	100.0

However, these solids not fat constituents in the colostrum milk decrease very rapidly so that the milk becomes "normal" at the seventh or eighth milking. This colostrum milk, although it is not in any way poisonous, is very undesirable for purposes other than food for the calf. It should, therefore, not be delivered to a creamery or cheese factory until it is fit for human use.

The casein in milk varies with different animals from 1.8 per cent to 3.0 per cent, but in the individual it is quite constant. This casein, with the albumen, comprise what are known as proteids of milk. These proteids are very valuable as food and furnish the muscle producing elements so essential. The casein and the fat constitute what are known as the cheese solids of milk. These two components determine the value of the milk for cheese production.

The sugar in the milk is an important constituent, but should not be confused with commercial cane sugar. Milk sugar is only about one-fourth as sweet as ordinary cane sugar. It is manufactured from the whey at a few cheese factories in this country, but has very little commercial value, being used only in putting up modified milk, etc.

A great deal may be said in regard to the quality of milk as affected by varying conditions, such as slow and fast milking, sudden changes in the feed and the nervous condition of the cow. Suffice it to say that a good dairyman will always treat his cows kindly, will not be boisterous while handling them, will not excite them in any way, will feed them regularly and provide shelter for them. He will remember that the cow is one of his best friends and that she represents so much capital invested, and that abusing her will very materially affect the dividends that she will be able to pay him.

CHAPTER IV.

MILK SECRETION.

It is very essential that a dairyman should understand the fundamental principles connected with his work. Not the least of these is the secretion of milk. In this brief work we cannot discuss in detail the various theories and opinions advanced in regard to the secretion of milk, but will in a general way cover the ground so that the reader will have a fair understanding.

Milk may be briefly defined as a characteristic secretion of the mammary glands. Its primary function, naturally, is for the nutrition of the young. As a food for young animals it cannot be excelled, for it contains elements that are necessary for the building up of the tissues of the body, and it contains these elements in the proper proportion. The class of animals that suckle their young are termed "mammals" and are nearly all four-footed animals. To this order, however, belong some animals that live in the sea, such as porpoises and whales, which secrete a fluid very similar to that of the milk of land animals; but with a few exceptions all mammals are land animals. We shall, however, confine our discussion of milk in this work to that produced by cows, although the milk of other animals, such as sheep and goats, is used as food in different places, especially in various parts of Europe.

The glands which secrete the milk are only two in number. There may be one lobe to each gland, or, as in the case of the dog or swine, several. In cows these lobes are termed "quarters," and there are two to each gland. These four quarters form what is termed the udder.

These glands are separated from each other by a membrane. There is, therefore, no connection between the right and left side of the udder. Each teat has practically its own system of cisterns, channels and cells, and although there seems to be some connection between the two lobes in each gland, practically there is none. This is shown by the fact that one of the quarters may be diseased without affecting the other. It is well known, however, that we can get more than half as much milk from one teat than we can if we milk both teats at the same time, which shows that there must be some relation between the two lobes.

Just above each teat we find a small cavity from which there lead many small channels; these in turn lead to other but smaller cavities. All these cavities are termed "cisterns." These small channels, with their cisterns, ramify the udder, becoming smaller and smaller, finally terminating in cells. These are the alveoli cells. The inner wall of the alveoli cell is made up of a layer of very minute cells; sometimes there are two or three layers of these. These small cells are filled with protoplasm, and when this protoplasm is discharged it is termed milk.

At one time it was the general belief that the udder was a reservoir, and it may be that many readers still have the impression that this is the case. This is not true, for the total capacity of all the reservoirs or cisterns is not one-fourth the yield of the milk.

The glands secrete milk all the time, but principally at the time of milking. We can compare this to the secreting of tears by the tear glands of the eye. These glands secrete tears all the time, but especially when an animal experiences great joy or grief. Similarly the nervous condition of the cow at the time of milking will greatly influence the secretion of milk.

As previously stated, there are many theories advanced as to the formation of milk. It is claimed by some that milk is filtered out of the blood; the udder being well supplied with arteries and veins probably gave rise to this idea.

We find, however, that there is very little if any milk sugar in the blood, while there is a great deal in milk. No casein is found in the blood. It is also a fact that the albumen in milk coagulates differently than the albumen of the blood. Further, it may be stated that the ash in milk is that of potassium salts, while the ash of the blood is largely that of sodium salts. It is believed that somehow in the process of secretion certain parts of the blood are changed into casein, that other constituents pass into the cells without very much change, and when the cells within the alveoli cells break down, the resulting product is milk.

The attention of the reader is now called to a very important point, viz.: that the tendency of the cell is always to produce milk of its own particular composition. This tendency is very constant, and therefore the composition of milk cannot be permanently changed by a change of feed. That is, the quantity of milk which a cow produces may be considerably increased, but the quality will remain practically the same. To make this plain, we may use this illustration: A tree will always produce the same kind of fruit; by giving the tree good food it is possible to increase its yield, but a winesap tree will always produce winesap apples. So it is with the cow. It is the nature of the cells to secrete a particular grade of milk, and therefore no system of feeding will permanently increase or decrease its fat content. The idea is prevalent among many farmers that a cow can be made to give rich or poor milk, depending on what she is fed.

The Danes did a great deal of work along this line, experimenting to see whether or not feed influenced the richness of the milk, and in conducting their experiments used over a thousand animals. The average variation was only about one one-hundredth of one per cent. Such a slight variation cannot be attributed to the method of feeding. Experiments have been conducted by taking a poor herd of cows and testing each individual carefully and then feeding judiciously. The quantity of milk produced was easily increased, but the quality always remained normal.

The fact that "fat cannot be fed into a cow" is very important. A farmer can test a heifer, and if she does not produce milk of a satisfactory quality he need not keep her, for he may rest assured that the quality of her milk will not materially change later on in her life. In this way, therefore, it is possible for a farmer to build up a good herd by selecting his cows. This topic will be discussed more at length in a later chapter.

CHAPTER V.

THE DAIRY COW.

Generally speaking, cattle may be classified as belonging to one of three types, viz.: beef, dual purpose and dairy.

To the beef type belong those which are kept on farms solely for their value as beef producers. They are as a rule compact in form, having a broad back and a deep, wide body. They are not adapted for dairying inasmuch as they usually do not secrete more milk than is necessary to raise the calf. They have small udders and are not persistent in their flow of milk. There are, however, individual exceptions among most of these breeds that produce a fair amount of milk, but the tendency of the members of this type is to convert their food into beef rather than into milk. To this type belong the Shorthorns, Hereford, Aberdeen Angus, Galloway and Sussex cattle.

To the dual purpose type belong those cattle that produce more milk than those of the beef type, and at the same time flesh up reasonably well. They are usually less in width than the beef type and have larger udders. They are presumed to milk well and when "dry" to convert their food rapidly into beef. There are many arguments produced both in favor of such a type and against it. It is argued by some that such breeds are really necessary in certain sections of this country. This type is many a farmer's ideal; but it is questionable whether or not such an ideal will ever be profitably realized. The Red Polled, Devon, and Brown Swiss cattle are the prominent breeds classed as dual purpose animals, though strictly speaking as individuals they tend either to produce milk or beef rather than both. Certain families of the Shorthorns are also included because they give a fair quantity of good testing milk and at the same time are fair producers of beef.

The dairy type includes such breeds as are not inclined to produce beef. They necessarily have less breadth of back, and, unlike the beef breeds, fleshiness is not desired. Cows belonging to this type should have a tendency to produce milk and not to convert their food into beef. It would be difficult to describe in brief the many desirable points which indicate a good dairy cow. Authorities usually agree that the ideal cow should have what is termed a "triple wedge" form. It must be noted, however, that occasionally there are individuals that do not conform to the ideal yet are good dairy cows. However, these are only exceptions. It is of the utmost importance that the dairy cow have ample room in her body for such organs as the lungs, heart, digestive and maternal organs. This indicates a vigorous constitution which is necessary in order that she may be able to withstand the strain of continually producing large quantities of milk. This widening of the body towards the rear gives to her the "wedge form." Inasmuch as she is usually compared to a machine which converts food into milk, it is very essential that she have a large "barrel," which is an indication that she can consume a large supply of food for the manufacture of her milk.

Drawing showing "triple wedge" form of a famous dairy cow. The wedge form as viewed from the top over the shoulders is more pronounced than in the drawing from the rear view, shown at the left.

The udder should be ample in size; it should have good form with four well shaped teats; it should be soft after milking and materially smaller than before milking. Meaty udders are very undesirable as they indicate a lack of capacity. Since the udder must be well supplied with arteries and veins in order to furnish the milk secreting cells with the food material from which they are to secrete milk, a good cow usually has large milk veins underneath her belly.

A great deal more might be said as to the desirable characteristics which a good dairy animal usually possesses, but suffice it to say that the real test of her value as a dairy cow is her fat producing qualities. This can only be learned by using a pair of scales to ascertain the amount of milk she produces, and a fat test to determine the richness of her milk. There are many cows that give a good flow of milk, reasonably rich in fat, during the forepart of their period of lactation, yet cows of this kind may be very undesirable animals to keep, owing to the fact that they may not be persistent milkers. The value of the methods employed in determining the productive qualities of an individual cow are discussed in detail in a separate chapter in this work to which we respectfully refer the reader.

It is unfortunate for the dairy industry that we do not find more pure bred stock in this country. We believe that the farmer should raise pure bred stock because it is more profitable for him to do so rather than to raise "scrubs." It may cost a trifle more to begin with, but it will be money well invested if he intends to make dairying a paying business. In case he cannot begin with pure bred stock, it will be well for him to grade up his cattle as rapidly as possible by the use of a pure bred sire. It may be well to discuss briefly a few of the distinctive dairy breeds, representatives of which are found in almost every community.

Loretta D. World famous champion Jersey cow at the St. Louis Exposition, 1904. This cow produced in 120 days 5,802.7 pounds milk testing 4.82 per cent, or 280.16 pounds butter fat. Weight 1,075 pounds. Courtesy of F. H. Scribner, Rosendale, Wis.

JERSEY—As the name indicates, they originally came from the Isle of Jersey, which is one of the small islands in the English Channel. Here the people bred their cattle along distinctive lines, with the result that they established a breed that has many able and enthusiastic champions. The Jerseys are usually small cows, weighing from 650 to 1,000 pounds, averaging about nine hundred pounds each. They produce milk rich in fat testing 4.0 per cent and over. As a rule they are persistent milkers but usually do not produce large quantities of milk. This latter statement is used as an argument against them. We find that these animals have some good records to sustain their claim as a notable dairy breed. At the World's Columbian Exposition, held in Chicago in 1893, a ninety-day test was conducted in which twenty-five Jerseys took part. Several of these animals were sick, but in spite of this the milk produced amounted to thirty-three pounds a day for each cow. At the St. Louis Exposition in 1904, twenty-five cows produced milk averaging forty-one and one-half pounds for each day for ninety days. These are remarkable showings and speak well

Colantha 4th's Johanna. World famous Holstein-Friesian cow which produced in one year 27,432.5 pounds milk testing 3.64 per cent, yielding 998.25 pounds butter fat. This is the largest amount of fat produced in one year by any cow of any breed. Courtesy of the owner, W. J. Gillett, Rosendale, Wisconsin.

for this breed. Although small in stature, we believe the time will come when breeders will be able to develop certain families of a larger frame and more vigorous constitution than the Jersey of the present time, and at the same time preserve in the families the desirable qualities possessed by the Jersey cow of today.

HOLSTEIN-FRIESIAN—It is not known just where the ancestors of this famous breed originated, but it is well known that Holstein-Friesians have been in Holland for hundreds of years, and the breed is one of the oldest, if not the oldest, in existence. The individuals have a large frame and weigh from 1,000 to 1,400 pounds. They are good feeders of roughage, and on account of this stand in favor with many farmers. The milk is not so rich as that of some other breeds, but what it lacks in quality is usually made up in quantity.

Yeksa Sunbeam. Celebrated Guernsey cow, owned by Helendale Farms, Athens, Wisconsin. She produced within one year 14,920.8 pounds milk testing 5.74 per cent, or 857.15 pounds butter fat. This amount of fat would make more than 1,000 pounds of butter. Courtesy owner, Rietbrock Estate.

The flow is, as a rule, exceedingly large and certain families of this breed produce milk testing 4.0 per cent and over. The greatest record of any cow for the amount of milk produced was that of a Holstein-Friesian, viz., Pieterje Second. This remarkable animal produced 30,315½ pounds of milk in one year. Cows of this breed have been reported as producing as much as 122½ pounds of milk per day. At the St. Louis Fair of 1904, fifteen Holstein-Friesian cows were entered in competition with Jerseys and other breeds. They were milked for 120 days and averaged 53.4 pounds each day. It is safe to say that a good Holstein-Friesian cow will produce six to seven thousand pounds of milk each year, if she is given proper care and treatment.

Guernsey—This breed has become exceedingly popular within the last few years. Like the Jersey, they derive their name from the island on which they originated, which is another one of the islands in the English Channel. Members of this breed have larger frames than do the Jerseys. They also have more vigorous constitutions and average 1,050 pounds in weight. They are good milkers and their milk is of a superior quality which tests well. This breed produces a butter fat which is distinctively yellow. In fact some of the butter produced from the milk of Guernsey cows and exhibited at a dairy convention was so yellow that it was believed by the judges that it contained coloring matter. The butter was accordingly analyzed and found to be entirely free from such artificial ingredients. The milk from this breed is splendidly adapted for city milk trade on account of this rich yellow tinge so attractive to the customer. It is generally conceded that the milk of the Guernsey is not quite so rich in fat as that of the Jersey, but

Typical Ayrshire cow. Owned by the Wisconsin Experiment Station, Madison. Notice the peculiar shape of the horns and the characteristic markings of this breed.

the quantity given is usually greater. At the Pan American Exposition the Jersey milk tested 4.82 per cent while the Guernsey tested 4.68 per cent.

It was at this exposition held at Buffalo that the ten-year-old Guernsey cow, Mary Marshall, produced 5,611 pounds of milk, yielding 301.13 pounds of butter fat. This test covered a period of six months. The performances of Yeksa Sunbeam and Dolly Bloom, both Guernsey cows, are explained in a note accompanying the illustrations.

Ayrshire—These cows are found principally in New England and Eastern States and Canada. They originally came from Scotland and possess a great deal of merit. Like the Holstein-Friesian they are as a rule persistent milkers. They are medium sized animals, weighing about one thousand pounds. The milk of this breed of cows is particularly adapted for cheese making, owing to the small size of its fat globules and its relatively large casein content. The milk tests usually from 3.5 to 4.0 per cent fat. At the Pan American Exposition the five Ayrshire cows ranked second in milk production, yielding 55 pounds per cow for each day of the test.

CHAPTER VI.

THE BABCOCK TEST.

As has already been stated, the Babcock test is responsible for much of the progress in dairying during the past fifteen years. Its operation is so simple, the principles upon which it is based are so easily understood, and its intelligent use by dairymen is of such great importance that it is deemed quite proper to give considerable space in this book to this test.

It will be remembered that milk is composed of water, fat, curd, sugar and ash in various proportions, and that the fat globules are simply floating or suspended in the milk serum. When these globules rise to the top naturally they drag the curd and other solids along with them and form a layer at the top, rich in fat, which we call cream. Before the invention of the Babcock test it was the practice in some places to collect samples of milk or cream, churn them and melt the lumps of butter in graduated tubes, from which the amount of fat could be estimated. The purpose of melting the churned butter was to collect the fat into a clear layer of oil. Sometimes several churnings and consequent rechurnings were necessary to make a clear test. This test, known as the churn test, was a slow, laborious, and somewhat unreliable process.

In the Babcock test the separation of butter fat from the other constituents is accomplished in a few minutes. The curd is dissolved by a strong acid which will not act upon the fat. The fat globules are brought to the surface by whirling in a machine called a centrifuge. This layer of fat is brought up into the neck of the test bottles into which the samples of milk were placed at the beginning of the test, and the percentage of fat read directly from the neck of the test bottle. The entire test takes about ten to fifteen minutes of time, is thoroughly reliable and can be made by anyone possessing ordinary intelligence.

DETAILS OF THE TEST.

1. Preparation of the Sample:

Great care is necessary in the preparation of the sample. If a herd is to be tested the entire milk of the whole herd must be thoroughly mixed before a portion is taken for testing. This mixing is accomplished by pouring from one vessel to another, and the sample taken *immediately* before any of the fat globules have had time to rise. If the milk stands for a minute even after being mixed, the sample will not be accurate, so rapidly do the fat globules tend to come to the surface.

If a single cow is to be tested, she must first be milked perfectly dry, then all of her milk must be thoroughly mixed and a portion of this taken for testing. It is important to have *all* of the cow's milk, as the fat content tends to increase during the process of milking, the strippings being much richer than the foremilk; often the foremilk will test less than one per cent, and the strippings over ten per cent. For this reason the sample can never be milked into a separate vessel if accurate results are desired, but must be taken from the whole amount of milk and then only after a thorough stirring.

If a small sample is to be tested this too must be thoroughly mixed before the final sample is taken in the pipette. If more than one test is to be made from the same sample the sample should be mixed each time before being drawn into the pipette. Thorough mixing is the most important part of sampling, and good sampling is one of the most important points to be observed in making a correct test.

2. Filling the Test Bottle:

When the sample has been thoroughly mixed the milk should be drawn into the pipette by suction with the mouth until it rises above the mark on the stem. The forefinger of the hand in which the pipette is held is then quickly placed on top of the pipette and the milk is allowed to run down to the mark where it is checked and held by the forefinger. The test bottle is taken in the other hand, slightly inclined, the filled pipette introduced into the neck, the finger is removed and the milk allowed to run down the side of the neck into the test bottle. Great care should be used not to lose any of the sample; even if a few drops are spilled the test is spoiled and another test should be made.

3. Adding the Acid:

Ordinary commercial sulphuric acid at a specific gravity of 1.82 to 1.83 is used. It may be purchased at any drug store for three or four cents per pound. It is poisonous and must not be allowed to come in contact with the skin, hands, clothing or tin o iron vessels. If by accident any should be spilled, it should b washed off immediately, using plenty of water. An application o dilute ammonia is very beneficial in neutralizing the acid.

In making the test the acid measure is filled to the mark wit this acid, and the acid is poured down the inside of the neck of th test bottle in the same way in which the milk was introduced. I is important to let the acid run down the side of the bottle, an not drop it straight down through the milk, as this will burn th curd and cause black particles of burned curd to rise into the fa and spoil the test.

4. Mixing Milk and Acid:

The milk and acid having been placed in the test bottle, a now mixed by taking the bottle by the neck and giving it rotary motion. The acid immediately dissolves the curd, the bott gets hot and the contents turn black.

5. Whirling and Filling Bottles:

The bottles are now placed in the machine and whirled fo five minutes. They are then filled up to the bottom of the nec with hot water, using either the acid measure or the pipette for th purpose. If hard water is used the lime in it must be destroyed b adding to it a drop of acid before filling the bottles, otherwise th lime in the water may cause a foam to appear on the fat and spo the reading. Only a drop of acid should be used, and to preven accident this should be dropped from the acid measure and no from the bottle. *Great care* is necessary in handling this acid.

The bottles are whirled a second time for one minute, the fa brought up into the neck far enough so that it can be read by add ing a few drops more of hot water, the bottles returned to the teste and whirled a third time for a minute or two, when they are take out and read immediately.

6. Reading the Fat:

The fat column is read from its highest point to its lowest poin while yet hot (130-145 degrees F.) and before it has had time t solidify. If the fat should get cold it may be melted by placing th bottles in hot water well up to the neck.

If both ends of the fat column are above the zero point, not the reading of these two points and take their differences. For ex ample: If the lowest point of the fat is 1.8 per cent and th highest is 5.6 per cent, then the per cent of fat is 5.6—1.8 or 3. per cent. A quicker way is to place a pair of dividers with it legs so spread that one of them rests on the highest point and th other on the lowest point of the fat against the neck of the tes bottle and then move it down so that the lower leg rests at the zero point; the upper will rest at the correct reading of the fat.

7. Emptying the Waste:

The waste in the bottles should never be emptied into anything but earthen jars. This waste contains much strong acid, and should be thrown where it cannot do injury to plants or animals. It is usual to place a board cover over an ordinary jar, and then bore holes about three-fourths of an inch in diameter through this cover. Through these holes the necks of the inverted test bottles are thrust and their contents allowed to drain into the waste jar. The jar is then emptied where its contents are not likely to cause injury, and washed out with hot water to remove the grease undestroyed by the acid.

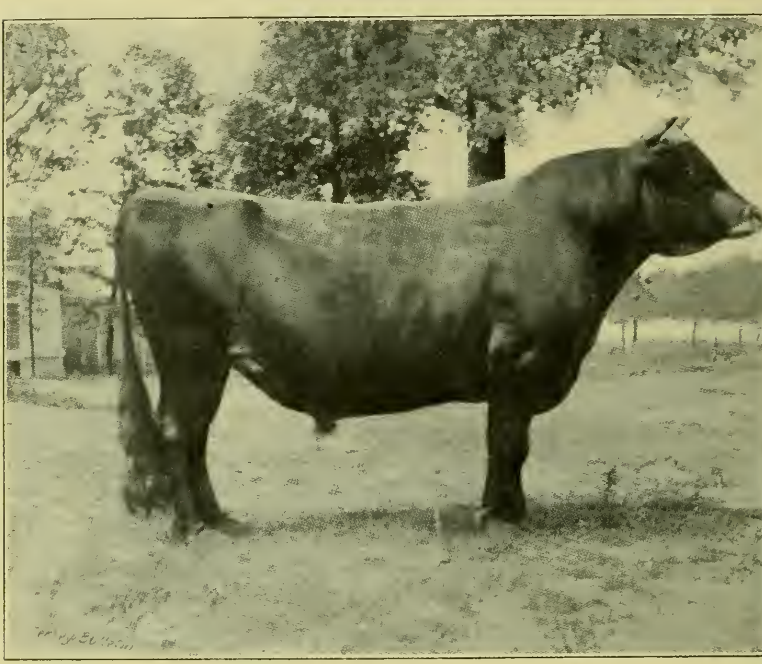
The importance of every dairyman owning a pair of scales and a Babcock tester is discussed in a later chapter of this work. More definite and minute instructions for making the test are usually given with the apparatus by reliable dealers in dairy supplies.

CHAPTER VII.

TESTING THE FARM HERD.

No dairyman should keep a cow that produces less than 250 pounds of butter fat annually, and an average of a pound a day for 300 days of the year is not too high a standard. Whole herds have frequently been found which produced even more than that. Of fifty-seven cows tested in Wisconsin in 1904 and 1905 for admission to the Advanced Register of the Holstein-Friesian Association, during a period of one week, the highest record for that time was 20¼ pounds, or nearly three pounds of butter fat daily. The lowest was 11.6 pounds, and the average of the entire lot was a trifle less than 15 pounds or over two pounds of fat daily per cow. Colantha 4th's Johanna was among this number, and was awarded first place for producing 12¼ pounds of butter fat in a week, 375 days after calving. This remarkable animal has since produced 998.26 pounds of butter fat during the year 1907, and by this phenomenal yield has earned for herself the title of the "World's Champion Cow." In a single month this cow produced 110.83 pounds of butter fat, a larger amount than is produced in a whole year by so called "dairy cows" in many herds. While this cow has outstripped all competitors and stands in a class by herself, there are many others holding records of over five hundred pounds of butter fat annually.

There is a cow in Wisconsin, belonging to the University herd, of Red Polled origin, not essentially a dairy breed, that has a record of 650 pounds in one year. In all the numerous "official" tests that have been made in Wisconsin during the past few years, very few of the cows have been found to fall below the three hundred pound mark, and the majority of them exceed four hundred pounds of butter fat annually.



Merry Maiden's Third Son. Grand champion Jersey bull of the World's Fair, St. Louis, 1904. Grandson of the celebrated Brown Bessie. Courtesy of the owner, H. C. Taylor, Orfordville, Wisconsin.

Adopting 300 pounds of butter fat as a standard which the dairyman may reasonably expect his cows to attain, let us see what such a cow is worth to him. It is well known that the amount of butter made from a given quantity of butter fat exceeds the weight of fat by about one-sixth. This is because of the water, curd and salt, which are normal constituents of butter, and which, added to the fat, increase its weight. Three hundred pounds of fat, then, will make one-sixth more butter, or 350 pounds of butter. During the past seven years good creamery butter has averaged about 24 cents per pound the year round. The cow that has returned to the farmer 350 pounds of good butter has brought him $84, a pretty neat sum. And here, too many let the calculation stop. Herein lies the error. Though she has returned him this amount, he must not forget that she has cost him something in feed and care. During the period from 1900 to 1908 this cost has not been far from $40 per year in the north central states. Deducting this from the amount received for the butter leaves a nice little profit of $44. Neither must it be forgotten that in addition to this there is the skim milk which has been fed to the pigs and calves, from which additional profit has been secured. Nor should we forget that she has probably eaten hay and grain raised on the farm, and the fertility in the manure has found its way back to the soil.

Shadybrook Gerben. Leading Holstein-Friesian cow at the Louisiana Purchase Exposition, St. Louis, 1904. In 120 days she produced 8,101.7 pounds of milk testing 3.48 per cent, or 282.6 pounds butter fat. Notice the wedge shaped form and the unusually large udder of this remarkable cow. Weight 1,319 pounds. Courtesy owner, M. E. Moore, Cameron, Missouri.

Let us suppose another case. Instead of producing fat for 350 pounds of butter let us see what would have been the result had she produced sufficient fat for 200 pounds of butter only. This butter at the same rate would have brought $48, and the farmer's profit would have been but $8, or less than one-fifth as much as that of the first cow. In other words, the first cow is worth more to the dairyman than five of the second.

Looking at it from still another point of view. Suppose another cow can produce but 150 pounds of butter annually, what is she worth? Let us see. At 24 cents per pound this amount of butter is worth $36, or $4 less than it costs to keep the cow that produced it.

Where dairying has been tried and abandoned as unprofitable, in nine cases out of ten it has been because the farmer kept just this kind of cows. How necessary then that he know just what each member of his herd is worth to him. He can know this if he is willing to spend the time and effort necessary to weigh and test the milk of each cow in his herd.

The test is made in the following manner: A bottle holding about a pint is labeled, showing the name and number of the cow, and into this bottle is placed a piece of bichromate of potassium the size of a pea. This chemical is a cheap preservative which can be purchased at any drug store and keeps the sample from souring.

Before the milk is sampled it is thoroughly mixed as under directions for sampling already given in the chapter on the Babcock Test, and a tablespoonful of this milk is placed in the bottle. This sampling is repeated at each successive milking and the sample for testing is taken from this composite sample. In this way a single test will answer for each cow. If the cream in the sample gets thick or churns, it may be easily mixed up again with the milk if the sample bottle is first placed in warm water. In making a composite test, the same care should be exercised in mixing the sample, as is necessary in all testing with the Babcock test.

By taking composite samples of the milk from each cow in the herd, testing them weekly and keeping an accurate record of these tests and of the weight of milk given by each cow every day of her milking period, the dairyman may ascertain for himself exactly what each cow is worth to him. This is the best and *only reliable* method, and the one followed at most well regulated dairies. Of course, it takes time, but it pays in the long run.

Fairly accurate results may be obtained, however, by weighing and testing one day in each week during the whole period of lactation, multiplying the weight by 7 to get the amount given by each cow. Another practical method is to take weights and composite samples for six consecutive days each month during the whole period of lactation, and multiplying these weights by 5 to get the weight of milk given by each cow during each particular month of her milking period.

Too many farmers make a single weight and test of the milk of their several cows and then let the matter drop. This is a serious mistake, as it teaches next to nothing, and the only way that the dairyman may know exactly what each of his cows is worth to him is by testing frequently, weighing every day in the year and multiplying the total weight by the average test to get the weight of butter fat. There are shorter methods requiring less time, but they are all open to one objection—*inaccuracy*—and are not recommended.

Dolly Bloom. Noted Guernsey cow. Has remarkable record of 17,297.5 pounds milk in one year, testing 4.87 per cent, yielding 836.2 pounds butter fat. Notice the characteristic Guernsey markings and the well formed udder. Courtesy owner, Langwater Farms, North Easton, Massachusetts.

The simplest and easiest of these methods is to weigh and test the milk of each cow for six days during the fifth month of her milking period. It has been shown by experiment that the fat production for the fifth month represents to a considerable degree the average production for the ten months that a cow is in milk. If this be true then this weight multiplied by five will give the average weight produced monthly, and this monthly average multiplied by ten will give the total amount of milk produced in ten months, the number of months every good dairy cow should give milk during the year. This total amount of milk multiplied by the test will give the yield of fat, to which one-sixth is added to find the butter yield. This method is rapid and fairly accurate. One example to illustrate: Suppose a cow is found to give 100 pounds of milk in six days. Then $100 \times 5 \times 10 = 5000$ pounds of milk annually. The test is 4.2 per cent. Then 5000×4.2 per cent=210 lbs. butter fat; 1-6 of 210 is 35; then $210 + 35 = 245$, or this cow produces approximately 245 pounds of butter annually.

Brown Bessie. Typical Jersey cow. Champion butter cow of the ninety-day test at the Columbian Exposition, Chicago, 1893. During the ninety days she produced 3,634 pounds of milk, yielding 178.12 pounds butter fat. Note the well formed and capacious udder. Courtesy of the owner, H. C. Taylor, Orfordville, Wisconsin.

Every good dairyman should know about what each cow in his herd is producing and send to the slaughter house all cows that are not yielding him a profit. The only way for him to learn this is by weighing and testing the milk from each cow in some such manner as has been outlined herein, preferably for every day of the time that the cow is in milk during the year. It should also be added that he should take into account the amount of feed consumed by each cow. It is not always the largest fat producers that are the most profitable cows, but the ones that produce the largest amount of fat at the least cost.

The following from Hoard's Dairyman gives the actual herd record as kept by an Oregon dairyman:

"Hoard's Dairyman:—I enclose the report of our dairy herd of 20 cows for the year from Jan. 1st, 1907, to Dec. 31. Our herd consists of mixed stock with some Jersey blood in most of them. We bought a full blood Jersey bull last summer and are going to breed up our herd.

"I credit each cow every month with what the price was at that time and that causes the price received for the fat to differ with the different cows. The butter was made at home and shipped to Portland, the milk is weighed mornings and evenings."

No. of Cow.	Lbs. Milk.	Ave Test.	Lbs. Butter-Fat.	Ave. Price.	Amount.
14	6,907	4.91	339.42	.323	$109.70
13	7,905	4.08	322.55	.337	109.00
9	7,158	4.41	315.70	.332	104.82
10	6,575	4.61	303.55	.33	100.32
4	6,132	4.77	292.88	.305	89.55
6	7,915	3.56	282.15	.334	94.46
15	6,642	4.14	275.23	.337	93.10
7	6,455	3.9	252.35	.343	86.65
1	6,267	3.05	251.50	.319	80.41
2	5,994	4.14	248.65	.327	81.37
16	5,123	4.62	237.17	.341	81.00
11	5,210	4.44	231.80	.327	76.02
20	5,230	4.38	229.55	.323	75.20
18	4,608	4.67	215.35	.326	70.43
17	5,547	3.86	214.15	.332	71.16
19	4,588	4.55	209.16	.323	67.64
3	5,787	3.6	208.66	.312	65.26
12	3,943	4.43	174.90	.297	52.00
Total ..	107,986		4,604.72		$1,448.09
Ave. ...	6,000	4.26	255.81	.314	80.45
Average cost of feed........................					$36.65
Net profit					$43.80
5	3,923	3.6	141.35	.328	46.50
8	2,060	5.0	103.15	.357	36.84

"Numbers 5 and 8 are heifers milked six and four and one-third months respectively.

"Dallas, Ore."

* * *

Record of the world's champion cow, Colantha 4th's Johanna, from Hoard's Dairyman:

Month	Milk, lbs.	Test per cent.	Fat lbs.
Dec., 1906, 9 days	627.8	4.35	27.31
January, 1907	2,657.5	3.92	104.28
February	2,677.5	3.83	102.55
March	3,701.3	3.67	99.14
April	2,508.7	3.56	89.31
May	2,643.2	3.56	94.10
June	2,353.7	3.45	81.20
July	2,235.2	3.37	75.33
August	1,788.6	3.95	70.65
September	1,756.1	3.69	64.80
October	2,031.8	3.30	67.05
November	1,994.8	3.61	72.00
December—22 days	1,456.5	3.47	50.54
Total	27,432.7	3.64	998.26

"She has the following yearly record made when she was four years old: Milk, 19,309.3 lbs.; fat, 693.54 lbs.

Following are the seven day records made at five, eight, ten and eleven months after calving and for periods of one week, under the supervision of the Wisconsin College of Agriculture:

Time After Calving	Milk, lbs.	Fat per cent.	Fat lbs.
Five months	613.0	3.56	21.80
Eight months	378.8	3.95	14.96
Ten months	468.7	3.40	15.95
Eleven months	478.6	3.61	17.28

"The seven day record made eleven months after calving is the largest ever made by a cow so far along in the period of lactation. In fact, it beats all weekly records made eight months after calving.

"So far as we know this cow has made a clean sweep of all records from the one day to the yearly."

CHAPTER VIII.

CREAM SEPARATION.

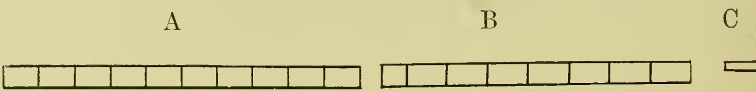
There are three methods of cream separation in common use, viz., gravity, dilution and centrifugal. Of these three, gravity is the oldest and until very recent years the most widely used method. It consists simply in setting the milk in cans or pans and allowing the fat to rise to the top, it being forced up by gravity because it is so much lighter than the milk serum. In the dilution process cold water is poured directly into the milk on the theory that it will make the milk thinner and allow the fat globules to rise to the top more easily. In the centrifugal process the fat is separated from the milk by centrifugal force, that force which causes the mud to fly from a rapidly revolving wagon wheel or the water from a grindstone. In this process the milk is run into a rapidly revolving bowl, the heavier parts crowd to the outside and the fat or cream is forced toward the center and each is crowded out through little holes into spouts provided for the purpose of carrying them into their respective vessels. Of these three methods centrifugal separation is the most efficient.

One of the reasons why dairying, before the invention of the Babcock test and the centrifugal separator, was unprofitable is because of the large losses of butter fat in the skim milk separated by the gravity process. No matter how careful the dairyman may be to secure a low temperature, the one most favorable to good separation by the gravity process, the skim milk losses are seldom less than one per cent and often much more than that. Skim milk from Jersey cows separated by the gravity process has been tested and repeatedly found to contain three per cent of butter fat. Extensive experiments conducted by the Cornell Station show an average of over one per cent of fat in the skim milk when the whole milk was set in water at a temperature of 60 degrees F. Since this one per cent represents from one-fourth to one-third of all the fat in average milk, this needless waste may easily change a profit into a loss. To illustrate: Suppose a cow produces 200 pounds of butter fat in a year. This is worth at 25c per pound, the sum of $50. If it costs $40 to feed this cow for a year, the farmer's net profit on her, if all the fat is saved, is just $10. Now, suppose one-fourth of it be lost in creaming it by the gravity procress, the remainder is worth just $37.50, or $2.50 less than the cost of keeping the cow. In the old-fashioned method of dairying this was too often the case. This loss the centrifugal separator has saved and the Babcock test has revealed the facts in the case. Little wonder it is that dairying is growing so rapidly into popular favor.

Dilution methods of separation are likewise to be condemned as extravagant and wasteful.

A few years ago dilution methods and appliances were on the "boom," but fortunately this "boom" was of short duration. Cornell and many of the other experiment stations investigated the dilution methods and compared them with the old fashioned gravity methods. The average fat content of the skim milk by the dilution process was found to be three-fourths of one per cent when set at 60 degrees F. This is about one-fifth of the entire fat content of the whole milk. At the Kansas station still greater losses were found to exist, the average being one per cent or equal to that separated by the gravity process. Even the much advertised Cooley system showed an average of one per cent in the Cornell experiments.

Drawing showing relative fat losses in skim milk when separated by (A) gravity, (B) dilution, and (C) centrifugal processes.



Against these wasteful methods we should place the skim milk tests of the centrifugal separator. Many have repeatedly tested the skim milk of these machines, both hand and power, and have rarely found it to contain .10 of one per cent, often so low as .02 of one per cent when tested by the Babcock test. In the Cornell experiments just referred to the average loss was from one- to two-tenths per cent, varying with the different conditions and the different styles of machines used. A good separator when not crowded and run at the proper speed with milk at the right temperature should not show to exceed one-tenth of one per cent of fat in the skim milk by the Babcock test. This is the chief reason for the rapid rise of the dairy industry since 1879, the year in which the centrifugal separator was invented.

CHAPTER IX.

THE FARM SEPARATOR.

If the farmer is so remote from a factory that he finds it impossible to haul his milk there, he may make use of the farm separator to advantage. In the western states many farmers own and operate separators, hence a word about the principles upon which their operation is based and some general directions for their care and use may not be out of place here.

As was stated in the preceding chapter, their operation depends on centrifugal force. The old fashioned "sling-shot" serves to illustrate this principle. In this plaything a stone is placed in a little hole cut in a piece of leather to which are attached two strings. The "shot" is then whirled rapidly around the head and one of the strings suddenly loosened when the stone flies off in a straight line. The boy who is able to whirl his sling-shot with the greatest speed succeeds in throwing his stone the farthest, that is he gives to it the greatest force. Now, in the cream separator the builders have figured out just how rapidly the bowls must rotate in order to throw the skim milk all to the outside and force the fat globules to the center. The separator must, therefore, be kept up to this calculated speed if the separation is to be complete. This speed is usually plainly marked on the machine and the operator should see to it that the indicated speed is maintained.

There are two types of machines on the market, the disc and the hollow bowl. In the disc machine the milk is separated in thin layers and for this reason a slower speed may be maintained. In the bowl machine there are fewer parts and therefore the machine is easier to clean, but it necessitates a much higher speed to separate the larger volume of milk. This increased speed means more power and in some cases it may mean danger from the bursting of the rapidly revolving bowl. However, the bowl type of machine is being greatly improved and a style may yet be produced that is not open to any of the above objections.

Another condition which affects the completeness of the separation is temperature. The best machines will not do close work on cold milk. The most favorable temperature for the farmer to use is from 90 degrees F. to 100 degrees F., or the temperature of milk when it is first drawn from the cow. In no case should the milk be allowed to cool or the cream to rise before separation. If the milk is cold the fat losses are large and the machine is easily clogged. If the cream has risen it may be churned in the machine and the small granules of butter will be lost. It is a good practice to run a quart of warm water through the machine to warm it up before the milk is put into it.

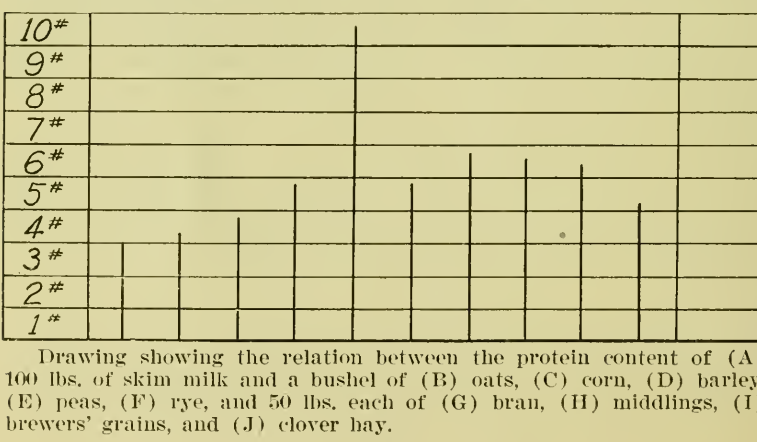
To secure the best results and the cleanest and most nearly perfect cream, it is best to wash the separator each time after it is used. The slime should be removed, and the parts thoroughly scalded to destroy the germs which are certain to be present. These germs are found in large quantities in the bowl and if not destroyed by heat may cause serious damage to the cream. The separator should be washed twice daily and it should be thoroughly scalded and dried in the sun. Heat and sunlight are death to germ life.

All bearings should be kept thoroughly oiled with the best separator oil. It is poor economy indeed to spoil a good machine by using poor oil. Some separators that are still doing good work have been known to be in constant use for fifteen years. This is because the machines have been well cared for.

CHAPTER X.

VALUE OF SKIM MILK.

When the milk is separated from the cream either at the farm or at the factory, the farmer has, as a by-product of dairying, a quantity of skim milk which is one of the very best of feeds for calves, pigs and even chickens, ducks and geese. In some localities there is a strong prejudice against the introduction of the centrifugal separator on the ground that the skim milk is spoiled for feed. This prejudice is wholly unfounded and clearly disproven by the experience of both dairymen and investigators. In the first place none of the food substances are removed from the milk but the fat, and this fat can easily be supplied by a much cheaper substitute. Butter fat is worth, say 30 cents per pound. Two or three cents' worth of oil meal will furnish as much food matter as a pound of butter fat. Then all that the dairyman has to do is to add a few pounds of oil meal to each one hundred pounds of skim milk and its feeding value is just as great as new or whole milk. When the milk is separated on the farm this skim milk may be fed warm and sweet soon after it is drawn from the cow and if oil meal, bran, middlings, gluten feed, or some other cheap feed rich in oil and protein is added to it in proper proportions, it is fully the equal of whole milk as a feeding stuff. Experiments with hand fed calves carried on at the Kansas Experiment Station have conclusively demonstrated this fact. Good "baby beef" was made with separator skim milk as a foundation feed, and the calves so fed made greater gains at a less cost than those fed on whole milk. The same results were obtained at the Iowa station.



Drawing showing the relation between the protein content of (A) 100 lbs. of skim milk and a bushel of (B) oats, (C) corn, (D) barley, (E) peas, (F) rye, and 50 lbs. each of (G) bran, (H) middlings, (I) brewers' grains, and (J) clover hay.

The Nebraska and Missouri station records show similar results, and, if further confirmation is needed, one has only to glance at the composition of milk to know that there are over nine pounds of the very best food solids, all easily digestible, left in every hundred pounds of milk after the fat has been removed. Now, to restore the feeding value it is only necessary to substitute for the fat an equal amount of digestible nutrients. This, five or six pounds of any of the protein foods mentioned above, will do.

Skim milk is especially valuable in hog raising, and it should form the basis of food for these animals on every dairy farm. Some farmers believe that the best and cheapest pork is made from corn alone with nothing but water to drink. Here again experimenters have proven that this is not the case. On the contrary, pork produced from this diet is much more expensive than that produced from any kind of mixed feeds. But the largest profit in hog raising comes from young pork six or seven months old. The first one hundred pounds of pork is always the cheapest to produce, the second hundred pounds is a little more costly, and so on until after the hog is a year old and has been well fed up to this time, the feed necessary to produce a pound of pork is actually worth more than the pork produced. The farmer, then, makes the most money on pig-pork, and pig-pork cannot be produced to advantage without milk. Skim milk mixed with ground corn, ground oats, bran, oil meal, middlings, or gluten feed, and supplemented during the fattening period with a liberal allowance of corn, makes the very best and cheapest pork.

CHAPTER XI.

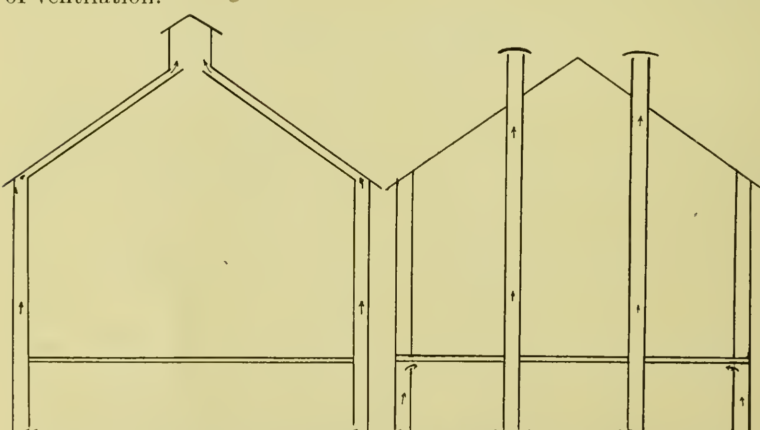
THE BARN.

There are two buildings that the dairy farmer cannot well get along without. A good, clean, well ventilated barn in which to house his herd, and one or more silos in which to store a supply of palatable green food for the winter months.

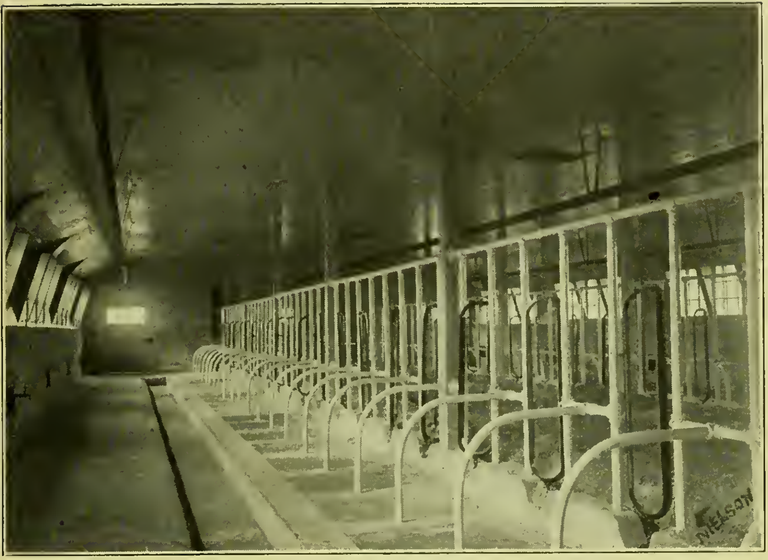
But little need be said about the construction of the barn. The careful farmer will adapt the barn to the size of the farm, the number of cows kept thereon, the kind of grain and roughage stored for food, and other local conditions. He will undoubtedly be able to draw his own plans, or to secure someone to design a barn for him that will suit his own special needs better than any plan which the writer can suggest. But there is one feature of barn construction so greatly neglected that it deserves to be mentioned in every treatise on dairy farming. This important feature is *ventilation.*

In our efforts to provide warm and comfortable quarters for our stock we have overlooked, in many cases, the most important matter of all—proper ventilation. As we enter some stables on a winter's morning, after the barn has been closed all night, we are almost stifled by the odors and impurities which fill the air. These must necessarily be very harmful to the animals that are forced to breathe them over and over again. In such stables no provision is made for admitting fresh air or for withdrawing that which has become charged with impurities and robbed of its life-giving oxygen. Oxygen is the one air element absolutely necessary to all animal life. We ourselves know only too well the debilitating effect of breathing bad air. The respiratory organs of animals are very similar to our own and they too must suffer from the bad effects of breathing impure air. Without doubt the alarming prevalence of tuberculosis among dairy cattle is largely due to this cause. Hence this neglected feature of barn construction is deemed worthy of detailed mention in this book.

On the farm of Ex-Governor W. D. Hoard of Wisconsin, editor of Hoard's Dairyman, and one of the best authorities on dairying in the world, may be seen a barn perfect in its ventilation. In this barn the air is as pure and fresh and as free from bad odors as it is in the most sanitary home. The method of ventilation in use in this barn is known as the King system, and it is so perfect in its operation, so inexpensive, and so easy to install that no up-to-date dairy barn should be built without this or a similar system of ventilation.



Drawing showing two methods of drawing off the bad air from the dairy barn. In the figure at the right the best method of admitting fresh air is shown.



Interior view of a modern, sanitary dairy barn where certified milk is produced. Notice the cement floors and the boards placed on the cement for the cows to lie on.

A method for tying cows; used frequently in up-to-date barns.

In this system air is taken in on the outside of the barn near the ground, passes up through an air space in the walls made in the form of a wooden box, and is admitted into the barn near the ceiling. This method of admitting the air prevents draughts and forces the bad air to the floor where it is drawn out through ventilating flues that extend from one foot of the floor to above the roof of the barn. It is important that these flues reach nearly to the floor, otherwise the *warm* air of the barn which is to be found near the ceiling, and not the bad air, which is to be found near the floor, will be drawn off. These ventilating flues may be made from wood or from galvanized iron, tin or sheet iron pipe. A single flue 2x2 feet, inside measure, is said to be sufficient for twenty cows. The intake flues should be of the same capacity. If two or more smaller flues are used, which in the judgment of the writer is to be preferred, their combined capacity should be the same as that of the larger flue. If more than twenty cows are to be stabled the size of the ventilating flues should be increased proportionately.

This system was designed by Professor King of Madison, Wisconsin, hence its name, and has found widespread adoption.

Fresh air is necessary to the health of the stock. So, too, is light. It is well known that sunlight will destroy germ life. The dairyman while providing proper ventilation should also provide for admitting an abundance of sunlight into his barn. Fresh air and plenty of sunlight are the surest means of preventing germ diseases in the dairy herd.

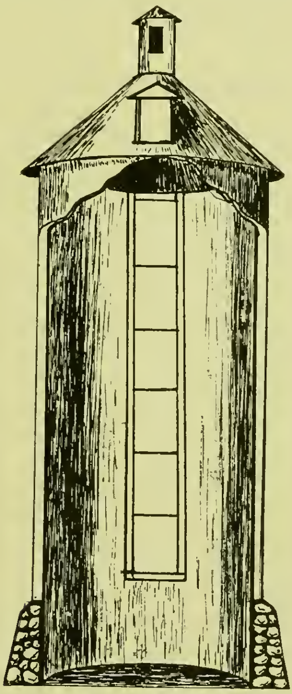
CHAPTER XII.

THE SILO.

The silo is the one farm building that needs the most careful construction. The importance of silage as a feeding stuff is growing more apparent as dairying advances. Nature has provided in summer proper food for most farm animals, and the nearer summer conditions can be maintained throughout the year the greater will be the farmer's success. Hence the importance of silage as a feeding stuff. It is a green feed preserved in its natural condition, or nearly so, for winter feeding. As soon as the pasture gets short in the fall the silo may be opened and feeding of ensilage begun. In this way there need be little if any diminution in the flow of milk.

But the silage will not keep well in a poorly constructed silo. Whatever the type of silo the farmer chooses to build, four things must be observed: It must be strong, as nearly *air tight* as possible, *perfectly smooth on the inside,* and placed on a *strong, solid foundation.*

The silo must be almost air tight because the air contains germs that will set to work upon the silage and cause it to spoil and decay if the air is not excluded. Silage is something like canned fruit in this respect. The silo must be strong because the green feed with which it is filled is very heavy and packs down very solidly. This exerts a tremendous pressure which will spring or burst the walls of a poorly constructed silo and admit the air, causing the silage to spoil. It should be perfectly smooth on the inside because the silage should settle evenly. Projections or rough places on the inner walls of a silo will prevent the even settling and cause dead air spaces which will spoil the silage. It must rest on a strong, solid foundation because the side pressure and weight at the bottom are very great. This pressure may be so great as to burst a heavy stone wall, and the great weight will cause a silo placed on a poor foundation to settle out of shape and crack the walls.



Drawing showing general plan for the construction of a double wall silo with dead air space between, stone foundation, cement floor, ventilator on top and feeding and filling doors on opposite sides.

If this building is so constructed as to provide for sufficient ventilation and to prevent freezing, and proper care is used in filling the silo, the silage will be found to be one of the most satisfactory feeds for dairy cows, especially when winter dairying is pursued.

There are four types of silos in common use, wood, brick, stone and cement, but they are all built on the same general plan. A hole four or five feet deep is dug in the ground. The bottom of this hole is covered with a layer of concrete and cement and the sides walled up for a foot or two above the top with a heavy stone wall, at least two feet thick. On top of this wall the silo is built in two thicknesses of whatever material is used, with a dead air space between. The filling doors open to the outside, and the feeding doors open into the barn. A ventilator is placed on top, and the walls are strengthened with hoops, rods or iron bands. In warmer climates where there is slight danger from frost, another type known as the stave silo is used. This is very much like a large barrel, and the cost of building such a silo is considerably less than the double wall type.

CHAPTER XIII.

FEED FOR THE COW.

The cow may be compared to a machine. When we stop to consider that the real purpose of the cow from the dairyman's standpoint is to produce milk, in the same way that the purpose of a machine is to produce some given article, we are justified in making the comparison. We give the cow a certain quantity of food and from this we expect her to maintain herself and at the same time convert a good share of the food into milk. Good dairymen realize that the profit comes from the excess of food that she consumes over and above that required for her bodily maintenance.

Investigators have found that the daily maintenance ration of a cow weighing about one thousand pounds is: .7 lbs. digestible protein, 8.0 lbs. digestible carbohydrates, and 0.1 lb. ether extract.

Granting that the above is true we can easily see that a dairyman, in order to get profit from his herd must give each cow more than the above maintenance ration before he can expect her to return a profit to him. It would be a foolish engineer that would only turn on steam sufficient to keep his engine moving, when it is at his disposal to give it all the steam necessary to work it to its full capacity. The engineer, therefore, takes into consideration the size of the engine, the particular type of engine, and the work to be performed. So, too, must the dairyman take into consideration the size of the cow, her individuality and also the particular type of cow. A three-year-old heifer cannot be expected to be as productive as a cow several years older. A good type of cow will do better work than a poor type, in the same way that a Corliss engine will produce more power from a given amount of steam than a common slide valve engine. Inasmuch as the individual requirements of the animal must be given some weight by a good dairyman it can readily be seen that herd feeding is not advisable or profitable. It would be foolish for a dairyman, if he expects to get the best results from his cows, to feed all the cows in the herd the same way, regardless of whether they are giving 15, 20 or 30 lbs. of milk per day. This may be best emphasized by calling attention to the standard rations used in this connection all over the world. These are suggested by the eminent German authorities, Wolff-Lehman, as the result of their investigations.

WOLFF-LEHMANN MODIFIED STANDARDS.

	Dry Matter Lbs.	Protein Lbs.	Digestible Nutrients Carbohy-drates Lbs.	Ether Extract Lbs.	Nutritive Ratio
1. When giving 11 lbs. of milk daily..	25.0	1.6	10.0	.3	1:6.7
2. When giving 16½ lbs of milk daily..	27.0	2.0	11.0	.4	1:6.0
3. When giving 22 lbs. of milk daily..	29.0	2.5	13.0	.5	1:5.7
4. When giving 27½ lbs. of milk daily.	32.0	3.3	13.0	.8	1:4.5
Standard maintenance ration........	18.0	.7	8.0	.1	1:11.8

In looking over this table the reader will at once notice that the cow receives more feed when she is giving a larger quantity of milk, especially is the proportional increase greater in protein than in carbohydrates. The reason for this is very evident; protein is a very essential part of all foods. It is, in fact, that part which determines its value as a food: it is the nitrogenous part or that which is necessary for the formation of muscles of the body, casein in milk, etc. It is also argued by some that it is one of the sources of fat in milk. Such feeds as clover, alfalfa, bran, and gluten contain a great deal of protein, and for this reason they are very desirable feeds. Carbohydrates are found in more or less abundance in all feed and are easier to obtain than protein. Their chief property is the maintaining of the heat of the body. Starches and sugars are good examples of this class of feeds.

Ether extract, so called because this element is extracted by ether when an examination of food is made under chemical analysis, is, in homely language, the fat of the feed. The principal property of this part of the food is similar to that of carbohydrates, that is to maintain temperature. However, a pound of ether extract has within it the elements of more heat than a pound of carbohydrates. It is customary to say that one pound of ether extract has from 2.2 to 2.5 times the heat energy of a pound of carbohydrates.

In compounding a ration it is customary to estimate the amount of dry matter in the feed, that is, the amount that the feed would weigh if all the water it contained was driven off by heat. Similarly it is necessary to estimate the amounts of protein, carbohydrates and ether extract. There are several things, however, that must be taken into consideration. A good share of the protein is not digestible and therefore the animal may be charged with receiving protein which she cannot use. We are indebted to Prof. W. A. Henry for the use of the following tables, taken from his work, "Feeds and Feeding":

TABLE I.

Water and total nutrients per 100 pounds feed.

Feeding Stuffs Roughage	Water Lbs.	Protein Lbs.	Crude Fiber Lbs.	Nitrogen Free Extract	Ether Extract Lbs.
Corn stover, field cured....	40.5	3.8	19.7	31.5	1.1
Red clover hay............	15.3	12.3	24.8	38.1	3.3
Timothy hay...............	13.2	5.9	29.0	45.0	2.5
Oat straw	9.2	4.0	37.0	42.4	2.3
Concentrates.					
Corn, dent	10.6	10.3	2.2	70.4	5.0
Oats	11.0	11.8	9.5	59.7	5.0
Wheat bran	11.9	15.4	9.0	53.9	4.0
Linseed meal, O. P.........	9.2	32.9	8.9	35.4	7.8

TABLE II.

Percentage Digestibility of Nutrients.

Feeding Stuffs Roughage	Dry Matter	Protein	Crude Fiber	Nitrogen Free Extr.	Ether Extr
Corn stover in all varieties........	60	45	67	61	62
Red clover hay....................	55	55	46	64	53
Timothy hay	57	48	52	63	57
Oat straw	48	30	54	44	33
Concentrates.					
Corn	91	76	58	93	86
Oats	70	78	20	76	83
Wheat bran	61	79	22	69	68
Linseed meal, O. P................	79	89	57	78	89

TABLE III.

Feeding Stuffs Roughage	Total Dry Matter	Total digestible substances in 100 Pounds: Protein	Carbohydrates	Ether Extract	Nutritive Ratio
Corn stover	59.5	1.7	32.4	0.7	1:20.0
Red clover hay	84.7	6.8	35.8	1.7	1: 5.8
Timothy hay	86.8	2.8	43.4	1.4	1:16.7
Oat straw	90.8	1.2	38.6	0.8	1:33.7
Concentrates.					
Corn or corn meal........	89.4	7.8	66.7	4.3	1: 9.8
Oats	89.0	9.2	47.3	4.2	1: 6.2
Wheat bran	88.1	12.2	39.2	2.7	1: 3.7
Oil meal, O. P...........	90.8	29.3	32.7	7.0	1: 1.7

In the above, attention may be called to the total protein content of wheat bran, which is 15.4 pounds per 100 pounds of the feed. In the second table it will be learned that 79 per cent of the 15.4 pounds is digestible, leaving in all, as will be noticed in the last table, only 12.2 pounds, the total protein available for the animal.

Notice, also, oat straw. It contains, as is shown in the first table, 4.0 per cent of protein, only 30 per cent, as shown in the second table, is digestible, or, in other words, 100 pounds of oat straw contains only 1.2 pounds of digestible protein. The value of knowing the amount of digestible nutrients the feed contains cannot be overestimated.

It may be cited that certain feeds, such as oat straw, are so deficient in nourishment that it would be necessary for a cow to eat two or three hundred pounds of the same in order to furnish her body with sufficient nourishment so that it would be able to secrete twenty to twenty-four pounds of milk a day. This, of course, is an impossibility, but is mentioned to show that a cow cannot be turned out to a straw stack with the expectation that her flow of milk will increase.

On the other hand it is well known that a pasture is about as good a ration as we ordinarily find, and for this reason cows usually give a large flow of milk during June and July because all the elements necessary to maintain the body and manufacture the milk are found in succulent pasture grass.

When we speak of a balanced ration we mean a ration where the protein, carbohydrates and ether extracts are in about the right proportion. The eminent German authorities, Wolff and Lehmann, adopted a standard whereby every cow yielding twenty-two pounds of milk daily should receive a ration containing 29 pounds of dry matter, of which 2.5 pounds should be digestible protein, 13 pounds digestible carbohydrates, and .5 pound digestible ether extract. The nutritive ratio which they adopted was 1:5.7.

The matter of computing the nutritive ratio is not so difficult as one might believe, and may be briefly explained as follows: Multiply the digestible ether extract by 2.4 (inasmuch as it is presumed that each pound of ether extract furnishes 2.4 times the heat units that are found in one pound of carbohydrates), add to this the digestible carbohydrates, and divide the sum by the digestible protein in the food. In the above multiplying .5 by 2.4 we get 1.2; adding 1.2 to 13.0 we get the sum 14.2; dividing this by 2.5 we get 5.7. The ratio of the protein, therefore, to the other constituents is 1:5.7, or 1 part of protein to every 5.7 parts of carbohydrates or their equivalent.

To better illustrate how to formulate a ration and to show that it is not so difficult but that it can be learned by any dairyman of ordinary intelligence, we will assume that the farmer is located somewhere in the central part of the United States, and has the following feeds at his disposal, timothy, clover, corn, oats and bran, from which to calculate a ration for his cows. The following is a table of the digestible nutrients in the feeds named:

TABLE IV.

Feed	Dry Matter in 100 Lbs.	Digestible Nutrients in 100 Lbs. Protein	Carbohydrates	Ether Extract
Timothy	86.8	2.8	43.4	1.4
Alsike clover	90.3	8.4	42.5	1.5
Corn	89.1	7.9	66.7	4.3
Oats	89.0	9.2	47.3	4.2
Bran	88.1	12.2	39.2	2.7

The first thing a dairyman must do is to compute a trial ration. Suppose he wants to feed a milch cow 10 pounds of timothy, 10 pounds of clover, 8 pounds of corn and 2 pounds of oats. He will then calculate the ration as follows:

TABLE V.

Timothy Hay

86.8÷100×10=8.68 Dry Matter.
2.8÷100×10= .28 Protein.
43.4÷100×10=4.34 Carbohydrates.
1.4÷100×10= .14 Ether Extract.

Alsike Clover

90.3÷100×10=9.03 Dry Matter.
8.4÷100×10= .84 Protein.
42.5÷100×10=4.25 Carbohydrates.
1.5÷100×10= .15 Ether Extract.

Corn

89.1÷100×8=7.128 Dry Matter.
7.7÷100×8= .632 Protein.
66.7÷100×8=5.336 Carbohydrates.
4.3÷100×8= .34 Ether Extract.

Oats

89.0÷100×2=1.78 Dry Matter.
9.2÷100×2= .184 Protein.
47.3÷100×2= .946 Carbohydrates.
4.2÷100×2= .084

Summarizing the foregoing he obtains the following:

TABLE VI.

Feed	Dry Matter	Digestible Nutriments Protein	Carbohydrates	Ether Extract
Timothy hay, 10 lbs.	8.68	.28	4.34	.14
Alsike clover hay, 10 lbs.	9.03	.84	4.25	.15
Corn, 8 lbs.	7.128	.632	5.336	.34
Oats, 2 lbs.	1.78	.184	.946	.084
Trial ration	26.618	1.936	14.872	.714
Wolff-Lehman standard	29.0	2.5	13.0	.50

In comparing the trial ration with that of the standard of Wolff and Lehmann ration for a cow producing 22 pounds of milk, he will find quite a deficiency in protein, and in order to correct this he can reduce the corn ration to 4 pounds and give the animal 4 pounds additional bran. The ration will then read as follows:

TABLE VII.

Feed	Dry Matter	Protein	Carbohydrates	Ether Extract
Timothy hay, 10 lbs.	8.68	.28	4.34	.14
Alsike clover hay, 10 lbs.	9.03	.84	4.25	.15
Corn, 4 lbs.	3.564	.316	2.668	.17
Oats, 2 lbs.	1.78	.184	.946	.084
Bran, 4 lbs.	3.524	.488	1.568	.108
Trial ration	26.578	2.108	13.772	.652
Wolff-Lehman standard	29.0	2.5	13.	.50

In the revised trial ration the protein is a little low and the nutritive ratio is only 1:7.2, rather than 1:5.7. We must take into consideration that the standard given is the standard set by German investigators and that many American authorities claim that 1:5.7 is entirely too narrow a ration to suit American conditions. Some of the American authorities believe that instead of 2.5 pounds of protein a cow giving 22 pounds of milk daily should receive about 2.1 pounds of protein.

The dairyman therefore can easily compute the amount of feed that each cow should receive per day; and can also compute the cost of this feed. By formulating several rations he can easily calculate the rations that will cost him the least and in this way he is able to save a great deal of money.

There is no subject connected with dairying which the interested farmer can study with more profit to himself than that of feeding the dairy cow. It is impossible in so brief a work as this to more than mention what can be done, but we suggest that the book published by Professor W. A. Henry of the Wisconsin Experiment Station at Madison, should be in the possession of those in any way connected with the feeding of dairy cows. There is no other book available on the subject that is so practical and at the same time so complete.

Herewith we append a list of the common feeds found in America, which may be used for reference. The table shows the dry matter and the digestible nutrients per 100 lbs. feeding stuff. The data for the same is taken from "Feeds and Feeding:"

TABLE VIII.

Concentrates	Dry Matter Lbs.	Protein Lbs.	Carbohydrates Lbs.	Ether Extract Lbs.
Corn, all analyses	89.1	7.9	66.7	4.3
Gluten meal	91.8	25.8	43.3	11.0
Wheat	89.5	10.2	69.2	1.7
Wheat bran	88.1	12.2	39.2	2.7
Wheat shorts	88.2	12.2	50.0	3.6
Rye	88.4	9.9	67.6	1.1
Rye bran	88.4	11.5	50.3	2.0
Rye shorts	90.7	11.9	45.1	1.6
Barley	89.1	8.7	65.6	1.6
Malt sprouts	89.8	18.6	37.1	1.7
Brewer's grains, dried	91.8	15.7	36.3	5.1
Oats	89.0	9.2	47.3	4.2
Sorghum seed	87.2	7.0	52.1	3.1
Kaffir corn	84.8	7.8	57.1	2.7
Millet	86.0	8.9	45.0	3.2
Flax seed	90.8	20.6	17.1	29.0
Linseed meal, old process	90.8	29.3	32.7	7.0
Linseed meal, new process	89.9	28.2	40.1	2.8
Cotton-seed meal	91.8	37.2	16.9	12.2
Peas	89.5	16.8	51.8	0.7
Soy bean	89.2	29.6	22.3	14.4
Cow peas	85.2	18.3	54.2	1.1
Roughage.				
Fodder corn, field cured	57.8	2.5	34.6	1.2
Corn stover, husked shock corn, field cured	59.5	1.7	32.4	0.7
Pasture grasses (mixed)	20.0	2.5	10.2	0.5
Hay.				
Timothy	86.8	2.8	43.4	1.4
Orchard grass	90.1	4.9	42.3	1.4
Redtop	91.1	4.8	46.9	1.0
Kentucky blue grass	78.8	4.8	37.3	2.0
Oat hay	91.1	4.3	46.4	1.5
Straw.				
Wheat	90.4	0.4	36.3	0.4
Oat	90.8	1.2	38.6	0.8
Legume hay and straw.				
Red clover, medium	84.7	6.8	35.8	1.7
Red clover, mammoth	78.8	5.7	32.0	1.9
Alsike clover	90.3	8.4	42.5	1.5
Crimson clover	90.4	10.5	34.9	1.2
Alfalfa	91.6	11.0	39.6	1.2
Cow peas	89.3	10.8	38.6	1.1
Pea vine straw	86.4	4.3	32.3	0.8
Silage.				
Corn	20.9	0.9	11.3	0.7
Clover	28.0	2.0	13.5	1.0
Alfalfa	27.5	3.0	8.5	1.9

Roots and tubers.				
Potato	21.1	0.9	16.3	0.1
Beet, common	13.0	1.2	8.8	0.1
Beets, sugar	13.5	1.1	10.2	0.1
Beet, mangel	9.1	1.1	5.4	0.1
Rutabaga	11.4	1.0	8.1	0.2
Miscellaneous.				
Cabbage	15.3	1.8	8.2	0.4
Beet pulp	10.2	0.6	7.3	.0
Cows' milk	12.8	3.6	4.9	3.7
Cows' milk, colostrum	25.4	17.6	2.7	3.6
Skim milk, gravity	9.6	3.1	4.7	0.8
Skim milk, centrifugal	9.4	3.9	5.2	0.3
Buttermilk	9.9	3.9	4.0	1.3
Whey	6.6	0.8	4.7	0.1

CHAPTER XIV.

RELATION OF DAIRYING TO THE SOIL.

Progressive farmers have learned that exclusive grain farming does not pay in the long run, and they have gone into dairying and prospered. Now, why is dairy farming so much better? Because the grain and hay raised on the farm are fed there and find their way back to the soil in the form of barnyard manure. Very little soil matter is sold from the farm in dairy farming. Professor W. H. Dexter says: "The maintenance of soil fertility constitutes one of the greatest opportunities for dairying. A ton of wheat worth $22 removes from the farm $7.50 worth of plant food. A ton of butter worth $500 removes less than fifty cents worth of plant food from the farm." A little calculation will show that the amount of fertilizer contained in the manure produced annually by a dairy cow is worth nearly twenty dollars, if it is carefully saved and returned again to the land.

Again, the wise dairy farmer raises much clover, alfalfa, cowpeas or soy beans for forage plants. These plants are legumes and have associated with them microscopic germs called bacteria which live in little nodules on the roots of these plants. To convince yourself of this fact, pull up any one of the above mentioned plants and examine its roots for these nodules. They are not always to be found, but usually can be. Now, what is the use of these germs? The soil contains but small quantities of nitrogen, a substance without which no plant can grow, no animal thrive, indeed, no life exist. This small quantity of nitrogen is combined in the soil with other elements in a form readily soluble in water, and in this dissolved condition finds its way into the plant through the roots. It is then built into the body of the plant. Animals get all their nitrogen from the plants on which they feed, and the plants get theirs from this small store of nitrogen in the soil. The air is four-fifths nitrogen, but, strangely enough, neither plants nor animals can make use of this abundant supply of "free" nitrogen, as it is called. But the little germs living in the nodules on the roots of clover and other legumes, can and do make use of this "free" nitrogen of the air. They take it and combine it with other substances and store it up in these nodules in much the same manner as the honey-bee stores up his supply of honey for the time of need. The clover plant then robs the nodules of their stored-up nitrogen and incorporates it into its own tissues. From the clover it is passed on to the dairy cow, finds its way into the milk pail, serves as food for pigs and calves and is ultimately returned again to the soil in the form of barnyard manure. Thus it will be seen that the use of clover, alfalfa and other legumes actually adds to the store of nitrogen in the soil and the dairy farmer, instead of exhausting the nitrogen in his soil finds it, under his intelligent management, continually improving.

It should be mentioned in this connection, however, that legumes do not add potash or phosphoric acid to the soil, but like every other plant, remove these substances. But since nitrogen is the substance soonest exhausted from almost every soil, and since the legumes raised on the farm are usually fed there, these plants may be said to maintain the fertility of the soil.

In determining upon the kind of dairying to be pursued, the farmer must be governed by conditions. Whether to sell his milk or to make it into butter or cheese will depend upon his nearness to factories and markets, the relative price of milk, butter and cheese, and other local conditions. One fact must be constantly kept in mind. All kinds of dairying are not equally light on the soil. The farmer who sells his milk to consumers takes from his farm all the soil elements found in the whole milk. The sale of cheese returns a portion of these soil elements in the whey, while the sale of butter removes from the farm practically nothing of a soil nature. The milk required to produce a ton of butter contains 450 pounds of fertilizing substances, worth about $45. The cheese made from the same amount of milk removes about half as much of these substances, while the total amount of soil matter in a ton of butter has already been stated to be worth less than fifty cents. All else being equal, it is better to make butter than cheese for the market as it is so very light on the soil. Again, the skim milk is available to feed on the farm, while whey has a much less feeding value.

In order to compare the effect of dairying on the soil with the other kinds of farming, let us suppose that forty acres of land will support ten cows. This is easily possible, and there are those who look forward to the time when they will have a cow to the acre on our best dairy farms. Should each cow produce 5,000 pounds of milk annually, we would have 50,000 pounds of milk. This amount will make on the average 5,000 pounds of cheese or 2,000 pounds of butter. It has already been shown that this amount of milk if sold from the farm to city consumers, removes about $45 worth of fertility, while the 5,000 pounds of cheese contains about $25 worth, and the ton of butter less than fifty cents worth. If clover or any of the other legumes has been raised for feed it has probably turned this value in air nitrogen back into the soil, so that very little if any of the fertility has been lost.

Now, what would be the result of raising grain, tobacco, potatoes or beets for the market on the same plat of ground? Let us see. The average production of oats, corn, wheat, rye, barley and potatoes for the United States, according to the year book of the Department of Agriculture, is as follows:

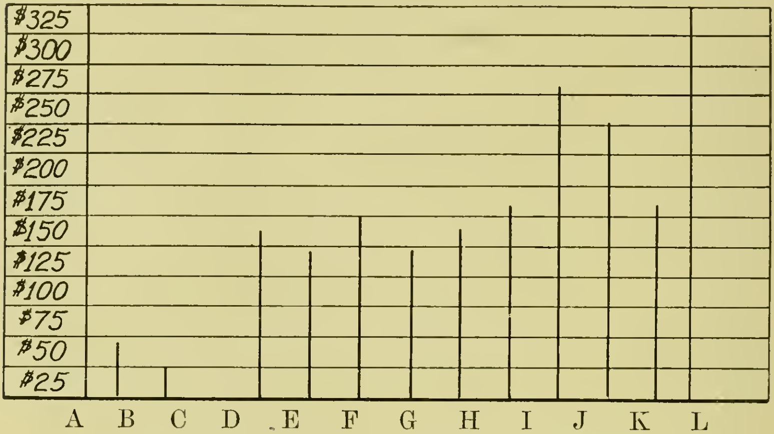
Oats	30 bu. per acre
Wheat	14 bu. per acre
Rye	15 bu. per acre
Corn	25 bu. per acre
Barley	25 bu. per acre
Potatoes	90 bu. per acre

These averages are low and much less than can ordinarily be raised per acre with intelligent farming. But accepting these averages for our forty acre farm, we have the following:

1,200 bushels of oats containing worth of soil fertility	$130.00
560 bushels of wheat containing worth of soil fertility	125.00
600 bushels of rye containing worth of soil fertility	120.00
1,000 bushels of corn containing worth of soil fertility	155.00
1,000 bushels of barley containing worth of soil fertility	145.00
3,600 bushels of potatoes containing worth of soil fertility	160.00

If tobacco is grown instead of these, with 1,000 pounds of this crop per acre, $275 worth of soil fertility is sold, and with ten tons of sugar beets per acre (a low estimate) $260 worth of soil fertility is removed annually.

These calculations are based on the average analyses of the above products, the average yield for the United States, and the present price of commercial fertilizers, viz., nitrogen, 15 cents per lb; phosphoric acid, 5 cents per lb., and potash, 5 cents per lb. It only requires a careful comparison of the above figures to convince the thoughtful farmer of the great advantage of dairy farming over other lines of agriculture. If it is impossible for the farmer to go into dairy farming exclusively he can do the next best thing, keep a few cows, raise legumes for feed, engage in diversified farming, practice rotation of crops, sell less off the farm and feed more on it. In this way he will preserve for himself more of his most valuable asset, the fertility of the land.



Drawing showing relative value of fertilities removed from a forty acre farm when (A) milk, (B) cheese, (C) butter, (D) wheat, (E) oats, (F) corn, (G) rye, (H) barley, (I) potatoes, (J) tobacco, (K) beets, (L) hay, are sold therefrom.

CHAPTER XV.

CARE OF THE COW.

One of the cardinal points that a good dairyman will observe in handling his cows is regularity in all his work. He will feed them at definite hours, and milk them at stated intervals; that is, if a cow is milked at six in the morning she should be milked at six o'clock at night, the best results being obtained when the time between milkings is twelve hours. It may be interesting to note that the records show that London receives its poorest milk on Monday. This is accounted for by the fact that the farmers are not so regular in their work on Sunday as during the rest of the week.

If for any reason it is advisable to change the feed of a herd it should be done gradually so that the cows will become accustomed to the change and not be affected in any way. For instance, when it becomes necessary to begin the feeding of ensilage a very small portion should be fed the first time, followed by a gradual increase in the amount. In this way cows will not get "off feed" so readily. Many dairymen are so skillful that they can keep changing feeds from time to time without the cows showing any bad effects. This is due to their judicious method of feeding.

The real purpose of keeping cows is to make a profit, and he is indeed a foolish dairyman who will furnish his cows with the best of feed and shelter, and then spoil it all by abusing them. If he is at all observing he will note within a very short time that it *does not pay to abuse or ill-treat a cow.* He must remember that she is a brute and he is a man, and if she ill-behaves in any way it is because she is following the law of nature and is trying to protect herself. A cow will hold up her milk because she is not in an equable frame of mind; perhaps she is afraid of punishment. Some milker may have clubbed her with a milk stool and she remembers it and is nervous. Scolding or loud and excited talking also make her nervous. It is needless to remark that chasing cows with dogs is not going to improve either the flow of milk or its quality. The practice of petting cows is to be commended, as they respond to kind and gentle treatment in a way that is profitable for the owner.

When cows were still in their wild state, nature provided them with horns to protect themselves and their offspring. However, as the dairyman now protects his herd against the ravages of wolves and other wild beasts, these appendages are not necessary and should be removed. This can be done in a humane way when they are calves and the effect is hardly noticeable. In case a cow is purchased that has horns, she should be dehorned as soon as possible, both as a protection for her owner and also the members of the herd. She will no doubt shrink in flesh at first, the flow of milk may be somewhat less, and the test will be apt to drop, but these are only temporary effects; in fact she will recover from this shrinkage within a week or two and is likely to gain more than she lost. Cattle that are dehorned become more docile and will not be in constant dread of being hooked by other members of the herd. They can be sheltered more conveniently; in fact there are so many advantages in dehorning that we cannot urge it too strongly.

In a previous chapter attention was called to the fact that a goodly share of the food provides heat and the maintenance for the body. It, therefore, is plain that if the body is not properly protected it will take more feed to maintain a cow and for this reason if for no other she should be well sheltered. It must be remembered that she has not so thick a skin as the steer and not so much fat on her body to protect her from the cold. That it is profitable to protect her from the weather has been proven over and over again. The Indiana Experiment Station conducted a series of experiments and found that cows required less feed when well housed, and that they gave more milk as a result of this care. In fact, sheltering three cows for forty-eight days gave an increased profit of $12.79, or $4.26 for each cow. This is quite an item when a herd of twenty or thirty animals is considered. Just how cows should be sheltered depends a great deal on the location of the dairy farm, but in another chapter the importance of a good barn is discussed, and also the necessity for providing sufficient fresh air and plenty of sunlight.

When sheltered during the winter season, it is very essential that cows be given sufficient exercise so that they are kept in a healthy condition. Some dairymen follow the rule that they allow their cows to go out of doors on such days as are comfortable for a man to walk about the yard for a short period of time in his shirt sleeves. For instance, if it should be a cold, rainy, drizzling day there would not be much pleasure for a man to walk about the yard without a coat and therefore it would not be advisable for him to turn his cows out. If the cow is not protected from rain as she should be, it has been demonstrated that the shrinkage of milk may be as much as ten per cent, and in case of a storm to which the cow is exposed, the shrinkage has been known to reach forty per cent. This, as every dairyman knows, is an enormous loss and goes to prove that it pays to protect the cows. In summer time they should be provided with a shady place where they can rest during the heat of the day. In fly time it may be profitable for the farmer to keep his cows in the barn during the day. He can do this by soiling them, but in case they are put in the barn it is well to darken the windows so that the flies will not bother them. All dairymen know that when flies appear there is a great loss in flesh and also a serious dropping off in the milk. For this reason it may be well for the farmer to consider keeping his cows in the barn altogether during the fly season. It may cause extra work, but all told he will be amply repaid in money for the trouble.

In all his conduct and actions toward his friends, the cows, the dairyman will always be governed by the bond of sympathy that should exist between him and the animals in his charge. If he follows these instincts he cannot make many serious mistakes in his treatment and care of them. He will provide his cows with clean, palatable food which they will eat with relish, rather than feed which they will eat merely to keep from starving. He will provide them with warm water to drink in winter, rather than ice-cold water, because he feels he would not like to drink such water himself. He will soon learn that it is profitable for him to warm the water rather than to send them to the pond where he has chopped a few holes in the ice, and expect them to drink sufficiently to meet their requirements. Experiment stations have proven that shrinkage in milk amounts to about eight per cent when this kind of water is supplied.

Dairy barn on the Wisconsin Experiment grounds, Madison, showing that art and utility may be combined with little additional expense. Note the artistic silo in the foreground, above which is placed a large water tank. To the left is seen the ventilating tower used in supplying the cow barn underneath with pure, wholesome air.

CHAPTER XVI.

CARE OF UTENSILS.

Tinware is undoubtedly the most satisfactory material for dairy utensils. Wooden vessels are very objectionable, inasmuch as the pores of the wood absorb the milk, and, therefore, soon become foul. In purchasing vessels those that are durable and well covered with tin should be selected. The corners should be flushed with solder so that the milk will not have hiding places, thus affording an opportunity for germs to grow. All utensils should be washed with a brush, as it is far more sanitary than a cloth, which will soon become foul in spite of the efforts made to keep it clean. Greasy soap powders should be avoided. There are many kinds of powder on the market that will dissolve dirt and grease and are still sanitary. If nothing better can be obtained either sal soda or borax may be used. One of the best purifying agencies that the dairyman has is the sunlight. After the vessels are washed they should be exposed to the sunshine and air, away from the dust, and placed so that they will drain well.

In washing tinware it should first be rinsed with cold water to remove the milk; it should then be washed with lukewarm water and finally scalded or steamed. If this method is followed it is very easy to wash the separator. Many dairymen make the mistake of flushing the separator with scalding hot water. This will have a tendency to cook on the impurities and about the only way that they can then be removed is to scrape them off with a knife. Whereas, if the separator is flushed with lukewarm water, taken apart and cleaned at once, it is not much of a task. It is needless to say that the separator should be washed each time it is used.

It has been proven that if the separator is allowed to stand without being washed, the impurities will dry on so that it will take considerable time and labor to wash it thoroughly. It is labor actually saved to wash the separator twice a day and only the separator that receives such care is in sanitary condition for future use.

CHAPTER XVII.

CARE OF MILK AND CREAM.

Milk, as it is secreted in the cells of the udder, is germ free. If it were possible to get the milk in this condition into germ free receptacles and if it could then be kept free from contamination, the milk would keep indefinitely. But this is impossible. A few germs always work their way up into the cavities of the cistern above the teat and multiply enormously, owing to the favorable conditions existing there. If this first milk, or foremilk, as it is called, is milked into the bucket, the practice of a good many milkers, we can see at once that contamination is introduced at the very beginning of the milking process. It is advisable to throw this foremilk away, and really there is little loss, as it is not very rich in fat.

The problem of the dairyman is to keep the milk from being contaminated either by dirt entering into it or by its absorbing undesirable odors. It is unnecessary to state that the stables should be clean and dry and well ventilated; the health of the animals demands it. In Denmark it is customary to whitewash the stables four times each year; they have found that it is very profitable to do this. Whitewash is odorless and very cheap, and it is a pity that dairymen in general do not use it more freely.

It goes without saying that there should be no cesspools about the stable, and the ground under the barn should be well drained.

Poor drainage cannot help but cause objectionable odors about the barn.

One of the things a dairyman will observe carefully is to do his feeding after milking so that the atmosphere will not contain so much dust. He will also feed his cows such feeds as ensilage, after milking rather than before or during milking time, because the odor of these feeds will taint the milk.

The udder and flanks should be wiped with a damp cloth immediately before milking so that dust and dirt will not be constantly falling into the milk pails. It has been demonstrated that twenty times as much dirt falls into the bucket when the udder is simply in a soiled condition as when it is wiped with a damp cloth, and one hundred times as much when the udder is dirty as when it has been kept clean.

Cows should have ample bedding, but this bedding should not be disturbed immediately before milking, inasmuch as that will cause the air to be filled with small particles of dust, a large share of which will find its way into the milk bucket.

The dairyman should always bear in mind that in handling milk he is dealing with a food product. Therefore, if any of his cows should be diseased or in ill health, or give gargety milk or bloody milk, this milk should not be used for human consumption. Colostrum milk or the milk which a cow secretes immediately after calving should not, of course, be used for four or five days, or until the milk has become normal; nor should cows' milk be used for the thirty days immediately before calving.

Taking everything into consideration, probably the best form of pail that a dairyman can use is one that is covered, as such a pail excludes practically all dirt. It has already been mentioned that a dairyman is dealing with a food product, hence the advisability of providing a clean, sanitary place in the barn where the milk can be held during the time of milking.

The milk should be strained as soon as possible through several thicknesses of cheesecloth. It is advised by some that milk should be aerated to remove animal heat and the odors absorbed from certain feeds. Although much may be said in favor of it, great care must be exercised in aerating milk. If a farmer is in doubt whether to aerate his milk or to cool it, it would be better for him to cool it for the reason that simply aerating will not reduce the temperature of the milk sufficiently. Aerating must be done in a very cleanly, sweet smelling place, otherwise during this process, the milk will absorb undesirable odors. In case the milk is not separated it should be cooled down at once, and this can only be done by placing the cans in cold water and stirring the milk frequently until cold. It is not advisable, of course, to cover the cans tightly, because milk will have a better flavor if some of the odors of the same are allowed to escape. It is poor policy to pour warm and cold milk together for the purpose of cooling the warm milk. This should never be done. In case a hand separator is used it is not necessary to cool at once, because the separator will do better work when the milk is at the temperature it comes from the cow.

The hand separator is becoming very popular. The advantages in using one of these machines, such as the increased value of the fresh skim milk and the amount of labor saved in hauling to the factory, are so well known that further comment is unnecessary. However, many farmers either wilfully or by reason of a lack of knowledge utterly neglect to take care of their cream properly and in this way bring the hand separator into disrepute. Cream should be cooled down at once to prevent its souring. It should be placed where the atmosphere is pure and where it will not absorb undesirable odors. It should be delivered to the factory at least every other day, and during the time that it is under the farmer's care it should be stirred occasionally. Many think that it is unnecessary to cool the cream, inasmuch as the butter maker will have to sour it anyway. It must be remembered that he should have control of the ripening process in order to make a uniform product from day to day. Even if the cream does not become sour, it ought not to stand longer than forty-eight hours for the reason that many organisms develop in cream held at a low temperature, and unfortunately such organisms have the property of imparting a very bitter flavor to the cream, which in turn is transmitted to the butter. Cream should be delivered to the factory sweet and clean before we have a right to expect the butter maker to place on the market an article that will bring the highest cash price.

There are other sources of contamination that should be guarded against. One of these is uncleanly habits on the part of the milker. It is desirable that he be attired in clean overalls and jacket; these need not be expensive and can be slipped on just before milking. The hands of the milker should be washed clean and dried before he begins his work. Much may be said as to the method of milking, but it is understood by all practical dairymen that a cow should be milked with "dry" and not with wet hands. Many have acquired the habit of milking "wet," as it is usually termed, and it may be hard for them to reform, but if they will observe the filthiness of this practice they will recognize this as a great source of contamination.

CHAPTER XVIII.

TUBERCULOSIS.

No treatise on the subject of dairying is complete unless some mention is made of tuberculosis, that dreaded disease which has already carried off thousands of cattle, and whose ravages continue, almost unabated.

It is said that one out of every seven people who die, fall victims to tuberculosis, or consumption, as it is commonly called. It is now pretty generally believed that tuberculosis in cattle and consumption in the human family are practically one and the same disease, and that this disease can be transmitted from one species to the other. Young children fed on the milk of tuberculous cows are likely to contract the disease, and calves and pigs consuming infected milk are almost certain to be affected.

Tuberculosis is a germ disease, that is, it is caused by the growth and multiplication of very minute organisms within the animal body. The disease cannot be contracted without the entrance of these germs. The introduction of a single infected animal into the herd is likely to inoculate the whole herd as the tubercle germs are thrown off with the saliva and other excretions. These germs when dry will live in the dark for months and, settling upon the hay and other feed, are transmitted from animal to animal. Skim milk from creameries and whey from cheese factories are other sources of infection. Here the milk from infected cows is mixed in a common tank with other milk and the whole supply thus becomes contaminated. In this way the disease is often spread throughout an entire neighborhood.

Tubercle bacilli cannot live at a temperature of 160 degrees F., and in direct sunlight they die in less than two hours. Pasteurizing whey and skim milk, that is heating it to 160 degrees F., will kill these germs, and prevent the spread of disease from factory centers. Plenty of sunlight, fresh air and the use of whitewash in stables, are effective means of preventing the rapid spreading of the disease in herds.

However, the disease cannot be communicated from one vicinity to another except through the introduction of diseased animals into the neighborhood, and some states have required that all animals imported within their borders should pass the tuberculin test. Now what is this test?

The United States Department of Agriculture is engaged in preparing and distributing tuberculin, a coffe-colored liquid, which if injected under the skin of infected animals will cause a rise in the animal's temperature. No change is produced, however, by injecting this substance under the skin of a healthy animal. During the test the animals must be kept in as nearly a normal condition as possible Before injection four temperatures are taken with a clinical thermometer, two hours apart. These temperatures are taken by inserting the thermometer in the rectum and allowing it to remain there for three or four minutes before reading. About half a teaspoonful (2 c. c.) of the tuberculin is then injected underneath the skin, usually at the shoulder, with an ordinary hypodermic syringe. Eight to ten hours after injection five more temperatures are taken in the same manner, two hours apart. A rise in temperature of two degrees is considered a "positive reaction," that is, the animal is said to be diseased.

Diseased animals should be removed from the rest of the herd and disposed of according to the law in force in the state.

The use of hand separators will prevent the introduction of the disease from factory skim milk and if no animals are purchased but those that have been tested, the herd may be kept free from the disease. Dr. H. L. Russell, dean of the College of Agriculture, University of Wisconsin, one of the greatest authorities on this subject in this country, says in a recent bulletin published by the Experiment Station at Madison:

"If dairy farmers will do three things they may keep their herds free from the scourge:—

"First—Find out the actual condition of their herds by applying the tuberculin test.

"Second—If found free, buy in the future only tested stock or test them before admitting same to herd.

"Third—For young stock and hogs use skim milk separated at home, or pasteurized properly at creamery or factory.

"If disease is found, reacting animals should be separated and disposed of properly, and the barns adequately disinfected. In the case of valuable animals, healthy calves may generally be secured from reacting cows, if calves are separated at birth and fed on *boiled milk* of mother or milk from non-reacting animals. Remember the danger from tuberculosis lies in its hidden course of development, and for the sake of the herd itself, as well as for human beings consuming the products of the herd, one cannot afford to neglect taking such steps as are necessary to find out positively the condition of their herd. If a stock owner is in the habit of buying and selling cattle, especially dairy stock, it is almost impossible to escape the disease. Even in some of the best beef breeds the disease has been widely prevalent. * * * If only tested dairy stock could be transferred from one owner to another the rapid spread of the disease would be checked, and it would not require much time to eradicate the herds already involved."

CHAPTER XIX.

DISPOSING OF MILK AND CREAM.

Assuming that the dairyman has a herd that is producing a good flow of milk, the question naturally arises, what shall he do with this milk in order to have it yield him the largest net returns? The answer can only be given by the dairyman himself after carefully studying his local situation. In certain localities it may be advisable to handle milk in a way differing from that in another locality, and local conditions must necessarily govern the methods of the disposal of milk. For instance, if a man is situated in close proximity to a city where the consumption of whole milk is very large it may be advisable for him to wholesale it directly to a milk dealer, or have a private trade of his own to which he can deliver the same. In this case the necessary additional investment in horses, wagons, etc., must be considered. In selling whole milk it must also be remembered that nothing is returned to the farm in the shape of skim milk. While the profits of selling milk in this way may appear larger, two things must be borne in mind, viz., the cost of delivery and the loss of the skim milk. The reader is referred to an earlier chapter entitled "The Relation of Dairying to the Soil," which calls attention to the loss by removal of fertility to the soil when selling whole milk off the farm.

Of course, if the farmer is eight or ten miles from a city such a method will be out of the question. He may then be compelled to sell his milk to a cheese factory, and in this case return to the farm about ninety pounds of whey for every one hundred pounds of milk delivered. The quality of whey varies greatly from time to time, depending upon the care it receives at the factory. Its food value is only about half as much as that of skim milk, because all of the casein has been removed from the milk in the process of cheese making.

Or he may have an opportunity to sell his milk to a creamery where practically eighty pounds of skim milk are returned to him for every one hundred pounds of milk delivered. Whether to sell to a creamery rather than to a cheese factory, or vice versa, depends entirely upon local conditions. However, he must not lose sight of the fact that the skim milk returned is of more value to him than the whey, if he can make use of the same for feeding purposes.

One of the most profitable methods in many places is the selling of milk in the shape of cream. Many objections have been raised by creamerymen against the introduction of the hand separator, but there is no question but that in many localities this is the only practical method that can be employed owing to the distance that the farmers live from the creamery, making long hauls necessary, which expense can be greatly reduced by delivering cream. Even in many important dairy regions of this country it has proven its worth, so that there is no question but that the hand separator is bound to have a place on many farms. The fact that the dairyman, owning one of these machines, has better skim milk to feed his young stock is an important item. Then again, we hear very much about the spread of tuberculosis and there is no question but that this disease can be spread through factory skim milk and whey. If the farmer wants to keep his herd free from this dread disease it behooves him to be very careful as to the feeding of these factory by-products.

Another important point is the fact that by the use of the hand separator the bulk that must be cooled is very materially lessened. Those who make an effort to deliver milk or cream in good condition appreciate this.

Instead of selling cream to a butter factory, it may be sold for direct consumption. This is probably the most profitable method and yields the largest returns. The demand for good cream is rapidly increasing. In every city parties may be found who want to get good cream and are willing to pay for it. They may be hotel managers, boarding house keepers, candy makers, ice cream manufacturers, and other people who are ready to contract for cream of a certain richness at a definite price per gallon.

To show that it pays to cater to this sort of trade let it be assumed that a dairyman can sell a gallon of twenty-five per cent cream for seventy cents. This may be more than a farmer can obtain in certain sections, but it is a fact that in many parts of this country even a higher price than this may be obtained.

A gallon of cream weighs from 8.2 to 8.4 pounds, depending upon its richness. Roughly speaking a gallon of cream testing 25 per cent contains about 2 pounds of fat. This 2 pounds of fat will make about 2 1-3 pounds of butter. If 70 cents is received for a gallon of 25 per cent cream it is practically equivalent to 30 cents a pound for butter. Besides this the extra labor of ripening the cream, washing the butter, salting and packing it are avoided.

There is no separator manufactured that will deliver cream uniform in richness from day to day. Variations in tests, as has been previously explained, may be due to the rate at which the milk is fed into the bowl, the speed at which the separator is turned, the richness of the milk, and the temperature of the milk. For the above reasons occasional testing of the cream, therefore, to determine its richness cannot be depended upon, and on this account a farmer may be delivering a richer cream than is contracted for, losing money thereby. He cannot expect to offset this by delivering a poorer cream at times, because this will arouse dissatisfaction and he will lay himself liable to a breach of contract. The only safe way is to test the cream each time it is delivered and then add sufficient milk to dilute it to the required per cent of fat. This is called standardizing and is not so difficult as might be imagined. How this may be done is best illustrated by the use of the diagram below:

Assuming that the dairyman has tested his cream and finds that it contains 30 per cent fat, he will place the 30 in the upper left hand corner of the square. It would be natural for him to dilute the cream with skim milk which we will assume tests 0, although it may test .1 of 1.0 per cent fat; for practical work, however, it may be said to test nothing; 0, therefore, is placed in the lower left hand corner. His contract calls for a 25 per cent cream, and 25 is placed where the diagonal lines cross in the center of the square. Subtracting 25 from 30 and following the diagonal line we place the difference, 5, in the lower right hand corner. The difference between 0 and 25 is 25 and we put that in the upper right hand corner. We now have figures in each of the four corners. The diagram may now be explained as follows: Of the 30 per cent cream we take 25 pounds and of the skim milk 5 pounds; pouring these two together we have 30 pounds of 25 per cent cream. In other words, for every 25 pounds of 30 per cent cream 5 pounds of skim milk must be added to dilute the cream so that it has a richness of 25 per cent fat, the quality of the cream contracted for.

Again, let us assume that a dairyman has contracted to sell a 20 per cent cream. He places the 20 in the center of the diagram. He tests his cream and finds that it contains 32 per cent fat. He has no skim milk with which to dilute this cream and must use whole milk. Upon testing the same he finds it to read 3.6 per cent fat. As before, he puts the cream test in the upper left hand corner and the milk test in the lower left hand corner. The difference between 20 and 32 is 12; this is placed in the lower right hand corner. The difference between 20 and 3.6 is 16.4 which is placed in the upper right hand corner. Now, for every 16.4 pounds of 32 per cent cream he must add 12 pounds of milk testing 3.6 per cent, and when he pours these two together he will have 28.4 pounds of 20 per cent cream.

The chief objection to the standardizing of cream is that it requires the dairyman to make a test of the cream each time it is to be delivered. This, however, is not a valid objection inasmuch as the returns usually more than pay for the trouble.

Whether or not it will be profitable for a farmer to invest in an equipment so that he can properly make butter is another question that he only can answer. The question resolves itself into this: Can he get an increased price for his product sufficient to warrant incurring the additional expenditure of money and labor necessary to produce a marketable product?

In certain sections of Europe butter is made of very sweet cream which finds a ready sale. Such butter, however, has a peculiar flat, insipid flavor, objectionable to most people at first, but a taste for which can easily be acquired. This kind of butter does not keep well and therefore must be delivered fresh from the churn.

In America people generally want what is known as ripened cream butter. Such butter has better keeping qualities. Cream for this kind of butter must undergo a fermentation process which is usually termed "ripening." One of the objects of ripening cream is to produce flavor, and as flavor is a most important point to be considered it is evident that the ripening must be done properly. To hasten this process, and at the same time to aid it, it is often advisable to add what is termed a "starter." A good starter is a quantity of milk or skim milk in which the desirable organisms producing good flavors in butter have gained the ascendency, and when added to the cream have a tendency to check the development of the less desirable organisms. In this way the dairyman may control the flavor of his butter.

The matter of temperature is also an important point. As a rule cream is ripened at a temperature of 65 to 70 degrees F., and when it reaches the right acidity (which may easily be determined by any one of the many acidity tests available), the cream is cooled to about 54 degrees and held at this temperature for at least two hours before churning, with an occasional stirring. When cream is held for three or four days before churning, it should be well stirred at least twice each day. It is not desirable to hold cream at a low temperature longer than necessary, because, as has been previously stated, at these low temperatures organisms develop that produce bitter flavors. Therefore the ripening process should be started as soon as possible after separation because the development of the lactic acid germs has a tendency to check the growth of these bitter flavor organisms. Great care must also be exercised to see that the cream does not get too sour, inasmuch as the keeping quality of the butter may be seriously impaired by over ripening.

The best kind of a churn is one that has no internal parts. A barrel churn is about as satisfactory as any on the market. The cream, being at a low temperature, should not gather in much less than thirty minutes, otherwise the butter is apt to have a soft body. When the butter is gathered into granules about the size of wheat grains the buttermilk should be drained off and some clean, cold water added and the butter washed. Care should be exercised to prevent overchurning, for when butter is gathered into large lumps it cannot be washed properly. Since the purpose of washing butter is to remove most of the curd it is very essential that the granules be left small so that the curd can be easily removed. The amount of salt added is governed by the demands of the market. During the working process the salt should be given time to dissolve so that when the butter has been worked enough there will be no grittiness. It is very essential that the salt be uniformly distributed throughout the butter, otherwise we obtain what is known as mottles. Mottles are quite characteristic of dairy butter, and are very undesirable. They can easily be avoided by observing care in the method of manufacturing the butter. The style of package is regulated by the demand of the consumer, and of late years the one pound prints and two pound rolls have become very popular. Any other size or style of package may be used, but in every case the package should be neat and attractive. In fact, the two points to be observed in making butter are to produce an article that will be attractive to the eye and tickle the palate.

In conclusion it may be well to compare the four methods of disposing of milk. To make this comparison we will assume that 100 pounds of milk are sold to a milkman at $1.30; this milk testing about 3.6 per cent fat, will make about 4.2 pounds of butter, or about 10 pounds of cheese, or about 1.8 gallons of 25 per cent cream. The butter is valued at 25 cents per pound net, the cheese at 11 cents per pound net and the cream containing 25 per cent fat at 70 cents per gallon net. It is likewise assumed that skim milk is worth 30 cents per hundred and whey 15 cents per hundred, and that the dairyman will receive about 80 pounds of skim milk or 90 pounds of whey for every 100 pounds of milk he delivers to the factory.

100 lbs. milk testing 3.6 per cent fat—

1.	Sold at wholesale		$1.30
2.	Made into butter, 4.2 lbs. at 25c per lb.	$1.05	
	80 lbs. skim milk at 30c per 100 lbs	.24	
			1.29
3.	Made into cheese, 10 lbs. at 11c per lb.	1.10	
	90 lbs. whey at 15c per 100 lbs	.13	
			1.23
4.	Sold as cream, 1.8 gal. 25 per cent cream at 70c per gal.	1.26	
	80 lbs. skim milk	.24	
			1.50

From the above the reader can easily see the profit in selling cream for direct consumption, providing he can get a suitable market for the same. Even at so low a figure as 60 cents per gallon, the dairyman would receive $1.32 for his 100 pounds of milk.