PROFITABLE DAIRYING

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PREFACE

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 give larger returns, but these large profits are more than offset by the loss to the soil and the uncertainty of a crop 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 this loss is scarcely perceptible. This is the chief reason why dairy farming is proving so profitable and is coming so rapidly into popular favor.

Recent investigation has shown that the dairy cow will convert grain and roughage into human food more economically than can be obtained from any other animal. Under favorable conditions 30 per cent of the digestible nutrients fed to a dairy cow are recovered again in the milk, while only about 5 per cent of them are retained in the body of a steer. In other words, a dairy cow makes use of six times as much of the raw material fed as does the steer. This is a most surprising revelation.

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 wise management he finds the soil of his farm growing richer and more productive. All of these somewhat surprising assertions admit of absolute proof and will be fully discussed in the chapters which follow.

But the one who reads this must not 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 get a few cows and that they will take care of him for the rest of his days. Both views 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. This book 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 those not trained for scientific work. Wherever it has been necessary to resort to unusual terms, these terms are fully explained in ordinary every-day language. It is hoped that this little book will be of real service to the dairy farmer by assisting him in improving his methods and increasing his profits.

We desire to thank the many breeders, supply houses, and manufacturing concerns, for their generosity in furnishing photographs and cuts. We especially desire to thank the Wisconsin

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THE AUTHORS.

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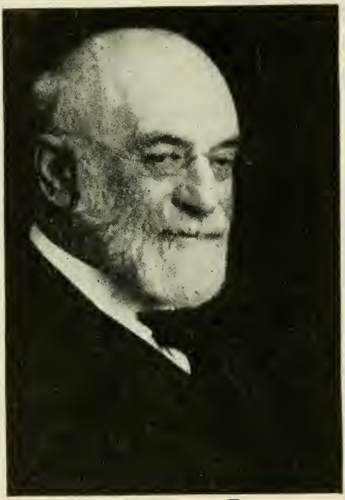


Very truly yours
S. M. Babcock

CHAPTER I

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—just about a quarter of a century of age. Its success 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.

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, until today there are a dozen or more styles of thoroughly reliable centrifugal separators in every-day use, but the principle employed by all of them is the same.

The influence of the separator. The centrifugal method of separation effected so large a saving of butter fat to the farmers that creameries sprang up rapidly, particularly in the north central states, 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, nor any practical 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 hundred weight. Of course such fraud was certain to cause dissatisfaction, besides being manifestly unjust.

Milk formerly sold by the pound. 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.

The butter fat test. 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 of Wisconsin 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 what is now known as 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.

Rapid development since 1890. 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. This number increased very slowly for twenty or thirty years, but very rapidly after 1890, until we now have, according to the census of 1910, the latest data available, 6,235 creameries and 3,846 cheese factories scattered throughout the United States.

Fig. 1. Dr. Babcock operating the original Babcock tester.

It may be argued from this that the dairy industry will soon be overdone. The following table will be of interest to those studying this question:

Population of the U. S. (Census 1890)—62,622,256.	
Population of the U. S. (Census 1910)—91,972,266.	
Increase in Population..................	46.7%
Production of Butter in the U. S. (Census 1890)	1,205,508,384 lbs.
Production of Butter in the U. S. (Census 1910)	1,619,415,263 "
Increase in Amount of Butter Produced...	34.3%
Production of Cheese in the U. S. (Census 1890)	256,761,888 lbs.
Production of Cheese in the U. S. (Census 1910)	320,532,181 "
Increase in Amount of Cheese Produced...	24.8%

Comparing the increase in the butter and cheese produced with the increase in population, it is seen that the population is increasing much more rapidly than is the supply of dairy products. Dairymen need not be alarmed, therefore, about an over-production.

Milk an economical food. 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. People are rapidly learning the economy of using dairy products. It has been estimated that one-sixth of the food consumed by the people of the United States is some form of dairy product. There are more digestible nutrients contained in milk than can be obtained from the same amount of money expended for meat, fish, or fruit at ordinary retail market prices. The cow is the most economical food producer extant. This fact will always operate to keep up the prices 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.

The following table is based on a report recently published by the State Food Commission of Illinois. Each food in this list contains approximately the same amount of nutritive material as one quart of milk.

	Weight		Approximate Weight Grams	Cost per Pounds Cents	Total Cost Cents
	Pounds	Ounces			
Milk, Whole........	2	2.36	975	....	8
Cheese, Full Cream.	....	5.6	160	22	7.7
Condensed Milk, Sweetened........	....	7.37	210	15	6.9
Eggs................	1	.62	470	35 (doz.)	22.3
Beef, Round........	....	11.85	335	20	14.8
Codfish, Salt.......	2	.48	920	7	14.3
Oysters.............	4	14.21	2,217	15	72.6
Tomatoes..........	7	....	3,175	5	35
Bananas...........	2	8.6	1,150	6	15
Apples.............	3	7.5	1,575	1.5	5.2

EXERCISES

1. What is meant by the statement: "The cow is the most economical food producer?"

2. If the above be true, will consumption of dairy products probably increase or decline?

3. Will consumption of meat in the United States increase or decline as population increases?

4. How does America compare with Europe in the consumption of meat?

5. Is there any other animal that may possibly be used to produce dairy products more cheaply than the cow?

CHAPTER II

COMPOSITION OF MILK

Appearance. Milk as secreted is opaque and white in appearance. Normally it usually has a slightly yellowish tinge, due to the fat globules it contains. The white color is due to suspended particles interfering with the passage of the light. Skim-milk, or milk from which the fat has been removed, has a bluish tinge. Milk has a sweet taste when first drawn owing to the presence of the milk sugar.

Specific gravity. Milk is heavier than water, having a specific gravity of about 1.029 to 1.033. This means that if a vessel held exactly 1.000 pound of water, this same vessel would hold from 1.029 to 1.033 pounds of milk.

The two parts 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 in this amount, consisting of all the constituents of the milk except the fat, would therefore weigh 96.3 pounds.

There is no chemical union 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 has been estimated that it would take a man ten years to count the number in a cubic centimeter of milk, counting at the rate of one hundred per minute, for ten hours per day.

Fat globules. 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 ten-thousandth of an inch. Some are so small, however, that they appear under a microscope as very tiny specks, too small to be measured.

Size and number of fat globules. 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.

Milk serum. 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. With the fat these 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	

Fat varies with the breeds. The most variable of these constituents is the fat; the casein also varies but not quite so much as the fat; 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:

	Solids	Fat
Jersey	14.70 per cent.	5.35 per cent.
Guernsey	14.71 per cent.	5.16 per cent.
Shorthorn	13.38 per cent.	4.5 per cent.
Ayrshire	12.61 per cent.	3.66 per cent.
Holstein-Friesian	11.85 per cent.	3.42 per cent.

It must not be inferred from this that all Jersey cows produce milk of the same richness given in this table. As a matter of fact there is a great difference between the individuals of each breed. Certain Holstein-Friesian cows have been known to produce milk testing 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 and over. This table shows the average test from a large number of cows.

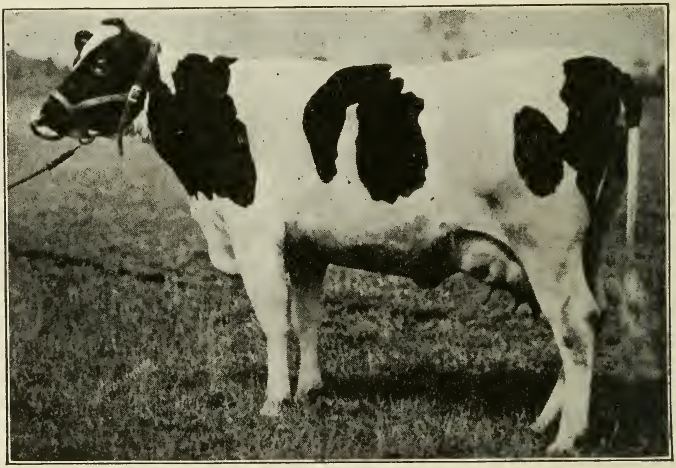


Fig. 2. Finderne Mutual Fayne.
A fine type of Holstein breed which produces a large quantity of milk of relatively low fat content.

Fat content increases as lactation advances. 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

Influence of time of milking. 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 milked twice only. 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.

Daily variations. 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.

Composition of colostrum. 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 below 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 as human food, is very undesirable for purposes other than food for the calf, and should not be delivered to a creamery or cheese factory until it is fit for human use.

Casein. 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, comprises what is 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.

Milk sugar. 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 to one-fifth as sweet as ordinary cane sugar. It is manufactured from the whey at a few cheese factories in this country, located where large quantities of whey are available, but has very little commercial value, being used only in the preparation of modified milk.

Kind treatment necessary. A great deal has been written 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. A good dairyman will always treat his cows kindly, will not be boisterous while handling them, or will not excite them in any other way, will feed them regularly and provide shelter for them. He will remember that besides being one of his best friends, the cow represents so much capital invested, and that abusing her will very materially affect the dividends that she will be able to pay him.

EXERCISES

1. How many pounds of milk solids in a hundred pounds of milk? How much water?
2. Which breed probably produces the greatest amount of solids per hundred pounds of milk?
3. How many pounds of solid food are produced by a cow giving 25 pounds of milk daily? This is equal in dry matter to how many pounds of beefsteak?
4. About how much solid food matter is produced by a cow giving 10,000 pounds of milk in a year?
5. This is equal in total food matter to how much beef? How many yearling steers would be necessary to equal in beef the food products of such a cow?
6. Do you weigh the milk of the home herd?
7. Do you know how much food material each of your cows produces in a year?

LABORATORY PROBLEMS

I. To Determine the Per Cent of Solids in Milk

1. Carefully weigh 100 grams of whole milk into a weighed dish.

2. Evaporate to dryness over a water bath or dry sand bath.

3. When the contents are thoroughly dried, reweigh and subtract the original weight of the dish. The weight in grams will be the per cent of total solids in the milk.

4. The loss in weight represents the water in the milk.

Note: To make sure that the sample was thoroughly dried it should be again placed on the bath and heated for some time. If there is no further decrease in weight it may be taken for granted that the sample was dry.

The solids of skim-milk, cream, and whey can be determined in the same manner.

LABORATORY PROBLEMS

II. To Determine the Casein in Milk

The casein in milk can be precipitated by very dilute acid. Albumen cannot be so precipitated.

1. To 100 grams of carefully separated skim-milk add a few cubic centimeters of dilute acetic acid to curdle it. If it does not curdle readily add a few cubic centimeters more. The temperature of the skim-milk should be from 80 to 100 degrees F. Care should be taken not to add too much acid, as it will have a tendency to dissolve the curd. If acetic acid is not available, dilute sulfuric acid may be used, but it does not answer the purpose so well as acetic acid. A few drops of rennet may also be used.

2. When coagulated break up the coagulum and filter. The filtration process can be hastened by allowing the curd to settle to the bottom of the beaker after heating up the curd about 10 degrees. Dry the curd on a water bath after filtration. It will be nearly pure casein.

CHAPTER III

MILK SECRETION

It is very essential that the 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 can discuss only in a general way the various theories and opinions advanced in regard to the secretion of milk.

Milk a secretion of the mammary glands. 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 the 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; with but a few exceptions, however, all mammals are land animals. We shall 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 parts of the world, especially in various parts of European countries.

Milk glands. 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.

The udder. These glands are separated from each other by a membrane. There is, therefore, no connection between the right and left sides of the udder. Each teat has practically its own system of cisterns, channels and cells. But there is more or less connection between the smaller ducts in the upper parts of the lobes on the same side. It is therefore possible to get more than half as much milk from one teat, if milked by itself, as can be obtained when both teats are milked at the same time.

Milk cisterns. 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. These cells are about one-thirtieth of an inch in diameter and are arranged in groups of three to five, having a common outlet. The inner walls of alveoli cells are made up of a layer of very minute epithelial cells; sometimes there are two or three layers of these cells. These small cells are filled with protoplasm, and when this protoplasm is discharged it is termed milk.

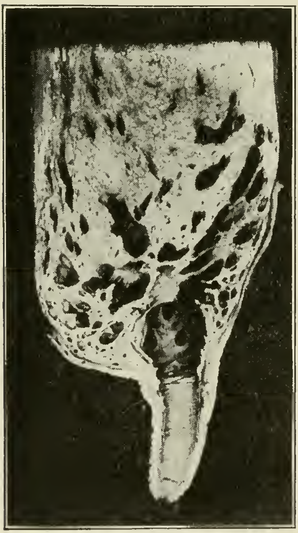


Fig. 3. Cross-section of a cow's udder, showing cavities and milk cisterns.

The udder not a reservoir. At one time it was the general belief that the udder was a reservoir, and it may be that many of us still have the impression that this is the case. That this is not true is easily shown by the fact that 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 was formerly claimed by some that milk is filtered out of the blood; the udder being well supplied with arteries and veins probably giving 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 from the albumen of the blood. Further, it is known that the ash in milk is not the same as the ash in the blood. It is believed that somehow in the process of secretion certain parts of the blood enter the cavity of the alveoli cells and that there certain changes take place, which result in the secretion of milk. While the process of secretion is going on, new epithelial cells are constantly being formed, but just how is not known at the present time.

Composition cannot be changed by feeding. 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 any particular change of feed. It is well understood that 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 prevalent among many farmers that a cow can be made to give rich or poor milk, depending on what she is fed, is entirely erroneous.

Danish experiments. The Danes did a great deal of work, experimenting to ascertain 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 the milk of 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.

EXERCISES

1. Why are large "milk veins" necessary to high milk production?
2. How do we know that the udder is not a reservoir in which milk is stored to be drawn at milking time?
3. On the other hand, how do we know that milk is being secreted all the time but principally at milking time?
4. Why do cows sometimes "leak" milk? Does this ever happen with light milkers? Hard milkers?
5. Can fat be fed into milk?
6. What influence does feed have on milk, if any?
7. Do you know which cows of your herd give the richest milk? Which the poorest?

LABORATORY PROBLEMS

III. To Determine the Albumen in Milk

1. Heat the filtrate obtained in Problem II to a boiling point for five minutes and filter; boil for another five minutes and filter again. The filtrate should then be clear and will contain the sugar, ash, and some potash.
2. Dry the residue on the filter paper. It is albumen.

IV. To Determine the Ash and Sugar Content of Milk

The filtrate obtained from Problem III will contain both the ash and the sugar.

1. Evaporate to dryness over a water bath. The gray residue will be both the sugar and the ash.
2. The residue can be burned over a free flame until the sugar is burned up. Ash will remain.

The per cent of milk sugar can be approximately determined by carefully obtaining the per cent of the other constituents in milk, such as water, fat, casein, albumen, and ash, adding them all together and subtracting the sum from 100.

Note: A qualitative test to show the presence of sugar can be made by using some of the filtrate. Add about 20 to 25 drops of the filtrate slowly to about 5 c.c. of hot Fehling's solution. After boiling a red precipitate will appear. This indicates the presence of sugar.

CHAPTER IV

THE BABCOCK TEST

As has already been stated, the Babcock test is responsible for much of the progress in dairying during the past twenty-five 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.

How fat was formerly estimated. It will be remembered that milk is composed of water, fat, curd, sugar, and ash in varying 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.

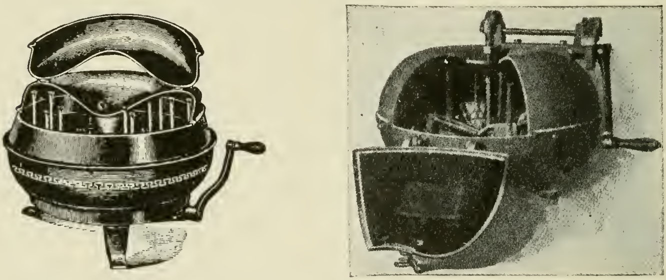
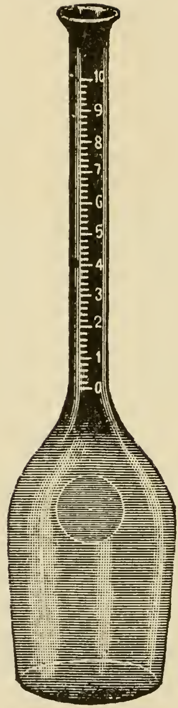


Fig. 4. The two principal types of hand testers.

The test measures the fat. 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 or 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



Acid measure. Pipette. Test bottle.

Fig. 5. The necessary glassware for making Babcock test.

to another, and the sample taken *immediately* before any of the fat globules have had time to rise.

If the milk stands for even a minute 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* 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 fat. 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 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; if only a few drops are spilled the test is spoiled and another sample should be taken.

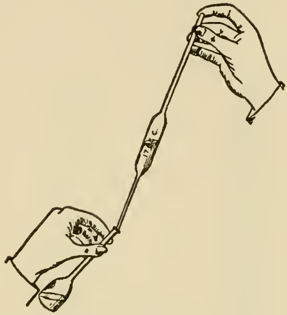
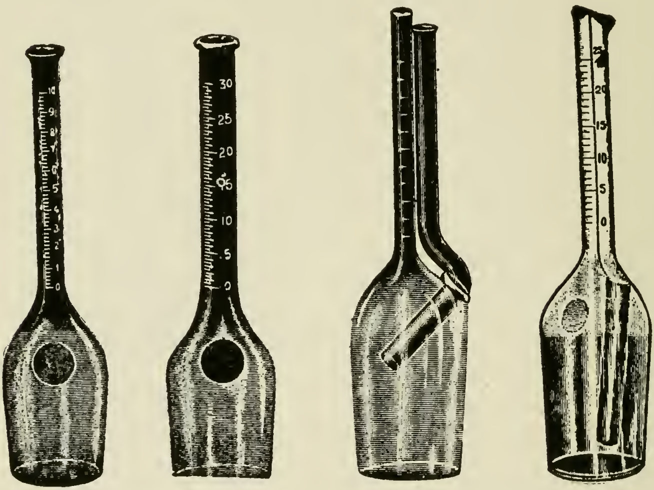


Fig. 6. By slowly releasing the pressure of the finger at the top of the pipette, the milk runs without loss into the test bottle.

3. **Adding the acid.** Ordinary commercial sulphuric acid at a specific gravity of 1.82 to 1.83 should be used. It may be purchased at any drug store for three or four cents per pound. A better place, however, to obtain the acid is from some creamery or cheese factory. These factories use large quantities of it and usually are glad to supply parties wanting small quantities. It is poisonous and must not be allowed to come in contact with the skin, hands, clothing or tin or iron vessels. If by accident any should be spilled,

it should be washed off immediately, using plenty of water. An application of diluted ammonia is very beneficial in neutralizing acid.



Whole milk bottle. Cream test bottle. Two types of double-necked skim-milk bottles.

Fig. 7. Every dairy laboratory should be equipped with a supply of these test bottles.

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

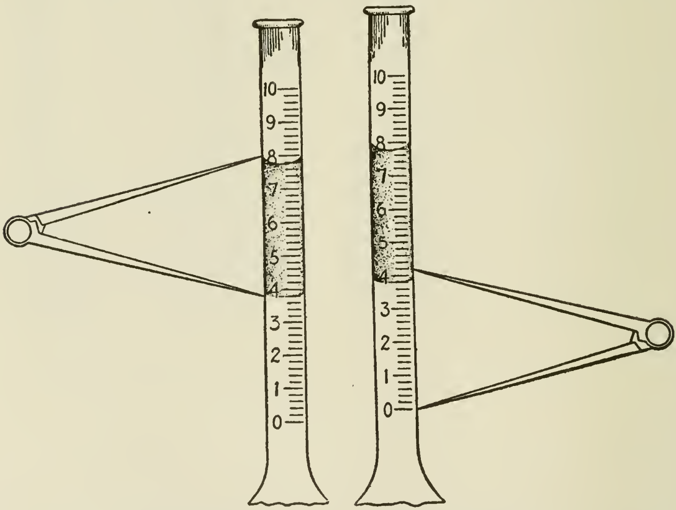
4. **Mixing milk and acid.** The milk and acid having been placed in the test bottle, are now mixed by taking the bottle by the neck and giving it a rotary motion. The acid immediately dissolves the curd, the bottle becomes hot and the contents turn black.

5. **Whirling and filling bottles.** The bottles are now placed in the machine and whirled for five minutes. They are then filled up to the bottom of the neck with hot water, using either the acid measure or the pipette for this purpose. If hard water is used the carbonates in it must be broken up by adding to it a few drops of acid before filling the bottles, otherwise the carbonates in the water may cause a foam to appear on the fat and spoil the reading. Only a few drops of acid should be used, and to prevent accident these should be dropped from the acid measure and not from the bottle. *Great care* is necessary in handling this acid.

The bottles are whirled a second time for one or two minutes, the fat is then brought up into the neck by adding a few more drops of hot water, the bottles returned to the tester and whirled a third time for a minute or two, when they are taken out and placed in a water bath having a temperature of 120-140 degrees F., where the fat column should be submerged for four or five minutes.

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

If both ends of the fat column are above the zero point, note the reading of these two points



Reading the test by use of dividers.
The dividers in the first position for reading the test. The dividers in the second position.
Fig. 8.

and take their difference. For example: If the lowest point of the fat is 1.8 per cent and the highest is 5.6 per cent, then the per cent of fat is 5.6—1.8 or 3.8 per cent. A quicker way is to place a pair of dividers against the neck of the test bottle with the legs so spread that one of them rests on the highest point and the other on the lowest point of the fat, 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 customary to place a board cover over an ordinary jar, and then bore holes about 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.

EXERCISES

1. Why are the milk bottles whirled at high speed in making a Babcock test?
2. What is the strong acid used for?
3. Why should the milk be thoroughly mixed immediately before taking the sample?

4. Do you know the "test" of each of your cows?

5. If not, take samples of the milk of each and test according to directions given. Great care should be exercised in taking the sample. Follow directions very carefully. If you do not happen to have a tester, ask your butter or cheese maker to test the samples for you or allow you to use his tester.

6. Can you give four reasons why the fat column in the neck of the milk test bottle may be light in color or have curd underneath the fat column?

7. Why do you read the extremes of the fat column from the bottom of the fat column to the bottom of the upper meniscus?

LABORATORY PROBLEMS

V. To Test Sample of Milk by the Babcock Test

Obtain samples of milk and proceed as follows:

a. Pour sample from one container to another several times in order to thoroughly mix the milk.

b. Immediately fill a 17.6 c.c. pipette to the mark on the stem and transfer to a milk test bottle.

c. Add 17.5 c.c. sulphuric acid and mix the same by holding the bottle in an inclined position and whirling it horizontally. Whirl until all the acid is mixed with the milk.

d. Place in tester and whirl for five minutes. Be sure that the tester is balanced. In case of an odd number of bottles, fill one with water and balance the tester with it.

e. Fill the bottle to the neck with hot water to which has been added a few drops of sulphuric acid; whirl two minutes more.

f. Add hot acidulated water, so as to bring the fat up to the 8 per cent mark. Give it a final whirling for two minutes.

g. Take bottles out of tester and place in water bath for four or five minutes.

Precautions

a. Never open the tester while the bottles are in motion.

b. Both milk and acid should be about room temperature. Do not use hot acid or hot milk.

c. Always have a bottle of ammonia water handy to use in case of an accident. If acid comes in contact with clothing, immediately use cold water and then ammonia water.

d. In case acid is accidentally spilled on the hands or the face, wash off at once with plenty of cold water. In case of a serious burn, consult a physician.

LABORATORY PROBLEMS

VI. To Determine the Importance of Thoroughly Mixing the Sample Just Before Taking Sample with a Pipette

a. Mix well a sample of milk. Test it at once.

b. Allow the sample to stand for ten minutes.

c. Take a sample with a pipette from the top of the milk. Test.

d. Take another sample from the bottom of the milk. Test. Compare results. Can you account for the difference in the tests obtained?

CHAPTER V

THE DAIRY COW

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

The beef-type. 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.

The dual-purpose-type. 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.

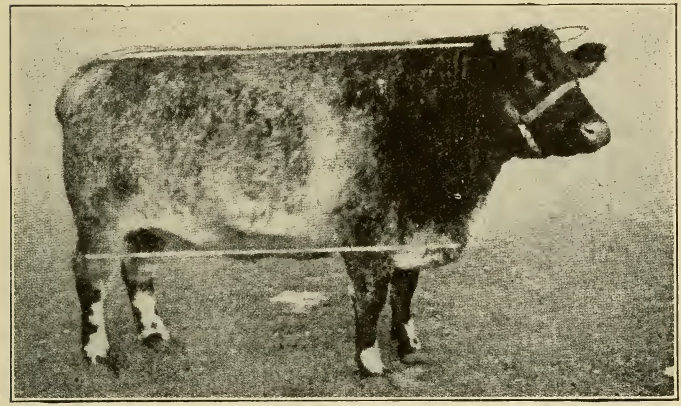


Fig. 9. Beef-type.
Note the blocky form of the animal's body.

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 still a question 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 good quantity of high-testing milk and at the same time are fair producers of beef.

The dairy-type. The dairy-type includes such breeds as are not inclined to produce beef. They

Fig. 10. Dairy-type.
The difference between beef- and dairy-types. The beef animal has straight top and bottom lines, while the dairy cow is wedge shaped.

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 is difficult to describe briefly 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 pro-

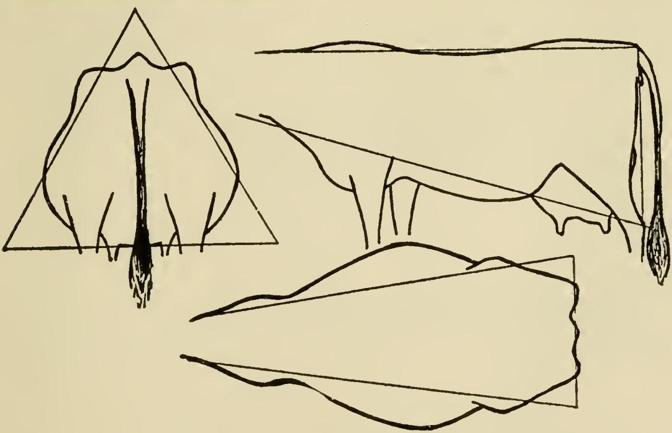


Fig. 11. Look for the wedges.
The body should be wedge-shaped when viewed from the front and top of the withers, wider at the hip bones and at the floor of the chest than at the point of the withers.

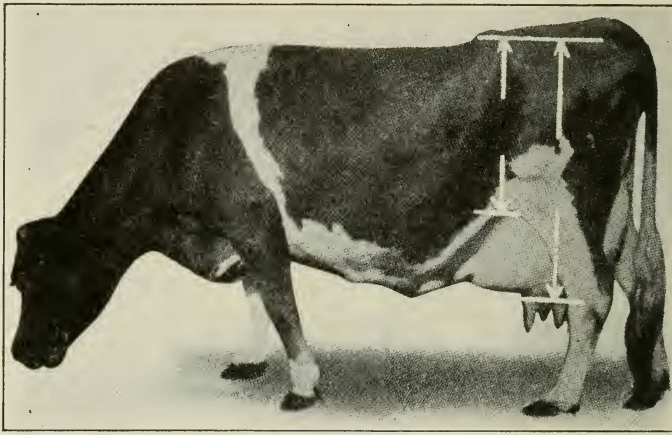


Fig. 12. Great digestive capacity is essential.
Fullness of flanks and good depth from the hips to the lower line of the rear flank and of the udder, together with well-sprung ribs, far apart, indicate a large digestive capacity.

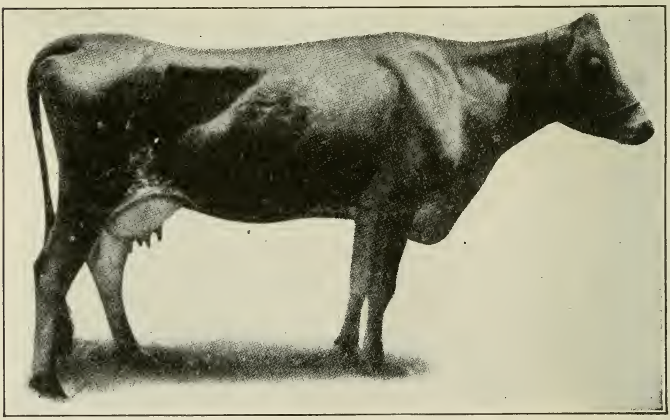


Fig. 13. A shallow body lacks capacity.
A narrow head, small eyes, nostrils and mouth, usually accompany a narrow, shallow body. A cow with these characteristics proves a disappointment as a milk producer.

ducing large quantities of milk. This widening of the body towards the rear gives to her the

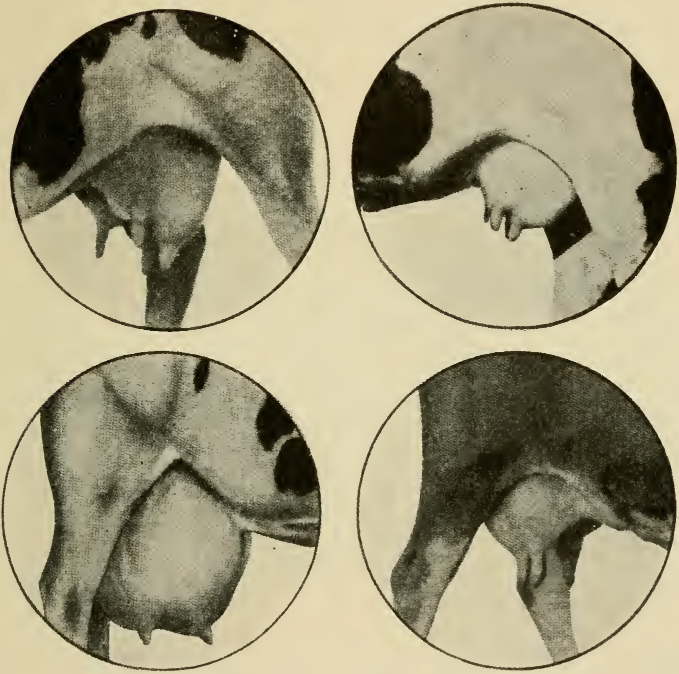


Fig. 14. Four types of undesirable udders.
Udders deficient in the forequarters, irregular in the size of quarters, pendulous in form or funnel shaped make milking hard and reduce the capacity for milk production.

"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.

The ideal udder. 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.

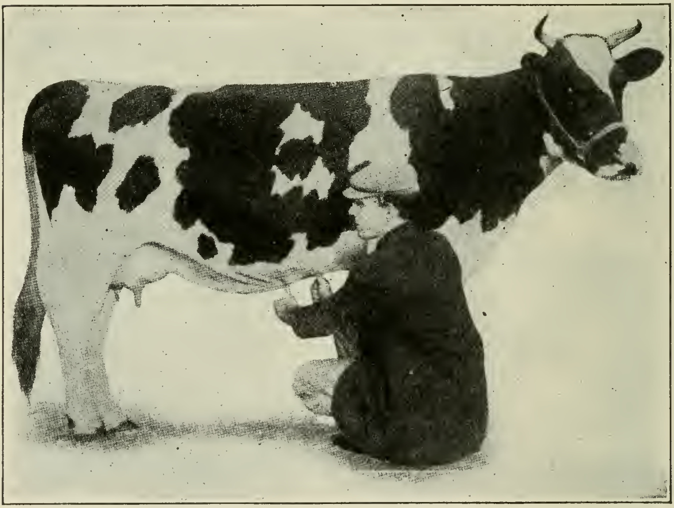


Fig. 15. The location of the milk wells.
Several milk wells of good size through which the mammary veins pass into the body are the best indications of the amount of blood that circulates through the udder and supplies the milk secreting glands.

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.

Production the best quality of a dairy cow. Though a good dairy cow usually possesses most of the desirable characteristics shown on the score card at the end of this chapter, it is sufficient to say here that the real test of her value as a dairy cow is her butter fat producing ability. 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 fore part 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 book.

Pure dairy breeds best. It is unfortunate for the dairy industry that we do not find more pure-bred stock in this country. The farmer should raise pure-bred stock because it is usually 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. Brief discussion of a few of the distinctive dairy breeds, representatives of which are found in almost every community, follow.

Jersey. As the name indicates, this breed 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 supporters. The Jerseys are usually small cows, weighing from 650 to 1,000 pounds, averaging about 900 pounds each. They produce milk rich in fat, testing 4 per cent and over. As a rule they are persistent milkers, but usually do not produce large quantities of milk. This latter statement is sometimes used as an argument against them. These animals have some good records to sustain their claim as a worthy 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 daily for ninety days. These are remarkable showings and speak well for this breed. Although at present the members of this breed are small in stature, the time will doubtless come when breeders will be able to develop certain families of a larger frame and more vigorous constitution than the Jersey of

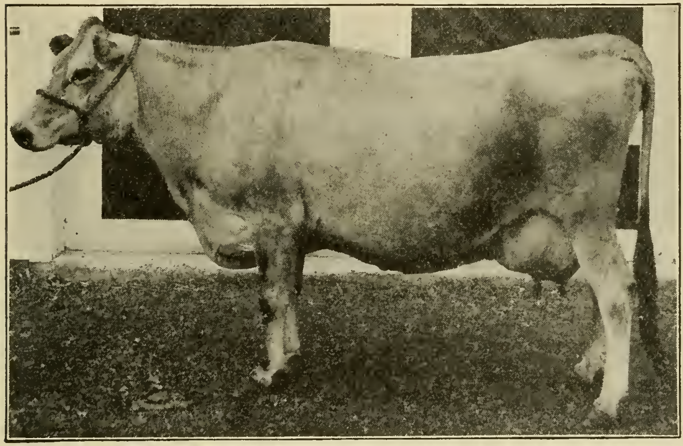


Fig. 16. Old Double Time.
A prize Jersey in the University of Wisconsin herd.

the present time, and at the same time preserve in the families the desirable qualities possessed by the Jersey cow 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 that 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.

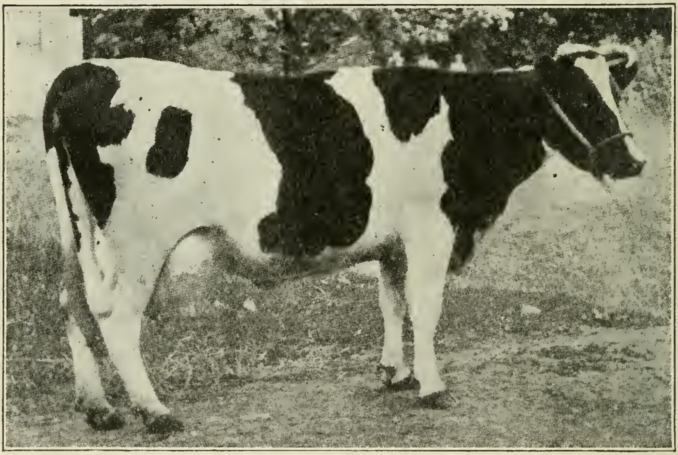


Fig. 17. Maplecrest Pontiac Daisy DeKol.
A high-testing Holstein cow, testing on official record 4.13 per cent.

The flow is, as a rule, exceedingly large and certain families of this breed produce milk testing 4 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 in 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. Any good Holstein-Friesian cow will produce six or 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, it derives its name from the island on which the breed originated, which is another of the islands in the British Channel. Members of this breed have larger frames than 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 to contain 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. The milk of the Guernsey is not usually quite so rich in fat as that of the Jersey, but the quantity given is somewhat greater. At the Pan-American Exposition the Jersey milk tested 4.82 per cent, while the Guernsey milk tested 4.68 per cent.

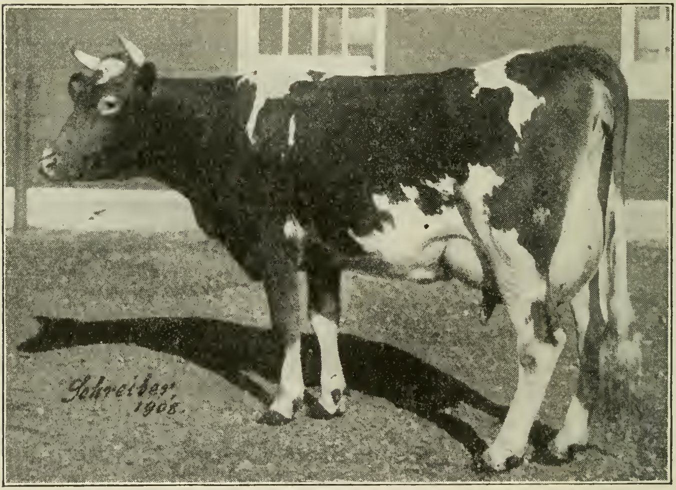


Fig. 18. Dolly Dimple.
A typical Guernsey cow. Note the well-shaped udder with its high attachments.

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 in a test covering a period of six months. A statement of the records of

Yeksa Sunbeam, May Rilma and Murne Cowan, Guernsey cows, is given on page 99.

Ayrshire. These cows are found principally in New England, the Eastern States and Canada. They came originally from Scotland and possess a great deal of merit. Like the Holstein-Friesian they are as a rule persistent milkers.

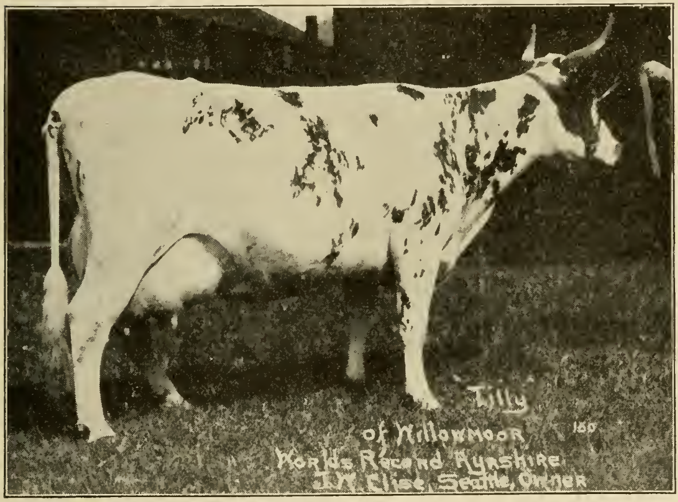


Fig. 19. Lilly.
A splendid type of Ayrshire dairy cow.

They are medium-sized animals, weighing about 1,000 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 usually tests from 3.5 to 4 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.

Dual-purpose breeds. In addition to the above leading dairy herds, there have been developed milking strains of the so-called dual-purpose breeds that give promise in the dairy world. Chief among these are the Brown Swiss, the Red Polled, and the Milking Shorthorns. It is argued in support of these breeds that their calves will help to supply the market for "baby-beef" and that their carcasses are much more valuable to the butcher than those of the strictly dairy breeds. It is quite probable, however, that when these breeds have developed striking dairy qualities, their forms will also change so as to render them less valuable for meat production.

EXERCISES

1. Why should a dairy cow have a "big middle?"
2. Why cannot an animal be a good beef and a good dairy cow at the same time?
3. Does a "heavy milker" often lay on flesh? Why?
4. Why is it necessary to "dry off" a cow in order to fatten her?
5. To what breed do your cows belong?
6. Of what type are they?
7. For your own satisfaction select the three cows in your own herd which are of the best dairy-type by

comparison with the description and pictures in this book and by use of the score card and the comparison card above.

LABORATORY PROBLEMS

VII. To Determine the Variation in the Fat Content from the Same Cow During the Process of Milking

a. Obtain samples of milk at the beginning of the milking.

b. Obtain sample of milk at about the middle of the milking.

c. Obtain sample of milk at the end of milking. Samples a, b and c can best be obtained by milking directly into small bottles.

d. Pour all the milk obtained (except samples a, b and c) back and forth several times. Sample.

Test all four samples and compare results. Why does the milk increase in richness during the milking process?

VIII. To Determine the Variation of the Fat Content of Milk from One Milking to Another

Sample and weigh each milking from an individual cow for a period of four days.

Tabulate the data and if possible plot a curve showing:

a. Variation in the test of the milk.

b. Variation in the quantity of the milk produced.

c. Variation in the amount of fat obtained at each milking.

DAIRY CATTLE COMPARISON CARD

Student..

Date...

	1st place	2nd place	3rd place	4th place	5th place
Dairy temperament					
Capacity					
Skin					
Constitution					
Top line					
Head					
Neck					
Shoulder					
Body					
Rump					
Veining					
Fore—udder					
Rear—udder					
Teats					
Udder					
Breed Characteristics					
Placing					

SCALE OF POINTS	Perfect	Points Deficient		Points Deficient	
		Student's score	Corrected	Student's score	Corrected
INDICATION OF CAPACITY FOR FEED—25 POINTS					
Face, broad between the eyes and long; muzzle clean cut; mouth large; lips strong; lower jaws lean and sinewy	5	......	......	......	......
Body, wedge shape as viewed from front, side and top; ribs, long, far apart and well sprung; breast full and wide; flanks, deep and full	10	......	......	......	......
Back, straight; chine, broad and open; loin, broad and roomy	5	......	......	......	......
Hips and thurls, wide apart and high	5	......	......	......	......
INDICATION OF DAIRY TEMPERAMENT—25 POINTS					
Head, clean cut and fine in contour; eyes, prominent, full and bright............	3	......	......	......	......
Neck, thin, long, neatly joined to head and shoulders and free from throatiness and dewlap	4	......	......	......	......
Brisket, lean and light......	2	......	......	......	......
Shoulders, lean, sloping, nicely laid up to body; points prominent; withers sharp.	4	......	......	......	......
Back, strong, prominent to tail head and open jointed.	3	......	......	......	......
Hips, prominent, sharp and level with back...........	3	......	......	......	......
Thighs, thin and incurving..	4	......	......	......	......
Tail, fine and tapering.......	1	......	......	......	......
Legs, straight; shank fine...	1	......	......	......	......
INDICATION OF WELL DEVELOPED MILK ORGANS—25 POINTS					
Rump, long, wide and level; pelvis roomy	3	......	......	......	......
Thighs, wide apart; twist, high and open............	3	......	......	......	......

SCALE OF POINTS	Perfect	Points Deficient		Points Deficient	
		Student's score	Corrected	Student's score	Corrected
Udder, large, pliable, extending well forward and high up behind; quarters, full, symmetrical, evenly joined and well held up to body..	15	......	......	......	......
Teats, plumb, good size, symmetrical and well placed...	4	......	......	......	......
INDICATIONS OF STRONG CIRCULATORY SYSTEM, HEALTH, VIGOR AND MILK FLOW—25 POINTS					
Eyes, bright and placid	2	......	......	......	......
Nostrils, large and open.....	3	......	......	......	......
Chest, roomy	5	......	......	......	......
Skin, pliable; hair, fine and straight; secretions, abundant in ear, on body and at end of tail................	7	......	......	......	......
Veins, prominent on face and udder; mammary veins. large, long, crooked and branching; milk wells large and numerous	7	......	......	......	......
Escutcheon, wide and extending high up...............	1	......	......	......	.....
Total	100	.....	......	.....	.....

CHAPTER VI

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 produce much more than that.

The three-hundred-pound standard. In a single month Colantha 4th's Johanna 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. 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 300-pound mark, and the majority of them exceed 400 pounds of butter fat annually.

Profit on 350 pounds butter production per cow. 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 the water, curd, and salt, which are normal constituents of butter, 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 five years good creamery butter has averaged about twenty-seven cents per pound the year round.* The cow that has returned to the farmer 350 pounds of good butter has brought him $95, a pretty neat sum. And here, too, many let the calculation stop. Herein lies the error. Though the cow has returned to the farmer this amount, he must not forget that she has cost him something in feed and care. During this same period this cost has not been far from $50 per year in the north central states. Deducting this from the amount received for the butter leaves a profit of $45. 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 eaten hay and grain raised on the farm, and the fertility in the manure has probably found its way back to the soil.

Profit in 200 pounds of butter production per cow. Let us suppose another case. Instead of producing fat for 350 pounds of butter, let us

*The five years preceding the world war.

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 $54, and the farmer's profit would have been but $4, or less than one-eleventh as much as that of the first cow. In other words, the first cow is worth more to the dairyman than eleven of the second.

Loss on 150 pounds of butter production per cow. 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 twenty-seven cents per pound this amount of butter is worth $40.50, or $9.50 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 cow. How necessary then that he should 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.

How individual tests are made. 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 is used to keep the sample from souring.

Before the milk is sampled it is thoroughly mixed, as stated under directions for sampling already given in the chapter on the Babcock test, and a few tablespoonfuls 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.

How to get reliable records. 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.

A shorter method. 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 to multiply these weights by 5 to get the weight of milk given by each cow during each particular month of her milking period.

A test of little value. 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.

Simpler but less accurate methods. 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

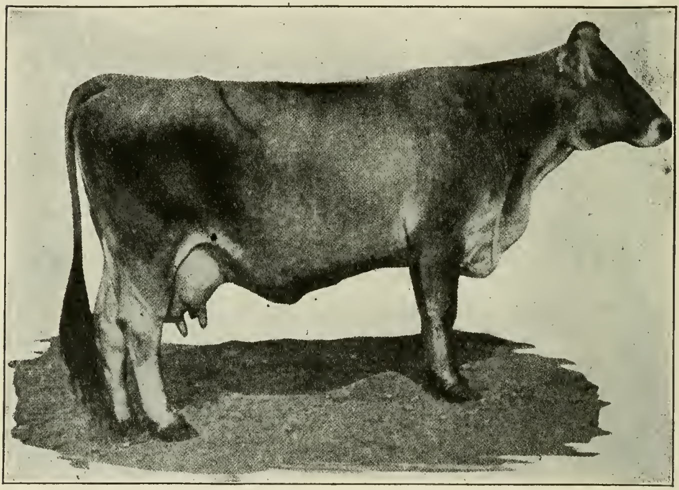


Fig. 20. College Bravura 2nd.
A fine old Brown Swiss cow of marked dairy-type.

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 during the fifth month of lactation. Then $100 \times 5 \times 10 = 5{,}000$ pounds of milk annually. The test is 4.2 per cent. Then 5,000 × 4.2 per cent = 210 pounds butter fat; 1/6 of 210 is 35; then 210 + 35 = 245, or this cow produces approximately 245 pounds of butter annually.

How to apply the results of the test. 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.

A single cow's record. In order to stimulate an interest in the production end of dairying, it is usually an easy matter for a high-school teacher to make arrangements with some party owning a cow whereby students are allowed to keep records of the production of some particular cow or cows. On the next page is given the record of a single cow in a herd belonging to a cow-testing association organized and conducted by schoolboys:

RECORD OF COW NO. 5

	Milk	Pounds B. F.	Value B. F.	Cost of Feed	1912-13 Net Returns
December	954	38.1	$ 13.18	$ 6.06	$ 7.12
January	784	31.3	14.06	6.06	8.00
February	638	26.8	11.39	5.47	5.92
March	725	29.7	11.88	6.99	4.89
April	766	34.5	13.45	6.76	6.69
May	623	28	9.24	3.78	5.46
June	762	40.4	12.52	2.00	10.52
July	254	19	5.13	2.00	3.13
August	Dry	....	....	2.00	—2.00
September	834	31.7	13.63	2.00	11.63
October	834	31.7	13.63	2.00	11.63
November	858	28.3	13.58	4.08	9.50
	8,032	339.5	$131.69	$49.20	$82.49

Herd records. The following shows the record of all the herds belonging to an association:

CLASSIFICATION OF HERDS

Butter Fat Basis—1913

Rank	Number Cows	Av. Lbs. Milk	Av. Test	Av. Lbs. Butter Fat	Highest Producer	Lowest Producer
1......	12	7,901	3.86%	305	376.3	229.7
2......	18	8,376	3.53	296	332.9	183
3......	13	8,041	3.65	293.3	344.1	214.7
4......	15	6,561	4.38	287.7	393.5	124.7
5......	28	7,753	3.62	280.7	426.8	110.6
6......	16	5,815	4.68	280.5	446.3	188.7
7......	8	8,317	3.28	273.4	367.9	229.7
8......	18	7,627	3.53	272.6	371.2	204.8
9......	6	6,452	3.87	261.5	339.5	197.5
10......	13	6,213	4.20	261.1	294.3	114
11......	17	6,772	3.6	243.9	312	105.3
12......	11	5,881	3.96	233.3	281.7	177.5
13......	8	4,964	4.60	228.4	344.9	158.5
14......	7	6,339	3.55	226.4	274.5	184.5
15......	22	6,288	3.53	222.1	366.8	166.6
16......	18	5,405	3.83	206	289.8	146.3
17......	24	5,007	3.64	182.3	238.6	120.9
18......	10	4,337	3.68	160	280.4	44
Total.	264					
Average of Ass'n.		6,924	3.78	261.7		
Av. cost of feed..		$48.79				
Average profit...		52.14				

A study of the table below will show the reasons for good herds.

COWS PRODUCING

Rank	Less 150 lbs.	100 to 250 lbs.	200 to 250 lbs.	250 to 300 lbs.	300 to 350 lbs.	350 to 400 lbs.	400 to 450 lbs.	Total
1....	..	..	2	4	1	5	..	12
2....	..	1	4	9	4	..	..	18
3....	..	..	4	..	9	..	..	13
4....	1	..	3	3	6	2	..	15
5....	5	4	6	6	3	1	3	28
6....	..	1	3	7	3	1	1	16
7....	..	..	2	3	2	1	..	8
8....	..	..	6	6	4	2	..	18
9....	..	2	..	3	1	..	..	6
10....	1	3	5	4	..	..	..	13
11....	2	4	7	2	2	..	..	17
12....	..	4	5	2	..	..	..	11
13....	..	3	1	4	..	..	..	8
14....	..	..	6	1	..	..	..	7
15....	..	9	6	5	1	1	..	22
16....	1	5	10	2	..	..	..	18
17....	4	16	4	..	..	..	..	24
18....	1	3	4	2	..	..	..	10
Totals	15	55	78	63	36	13	4	264

RECORD OF HERD NO. 8

Cow	Milk	Pounds Butter Fat	Value B. F.	Cost Feed	Returns B F.—C. F.
3.....	5,787	265.4	$104.38	$49.20	$55.18
4.....	7,489	270.2	107.49	49.20	58.29
5.....	8,032	339.5	131.69	49.20	82.49
6.....	4,997	198.4	72.94	47.52	25.42
8.....	7,837	298.7	116.74	49.20	67.54
9.....	4,572	197.5	76.60	36.06	40.54
Av.....	6,452	261.6	101.64	46.73	54.91
Without No. 9.	6,828	274.4	106.65	48.86	57.79
Increase	376	12.8	5.01	2.13	2.88

EXERCISES

1. From the data given in the record of cow No. 5 calculate the fat test for each month.

2. Using same data determine the price allowed for each pound of butter fat for each month.

3. Using the price per pound of butter fat just obtained calculate the total returns from each herd in the association.

4. At the average cost of feed per cow given at the bottom of the table what is the net profit made by each herd?

5. The average net profit per cow in each herd?

6. Do you know the profit over cost of feed of your own herd?

7. By use of one of the methods described in the last chapter determine this for the home herd.

LABORATORY PROBLEMS

IX. To Test Samples of Milk Which Are Partially Churned

It frequently happens that milk which has been put in bottles and carried some distance becomes partially churned. The difficulty in testing such samples arises from the fact the milk cannot be accurately sampled. The following method will give accurate results if carefully performed.

a. Take a small quantity of milk (200 to 300 c.c.) and test to determine the true percentage of fat it contains.

b. Shake the remainder of the sample in a tightly sealed bottle until butter granules appear on the sides of the bottle.

c. Add about 10 c.c. of ether to the sample to dissolve all the churned butter granules. If 10 c.c.'s are not sufficient, add a few more. It is necessary to keep an exact account of the amount used.

d. When all the butter granules have been dissolved, sample as in the case of milk. Add only one or two c.c. of acid at first and gently shake. Do not hurry the process, but give the ether plenty of time to evaporate. The acid should be added in small portions until the required amount has been added.

e. The reading must be corrected to allow for the ether added. Compare the result with the test of the original milk.

Note: This exercise requires extreme care and skill in its manipulation if accurate results are to be obtained.

X. To Determine the Calibration of Glassware Used in Connection with Babcock Test

a. Fill a 10 per cent milk test bottle to the zero mark with water. With a strip of blotting paper, carefully absorb the water adhering to the sides of the neck of the bottle. Observe particularly that the height of the water is exactly at the zero mark.

b. With a graduated burette, drop 2 c.c. of water into the bottle. Observe the height to which it fills the bottle. Test bottles are so made that it takes 2 c.c. to fill 10 per cent on the neck of the bottle, i. e., 2 c.c. of water or alcohol should exactly fill the space from 0 to the 10 per cent mark.

c. Prepare another bottle as under "a." Insert a Trowbridge plunger and observe the height to which it raises the water.

d. Cream bottles can likewise be tested.

e. Into a beaker place the contents of a 17.6 c.c. pipette of milk. If the pipette is accurate the amount of milk delivered will weigh 18 grams.

Note: In calibrating glassware many prefer to use colored denatured alcohol. The liquid should be at room temperature. It is not advisable to hold the bottles in the hand, as the heat of the hand may change the temperature and make the results inaccurate.

CHAPTER VII

CREAM SEPARATION

Three methods of 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 or warm 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 and the heavier part of the milk, which is the skim-milk, is crowded to the outside and the lighter portion, which is the cream, is forced toward the center. Each portion 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 by far the most efficient.

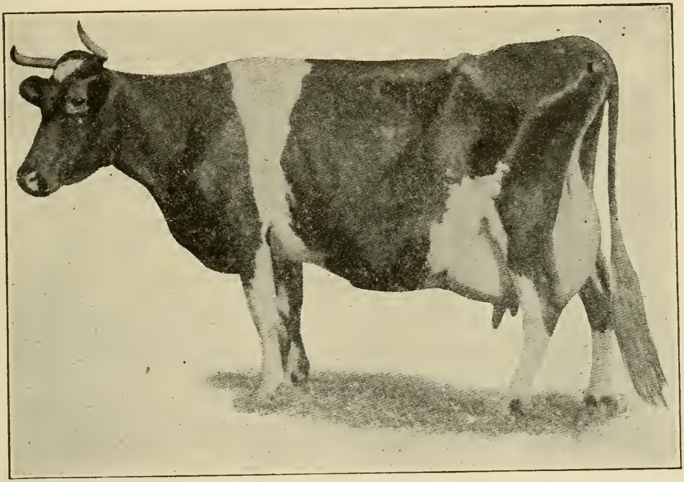


Fig. 21. A cow with marked dairy temperament.
Clean cut features about the head and face, the fine clean neck, the prominence and sharpness of the back bone, hip points and pin bones, the thin, incurving thighs and the clean, fine shanks in this cow are indications of extreme dairy temperament.

Fat losses in skim-milk make dairying unprofitable. One of the reasons why dairying, before the invention of the Babcock test and the centrifugal separator, was unprofitable was because of the large losses of butter fat in the skim-milk when separated by the gravity process. No matter how careful the dairyman may be to secure a proper temperature—the one most favorable to good separation by the gravity process—the skim-milk losses are very heavy.

Losses by gravity method. With the shallow pan method the losses vary with the conditions to which the milk is subjected. However, the skim-milk with this method of separation will rarely test less than five-tenths of one per cent. The deep setting method of cream separation was the best devised up to the time of the introduction of the centrifugal separator. In this method the milk after milking was immediately placed into long cylindrical cans, commonly called "shot-gun" cans. These were placed in cold water, preferably ice water. With this method the losses in the skim-milk were reduced to about two-tenths of one per cent. However, if the setting of the milk was delayed or the water was not cold, the increase in the loss of fat in the skim-milk was much greater.

Dilution causes large losses. 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 from six-tenths to one and two-tenths per cent fat. This is from one-fifth to one-third of the entire fat content of the whole milk. At the Kansas station still greater losses were found to exist.

A comparison of losses by various methods. The Indiana Experiment Station, after exhaustive experiments, published in a recent bulletin a summary of their findings showing the losses in the skim-milk under the most favorable conditions by the various methods to be as follows:

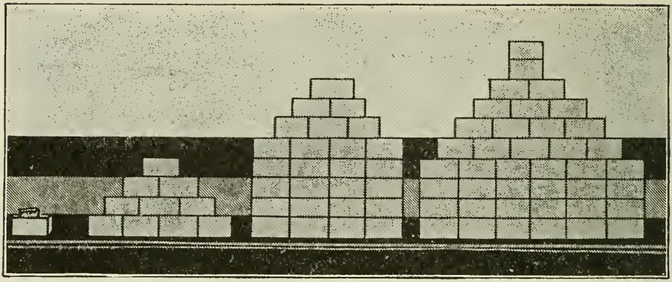
Hand separator method	.02 per cent
Deep setting method	.17 per cent
Shallow pan method	.44 per cent
Water dilution method	.68 per cent

The following table shows the amount of fat lost in the skim-milk under average conditions:

No. Cows	Lbs. Milk	Water Dilution Lbs. Fat	Shallow Pan Lbs. Fat	Deep Setting Lbs. Fat	Hand Separator Lbs. Fat
1	6,000	29.07	25.5	17.34	2.75
5	30,000	145.35	127.5	86.70	13.75
10	60,000	290.70	255	173.40	27.50
15	90,000	436.05	382.5	260.10	41.25
20	120,000	581.40	510	346.80	55

Compute the loss at the low rate of 25 cents per pound of fat.

The bulletin referred to uses the following graphic illustration to show the butter lost in the skim-milk from one cow in one year by the various methods of separation.



Hand Separator. Loss of Butter 1.2 lbs. — Deep Setting. Loss of butter 10.1 lbs. — Shallow Pan. Loss of butter 26.2 lbs. — Water Dilution. Loss of butter 40.5 lbs.

Fig. 22.
Comparison of fat losses by various methods of separation.

EXERCISES

1. What effect on the feeding value of the skim-milk will the dilution method of cream separation have?

2. Will Jersey milk separate by the gravity method better than Holstein milk? Why?

3. Will the milk of one breed separate better with a centrifugal separator than the milk of another breed?

4. What would be the loss in the fat of the skim-milk from a herd of ten cows by each of the methods described in this chapter, assuming butter to be worth thirty cents a pound?

5. What method of separation is used on your farm?

6. Do you test your whole milk? Your skim-milk?

7. Do you know whether you are losing fat in your skim-milk or not and how much?

LABORATORY PROBLEMS

XI. To Determine the Per Cent of Fat in Cream

a. Carefully weigh 18 grams of cream into a 30 per cent cream test bottle.

b. Add about the normal amount of sulphuric acid (17.5 c.c.).

c. Test as in the case of whole milk; that is, whirl three times and fill twice.

d. Place in a water bath having a temperature of 120 to 140 degrees.

e. Before reading add a few drops of white mineral oil or colored denatured alcohol. Care must be exercised to prevent the oil from mixing with the fat column. This can best be accomplished by allowing the oil to run slowly down the side of the neck.

LABORATORY PROBLEMS

XII. To Determine the Richness of Cream by Use of 50 Per Cent 9-Gram Bottle

In many states the 50 per cent 9-gram bottle is used instead of the 18-gram 30 per cent bottle. This means that 9 grams are used as a charge.

a. Weigh out 9 grams of cream into bottle.

b. Add about 9 c.c. of clear water. Mix.

c. Add normal amount of sulphuric acid (17.5 c.c.).

d. Test as in the case of milk. Place in water bath and then read, using white mineral oil or colored denatured alcohol to level the meniscus.

e. In case a 9-gram bottle is used the reading is direct, as the bottle is calibrated to read direct. In case an 18-gram bottle is used, then the reading must be multiplied by 2, because 9 grams is only half a charge.

CHAPTER VIII

THE FARM SEPARATOR

Use of farm separators widespread. When separators were first introduced they were built for factory purposes. They were large machines capable of separating the cream from two or three thousand pounds of milk per hour. The cost and the inconvenience of gathering the milk at the "whole milk" creameries were in very many cases so great that most of them have been forced to abandon their power separators. At the present time we find very few creameries still receiving whole milk. Instead, small separators have such decided advan-

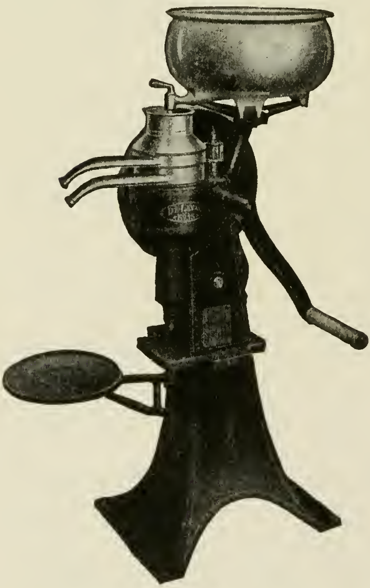


Fig. 23. A farm separator.

tages that, in sections of the country where dairying is carried on extensively, they are found on practically every farm, even though the farmer may have only a very few cows. 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.

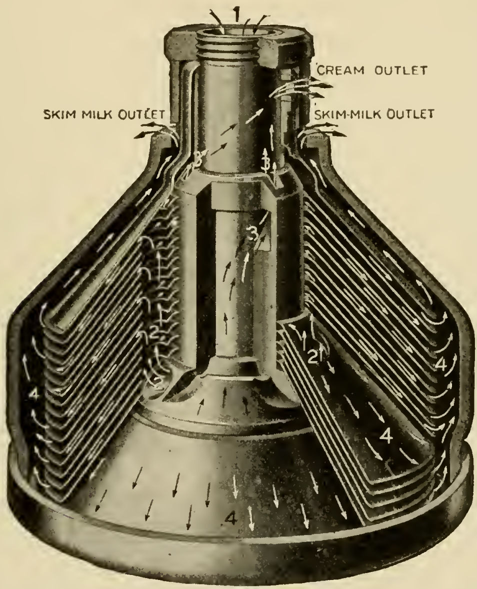


Fig. 24. Vertical section view showing interior of cream separator.

The principle of centrifugal separation. 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 the farthest; that is, he gives 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 all the skim-milk 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.

The effect of temperature in separation. 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 or warm it up before the milk is put into it.

Milk must be fed into bowl at a uniform rate. A third point that should be observed if satisfactory results are to be obtained is the uniformity with which the milk is introduced into the bowl. An even feed will do much to ensure an even cream test, all other conditions remaining the same.

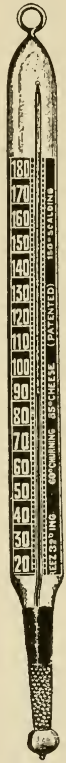


Fig. 25. A thermometer. A valuable piece of apparatus for the farm dairy.

Machine must be kept clean. 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.

Necessity for oiling. 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 work are known to have been in constant use for fifteen years. This is because the machines have been well cared for.

Vibration. The machine must be placed in a vertical position on a solid foundation and securely fastened, so as to prevent all vibration. Heavy losses are occasioned by an unbalanced bowl or any other source of vibration.

EXERCISES

1. Why can milk be separated at a temperature of 80° to 90° F. with less loss in the skim-milk than when it is separated at 60° to 70° F.?

2. Why wash the dishes in the home after each meal and wash a farm separator only once a day?

3. Why should the separator parts be left to air in the sun?

4. Why is it important to maintain the proper speed when separating milk?

5. What is the difference in composition between milk and cream?

6. What is the legal standard in your state for cream, milk, skim-milk?

LABORATORY PROBLEMS

XIII. To Study the Principles of the Centrifugal Cream Separator

1. Study the various parts of the separator and learn how to assemble them. Care must be exercised to see that the various parts are not damaged by dropping them or by jamming the parts together.

2. Oil the bearings well with good hand separator oil.

3. Determine the speed of the separator bowl per minute. This can easily be done by counting the revolutions of the bowl while the operator slowly turns the handle one complete revolution. Then multiply the number obtained by the number of revolutions made by the handle per minute.

4. Slowly bring the separator up to the proper speed, which is usually indicated on the handle. When at about one-fourth speed fill the bowl with lukewarm water. The object of this is to see if the bowl leaks. If it does, stop at once and locate the trouble.

5. If the milk to be used for this experiment is cold, warm it to a temperature of about 85 degrees. Stir well, weigh and place in milk container on the separator.

6. When all the foregoing observations have been made and precautions have been taken, carefully bring the separator bowl to full speed and slowly open the feed valve so that the rate of inflow is normal. There is usually a float to regulate this important matter. The exact time of starting the flow of milk should be observed and recorded.

7. Continue to separate the milk, being very careful to see that the correct speed is maintained. This

must not be a matter of "guess work," but should be observed carefully by means of a watch. When the milk has all been separated, the exact time should be again observed and recorded. Knowing the weight of the milk and the length of time taken to separate it, it is a matter of easy computation to determine the capacity of the separator per hour.

8. When all the milk has been separated, and while the bowl is still in motion, it is well to flush the bowl at once with either warm skim-milk or with a quart or two of lukewarm water. This is necessary, as otherwise there will be a large quantity of valuable cream remaining in the separator. In flushing the bowl the skim-milk or water should be poured into it as fast as the bowl will take it.

9. The separator bowl and tinware should be washed soon after they are used. The bowl should be taken apart and each part carefully cleaned, using lukewarm water. The different parts (except the rubber ring) should be scalded with hot water and allowed to dry in a clean, dry place, preferably in the sunshine. The bowl should not be put together until time to be used again.

10. The following observations should be made by the students:

Name of student.....................Date ....
Name of separator..................Number ....
Rev. of handle per min.....Speed of bowl per min.....
Lbs. of milk separated.....Time required............
Capacity of machine per hour......................
Pounds of milk separated..........................
Test of milk...
Pounds of fat in milk..............................

Pounds of cream..............................
Test of cream................................
Pounds of fat in cream.......................
Pounds of skim-milk..........................
Test of skim-milk............................
Pounds of fat lost in skim-milk..............
Pounds of cream per 100 pounds of milk.......

Note: Other exercises may be developed by the instructor to show the losses of fat in the skim-milk and the richness of the cream.

(a) When cold milk is separated instead of warm milk.
(b) When the speed of the separator is below normal.*
(c) When the separator is operated at only one-half capacity, or when "crowded to overcapacity."*
(d) When the cream screw is adjusted to get a richer or a thinner cream.

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*No separator should be run faster than recommended by the manufacturer.

CHAPTER IX

VALUE OF SKIM-MILK

One has only to consider 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.

Skim-milk an excellent feed. 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. None of the food substances are removed from the milk except the fat, and this fat can easily be supplied by a much cheaper substitute.

How skim-milk may be improved for feeding. 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.

Skim-milk necessary for pork production. 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 contary, 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.

A great dairyman's experience in feeding skim-milk. Former Governor Hoard, one of the great pioneers in dairying, once said:

"Put this statement to the fore: That for the past ten years no milk shipper or condensory has paid for milk what the cream is worth at the creamery for butter making, and the skim-milk is worth on the farm in the raising of good live stock. That any farmer if he will be intelligent can in a ten-year trial make more clean money by keeping the skim-milk on the farm, raising well-bred heifers and cows for sale, than in any other form of dairying. If the creamery does not see what it has to do with this problem, then it is not big enough for its place. Stop fighting the farm separator and go to work to teach the farmer better how to deal with the milk and cream at the farm end. Remember that the farm separator and calf and pig raising is the main defense of the creamery against the competition of milk shipping and condensing.

"Now a word, if you please, as to the real money value of good skim-milk for calf and pig raising. Of course, much depends on the kind of calves and pigs one raises and so does the price you get for butter depend on the kind of butter you make and sell."

An experiment in calf raising. "Here is an experiment of my own calf raising. I took ten grade Guernsey heifer calves, such as any ordinary farmer can produce, part of them bought right after birth of neighbors. I kept them till they were ten months old and sold them for $25 apiece. That is not a big price for fine heifer calves of *desirable* blood. I fed each of those calves a dollar's worth of oats; alfalfa hay to the amount of $1.50, and 50 cents worth of blood meal. That made $3.00. I allowed $3.00 for the carcass. That made a total of $6.00, leaving $19.00 to be credited to the 3,000 pounds of skim-milk each consumed. Understand, I charged the calf with the market value of the other food it consumed; the balance went to the skim-milk because it was the skim-milk that made all the rest available. Figuring that way, the skim-milk returned 63 cents a hundred. The butter fat in the milk averaged at that time, if I remember correctly, $1.50 per 100 pounds of milk. That made the whole milk worth in cash to me $2.13 per hundred pounds. Do you wonder that I say no milk shipper or condensory would pay me what my milk is worth even in raising nothing better than grade heifer calves? The skim-milk is worth over $3.00 a hundred when fed to pure-bred calves."

Skim-milk for pig feeding. "It is well established that 100 pounds of skim-milk will make five pounds of growth when fed alone to pigs weighing from 75 to 150 pounds. Multiply this growth by the price of pork and you have the minimum value of the skim-milk. Feed it in conjunction with corn meal and you add 20 per cent to its value or cash return, all as a result of the combination. These are well settled principles of feeding. Yet, how few farmers really and truly know and practice them."*

EXERCISES

1. According to the standards given, what is the value of skim-milk in your vicinity?

*These values increase with advance in prices.

2. Can you feed sour milk to calves?

3. What causes milk to sour?

4. What is "baby beef?" What do we mean by the term "milk-fed" chickens?

5. Do farmers as a rule raise their own cows in a "condensary" community?

LABORATORY PROBLEMS

XIV. To Make Cottage Cheese from Skim-Milk

An excellent food may be easily made from skim-milk as follows:

1. Obtain a quantity of clean, well-flavored, sweet skim-milk and add about a pint of good, clean-smelling, sour milk.

2. Heat to about 90 to 95 degrees and allow it to sour and thicken but not whey off; this wlll take about twenty-four hours.

3. Break up gently with a large spoon. Keep the curd in large, coarse pieces.

4. Heat to 110 degrees by hanging the bucket in warm water; stir gently while heating.

5. After half an hour or more, depending on how finely the curd was broken up, it settles rapidly and will be quite firm. Without stirring, tip the pail and draw as much whey as possible. Fill the pail up with clean, cold water and stir the curd until cooled.

6. Put the curd in a cold vat to drain for about half an hour.

7. When dry stir in one ounce of salt to five pounds of curd.

Note: Some prefer to add a small amount of cream to the finished cheese. This, of course, adds to the cost. As a rule people who care for it add a small amount of cream to the cottage cheese just before serving.

LABORATORY PROBLEMS

XV. To Determine the Acidity of Milk

Prepare a standard tablet solution by dissolving 5 Farrington alkali tablets in 97 c.c. of clean, soft water. The water may be condensed steam or pure rain water. The tablets can be purchased in boxes containing 1,000 each from any dairy supply house. If kept dry and away from the air, they will not lose strength. The solution as prepared above is so standardized that one cubic centimeter will neutralize one one-hundredths per cent acidity if a 17.6 c.c. of milk is used as a sample. The solution should be prepared several hours in advance to allow the tablets to dissolve. The small residue which does not dissolve is inert matter and does not interfere with the test. After the tablets have been dissolved the solution will not lose its strength for several weeks. It is well, however, not to mix up too much at a time and to keep the bottle well corked. No indicator is necessary, because an indicator has been incorporated in the tablets. For practical purposes a 100 c.c. graduated cylinder, a 17.6 c.c. pipette and a white china cup comprise the apparatus necessary to determine the acidity of milk and cream.

Determine the acidity of milk, cream, etc., by the following method:

1. Using a 17.6 c.c. pipette, transfer a pipetteful of the sample to be tested for acidity to a white china cup.
2. From a graduated cylinder add sufficient tablet solution to color the mixture a faintly permanent pink. It is well to give the cup a rotary motion while adding the solution. Some prefer to use a glass stirring rod to mix the solution with the sample.

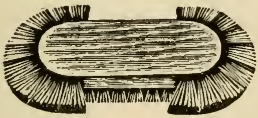
3. The number of cubic centimeters of solution required to give a permanent pink color will indicate the number of hundredths per cent acidity. For example, if it requires 18 cubic centimeters of the solution to color the mixture a faint pink, then the sample tested has an acidity of eighteen-hundredths of 1 per cent.

CHAPTER X

CARE OF UTENSILS

What kind of utensils to use. Tinware is undoubtedly the most satisfactory material for dairy utensils. Wooden vessels are very objectionable, because the pores of the wood absorb the milk and soon become clogged with impurities. In purchasing vessels only 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 find hiding places, thus affording an opportunity for the growth of germs. All utensils should be washed with a brush, as a brush is far more sanitary than a dish cloth, which will soon become insanitary in spite of the efforts made to keep it clean. Greasy soap powders should be avoided. There are many kinds of soap powder on the market that will dissolve dirt and grease and still remain 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 so placed that they will drain well.

How to wash utensils. In washing utensils they should first be rinsed with cold water to remove the milk; then washed with lukewarm



Hand brush for tinware.

Bottle brush.

Fig. 26.
For properly cleaning milk utensils good brushes are essential.

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. If the separator is flushed, however, with lukewarm water, and then taken apart and cleaned at once, it is not a difficult task. It is needless to add that the separator should be washed each time it is used.

Wash separator twice daily. 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.

It is time and money saved to wash all tinware carefully each time it is used. If this is not

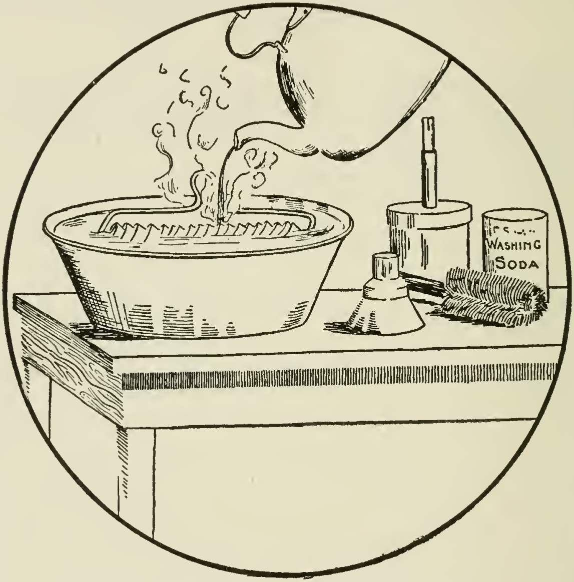


Fig. 27. Be thorough in cleaning separator.
To produce clean cream, the parts of a separator should be carefully washed with warm water each time, use a brush and cleansing powder, then scald with boiling water and spread tinware to dry in the sun.

done with the separator the interior of the bowl soon becomes rusty and small particles of curd will dry on certain parts of it, throwing it out of perfect balance, and the result will be large losses in the skim-milk. There is no reason why good tinware properly cared for should not last for many years. Neglect and misuse are the chief causes for dairy utensils getting out of proper condition.

EXERCISES

1. Why should a dish rag not be tolerated in a dairy?

2. How can you prove that sunlight will prevent bacterial growth?

3. Why not use wooden pails in preference to tin pails?

4. Would you like to use the cream from a separator washed only once a day?

LABORATORY PROBLEMS

XVI. To Determine the Per Cent of Solids and Solids Not Fat in Milk by Means of a Quevenne Lactometer

Fig. 28. Quevenne lactometer. The "dairy detective." It will show whether milk has been watered or skimmed, if used in connection with the fat test.

It is very essential when testing for fat, or when making any lactometer determination, to have the sample thoroughly mixed. The lactometer is standardized at a temperature of 60° F., and therefore the milk should be near that temperature. The milk should be poured into a tin cylinder, so that it will overflow when the lactometer is inserted. To prevent waste, the cylinder can be placed in a small dish before inserting the lactometer. Allow the lactometer to become stationary and read at once. Observe the temperature and correct the lactometer, reading by adding one-tenth lactometer degree for each degree F. that the milk is above 60 degrees, and subtract one-tenth for each degree it is below 60 degrees. Having taken your lactometer reading and having made the proper corrections of temperature, determine the solids not fat and the total solids by aid of the following formula: (It will be seen that it is necessary that the per cent of fat in the milk be known.)

$$\text{Solids not fat} = \tfrac{1}{4}\ \text{Lac. R.} + .2\ \text{fat}$$
$$\text{Total solids} = \tfrac{1}{4}\ \text{Lac. R.} + 1.2\ \text{fat}$$

To illustrate: If the lactometer reading is 32.0 at 56° F., and the milk tests 4.0 per cent fat, we determine the solids not fat as follows:

$$32.0 - .4 = 31.6$$
$$\tfrac{1}{4}\ \text{of}\ 31.6 = 7.9$$
$$.2\ \text{of}\ 4.00 = .8$$
$$7.9 + .8 = 8.7 = \text{S. N. F. in sample.}$$

Having carefully studied the above, get several samples of normal milk and determine the per cents of solids and solids not fat in the same.

Normal milk will have a lactometer reading varying from 29.0 to 33.0.

XVII. To Determine the Effect of Skimming Milk on the Lactometer Reading and on the Fat Content

1. Determine the lactometer reading and the fat content of a quantity of milk.
2. Set aside two pint jars full of milk.
3. Skim the cream from one of the jars after it has stood for an hour. Take the lactometer reading and the fat content of the milk.

4. Skim the cream from the other jar after it has stood for about two hours. Also take the lactometer reading and the fat content.

5. Determine the fat content and the lactometer reading of the skim-milk after all the fat has been removed.

6. Compare results obtained and note if there is any relation between the fat content and the lactometer reading.

Since 1905 the world's yearly records for fat production have been held successively by the following cows:

Year	Name	State	Breed	Lbs. Milk	Lbs. Fat
1905	Yeksa Sunbeam	Wis.	Guernsey	14,920.8	857.15
1907	Colantha 4th's Johanna	Wis.	Holstein	27,432.5	998.26
1911	Pontiac Clothilde De Kol II	N. Y.	Holstein	25,318.0	1,017.28
1912	Banostine Belle De Kol	Ohio	Holstein	27,404.4	1,058.34
1914	May Rilma	Pa.	Guernsey	19,673.0	1,073.41
1915	Murne Cowan	Ohio	Guernsey	24,008.0	1,098.18
1915	Finderne Holingen Fayne	N. J.	Holstein	24,612.8	1,116.05
1915	Finderne Pride Johanna Rue	N. J.	Holstein	28,403.7	1,176.47
1915	Duchess Skylark Ormsby	Minn.	Holstein	27,361.7	1,205.09

CHAPTER XI

CARE OF MILK AND CREAM

Pure milk germ free. 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, it 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, owing to the favorable conditions existing there, multiply enormously. 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 draw this foremilk on the ground; there is really very little loss, as it is not very rich in fat.

Some sanitary precautions. 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 should be unnecessary to state that the stables should be clean, dry and well-ventilated; the health of the animals demands it. In Denmark it is customary to whitewash the stables four times each year; experience having shown this to be a very profitable practice. Whitewash is odorless and very cheap, and it is to be regretted that dairymen in general do not use it more freely. There should be no cesspools about the stables, and the ground under the barn should be well drained. Poor drainage causes objectionable odors about the barn.

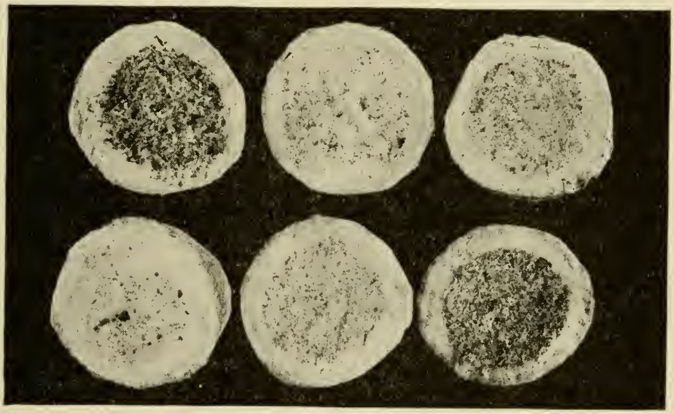


Fig. 29. Sediment test for determining cleanliness of milk.

Feeding after milking. One of the practices a good dairyman will observe is to do his feeding after milking, so that the atmosphere will not be filled with 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 foods taints the milk.

Keeping cows and udders clean. 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 pail. It has been demonstrated that twenty times as much dirt falls into the bucket when the udder is 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.

Milk a food product. Cows should have ample bedding, but this bedding should not be disturbed immediately before milking, since such a practice will cause the air to be filled with small particles of dust, a large number of which will find their way into the milk pail.

The dairyman should always bear in mind that in handling milk he is dealing with a food product. Therefore, if any of his cows are 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 cow's milk be used for the thirty days immediately before calving.

The use of covered pails. Taking everything in consideration, probably the best form of pail that a dairyman can use is the covered one, 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 place in the barn where the milk may be kept during the time of milking.

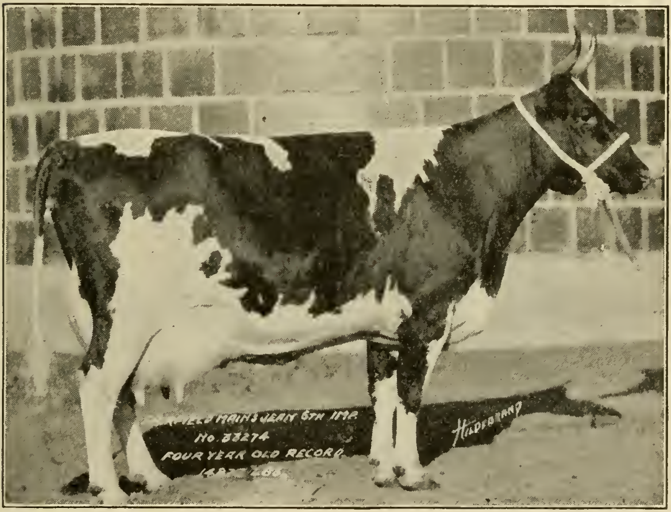


Fig. 30.
A cow that has been well groomed—one of the essentials in the production of clean milk.

Straining and aerating. The milk should be strained as soon as possible through several thicknesses of cheesecloth. It is advised by some that milk be aerated to remove animal heat and the odors absorbed from certain feeds. Although much may be said in favor of this practice, great care must be exercised in aerating milk. If a farmer is in doubt whether to aerate his milk or to cool it, cooling is advised for the reason that simply aerating milk will not reduce its temperature 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 its natural odors are allowed to escape. It is poor practice 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 has when drawn from the cow.

The farm separator. The farm 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 well known. However, many farmers neglect to take proper care of this cream and in this way bring the farm separator into disrepute.

The separator should not be placed in the barn. A suitable milk house will prove as profitable to a farmer as a suitable granary.

Caring for cream. Cream should be cooled down at once to prevent its souring. It should

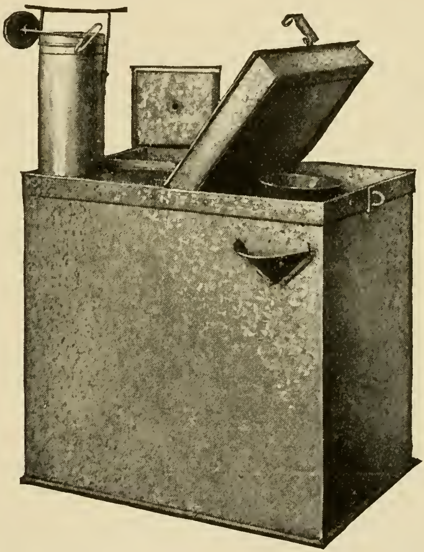


Fig. 31. Cream cooling tank.

be placed where the air 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 believe 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 if we expect the butter maker to produce and place on the market an article that will bring the highest market price.

Other sources of contamination. 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 thoroughly dried before he begins his work. 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 it as a great source of contamination.

EXERCISES

1. How many bacteria are there in a cubic centimeter of ordinary milk twenty-four hours old?
2. Are these bacteria larger or smaller than the fat globules?
3. How do bacteria get into the milk?
4. Why not keep the bacteria out by straining the milk through very fine absorbent cotton?
5. Will milk sour if kept at a temperature of 45° F.?
6. What causes some milk to be "ropey"?
7. Is colostrum milk poisonous?
8. Why do we have more bitter milk in the winter time than in the summer time?

LABORATORY PROBLEMS

XVIII. To Determine the Influence of Adding Water to Milk on the Lactometer Reading and Fat Content

1. Take a quart of milk and determine the lactometer reading and fat content of the same.
2. Add varying quantities of water, for example, 10 c.c., 20 c.c., 40 c.c., per 100 c.c. of milk and mix well. Determine the lactometer reading and fat content in each case.
3. Compare results obtained with those obtained under 1.

LABORATORY PROBLEMS

XIX. To Determine the Purity of Milk by Means of the Fermentation Test

1. Carefully wash with cleaning powder and hot

water six test tubes and rinse them thoroughly with boiling hot water.

2. Stopper with clean absorbent cotton.

3. Place the stoppered test tubes in a hot oven for some time to sterilize them.

4. Fill two test tubes two-thirds full with samples of milk known to have been milked in a cleanly way. Likewise fill two tubes with milk milked in the ordinary way. Fill two others with milk into which hairs, dirt, etc., were allowed to enter.

5. Place these samples in a water bath at a temperature of 98 to 100 degrees F., and make notation at the end of each four-hour period. Note particularly whether the curd is firm and solid, or broken up, wheyed off and gassy.

CHAPTER XII

DISPOSING OF MILK AND CREAM

City milk supply. Assuming that a dairyman has a herd 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 careful study of the local situation. In certain localities it may be advisable to handle milk in a way different from that in other localities. Local conditions necessarily govern the methods of the disposal of milk. If a dairyman is situated in close proximity to a city where the consumption of whole milk is very large, it may be advisable for him either to wholesale his product directly to a milk dealer, or to have a private trade of his own to which he can deliver the same. In the latter case the necessary additional investment in horses, wagons, and other equipment, must be considered. In selling whole milk it must be remembered that nothing is left on the farm in the shape of skim-milk. While the returns from selling milk in this way may appear large, two things must be borne in mind, viz., the *cost of delivery* and the *loss of the skim-milk*. The reader is referred to a later chapter, entitled The Relation of Dairying to the Soil, which calls attention to the loss to the soil by removal of fertility when selling whole milk off the farm.

Selling to a cheese factory. Of course, if the farmer is located 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, 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.

Hauling to a creamery. Or the dairy farmer may have an opportunity to sell his milk to a whole milk 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 either for feeding purposes.

Selling cream. One of the most profitable methods in many localities is the sale of milk in the shape of cream. Many objections have been raised by creamery men against the introduction of farm separators, but there is no question but that in many localities this is the only practical method that can be employed. The distances that the farmers live away from the creamery make long hauls necessary. This expense can be greatly reduced by delivering cream. Even in the important dairy regions of this country the farm separator has proven its worth. There is no longer a question but that the farm separator is bound to have a place on most dairy 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. There is no question but that this disease can be spread through factory skim-milk and whey. If the farmer wishes to keep his herd free from this dread disease he should be very careful in the feeding of these factory by-products. The farm separator insures safety in this respect.

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 the value of cooling.

Selling cream to city trade. 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 patrons may be found who want good cream and are willing to pay for it. They may be hotel managers, boarding house keepers, candy makers, ice cream manufacturers, or other people who are ready to contract for cream of a certain richness at a definite price per gallon.

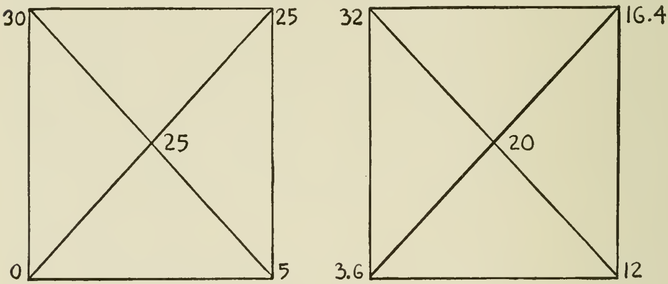
To illustrate that it pays to cater to this sort of trade, let it be assumed that a dairyman can sell a gallon of twenty-five per cent cream for seventy cents. This may be more than a farmer can obtain in certain sections, but in many parts of the country even a higher price than this can be obtained.

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 2.1 pounds of fat. This 2.1 pounds of fat will make about 2.5 pounds of butter. If 70 cents is received for a gallon of 25 per cent cream, it is practically equivalent to 28 cents a pound for butter. Besides this the extra labor and expense of ripening the cream, churning and washing the butter, salting and packing it, are avoided.

Variations in the richness of cream. 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 to determine its richness cannot be depended upon. On this account a farmer may be delivering a richer cream than is contracted for, thus losing money thereby. He cannot expect to offset this by delivering a poorer cream at times, because this will arouse dissatisfaction and make him liable to breach of contract. The only safe way is to test the cream each time it is to be delivered and 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 diagrams following:

How cream is standardized. 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 easiest 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



Diagrams for standardizing cream.

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 on the other diagonal. We now have figures in each of the four corners. The diagram may now be explained as follows, reading from left to right in the usual way: 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.

Another method. 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 as before. By testing his cream he 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 necessitates making 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 cost of the test.

An easier way. Another method of standardizing cream which may prove satisfactory, but which is not quite so accurate, is as follows: Find out how much the milk from the herd tests by testing at intervals for a few days. There naturally will be some variation, but a test of the milk every few days will give the dairyman a fair average. It will then only be necessary to weigh the milk and cream. We will assume that a milkman made a contract to deliver 18 per cent cream to an ice cream factory, that he had 280 pounds of milk and that it tested approximately 4.20 per cent. Multiplying 280 by 4.20 will give 11.7 pounds of fat; dividing the 11.7 by the test of the cream, 18, we get 65, or the number of pounds of cream testing 18 per cent which we should have that day. All that it is necessary for him to do now is to weigh the cream and add enough skim-milk to bring the weight up to 65 pounds. While this method is not quite so accurate, it is in most cases fairly satisfactory.

EXERCISES

1. What is the most profitable way of disposing of the milk in your vicinity?
2. What returns do you get per cow per year?
3. What is the cost of keeping a cow in your vicinity?
4. What is the weight of a gallon of milk? Of 20 per cent cream?
5. How many gallons of 20 per cent cream will you get from 100 pounds of 4 per cent milk?

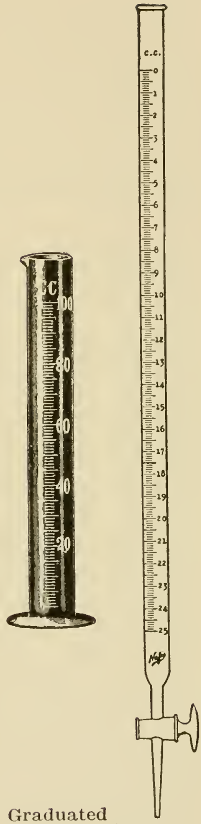
LABORATORY PROBLEMS

XX. To Determine the Rate of Increase of Acidity at Varying Temperatures

1. Divide a lot of milk into two parts. Allow one sample to sour at a relatively warm temperature (75 to 80 degrees F.). Keep the other sample cool with well water at a temperature of 50 to 55 degrees.

2. Determine the acidity of each lot at intervals of about four hours; continue until the samples do not increase in acidity.

3. Plot a curve to show the rate of the increase in the acidity of the milk.



Graduated cylinder. Burette.
Fig. 33.
The essential pieces of apparatus for making acidity tests of milk and cream.

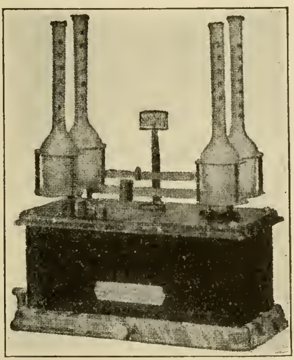


Fig. 32. Cream scales.*

*In most states the law requires cream samples to be weighed for testing.

CHAPTER XIV

BUTTER MAKING AND CHEESE MAKING

Should the dairyman make butter? Whether or not it will be profitable for a farmer to invest in equipment so that he can make butter properly is another question that he alone 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 most sections of this country, especially where the creameries are numerous, dairymen prefer to sell their cream to butter factories, and thus save the labor and expense incident to the manufacture of butter on a small scale. There are some so fortunately situated that they can get a higher price for their cream by selling it for direct consumption, and they do sell it that way. There are others who, for sentimental reasons, prefer to make their own butter, and therefore the extra expense and labor is not looked upon as a serious obstacle.

Sweet cream butter. In certain sections of

Europe butter is made of very sweet cream, which finds a ready sale. Such butter, however, has a peculiarly 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.

Ripened cream butter. 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 "souring" 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 good, sour milk or skim-milk in which the desirable organisms producing good flavors in butter have gained the ascendency, and which when added to the cream have a tendency to check the development of the less desirable organisms. In this way the butter maker may in a measure control the flavor of butter.

The ripening of cream. The matter of temperature is an important point. As a rule cream is ripened at a temperature of from 65 to 70 degrees F., and when it reaches an acidity of four-tenths to five-tenths of one per cent (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. 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 check the acidity, as the keeping quality of the butter may be seriously impaired by over ripening.

Churning. 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 begin to gather in much less than thirty minutes, otherwise the butter is likely 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 the curd, it is very essential that the granules be left small so that the curd can be easily removed. The amount of salt is governed by the demands of the market.

Fig. 34. The barrel churn. A modern tool for making home-made butter.

Salting. Probably the best way to add the salt, when small quantities of butter are made, is to practice what is termed "wet salting." By this method a small quantity of water is added to the salt to partly dissolve it, and then this brine and undissolved salt are added to the butter in the churn after the butter has been washed.

Working and packing. 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 exercising care in the method of manufacturing the butter. The style of package is regulated by the demands 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 ends to be achieved in the making of butter are to produce an article that will be attractive to the eye and "tickle the palate."

The overrun. A hundred pounds of butter fat in the milk will make approximately 116 pounds of butter. This is due to the fact that butter contains curd, salt, and water in addition to the butter fat.

The composition of butter is approximately as follows:

Fat	82.5%
Water	14.5%
Salt	2.0%
Curd	1.0%
	100.0%

The difference between the amount of fat and the amount of butter made from the same, expressed in percentage, is termed the "overrun."

This overrun will vary as the composition of butter varies. The overrun is also greatly influenced by the losses of fat in the skim-milk and the buttermilk. When the amount of fat in the cream is used as a basis of computation the overrun will amount approximately to from 20.0 to 21.0 per cent. This serves to explain why the butter made from a definite amount of cream will not correspond with the fat in the cream. For instance, 100 pounds of cream testing 33.00 per cent will contain 33 pounds of butter fat, but the butter made from this cream (if the overrun is 20.0 per cent) will amount to 39.6 pounds.

Cheese making in the United States. The manufacture of cheese from milk is carried on quite extensively in two sections of this country, centering in the states of New York and Wisconsin. Fifty years ago about one hundred million pounds of cheese were made annually on the farms of the United States, but owing to the superiority of factory cheese the amount made has steadily decreased until at the present time only about eight million pounds are made.

Making cheese on the farm. Farm cheese-making has almost become a lost art. This is because the labor and expense of making cheese in this manner are much greater than when it is made at the factory. Then, too, the factory men as a class are better trained, so that the quality of their cheese is better, and they have the advantage of being able to market their product more profitably. It is evident, therefore, that the manufacture of cheese on the farm is soon to be a thing of the past. This does not mean, however, that many types of "fancy" cheese can not be made to good advantage on a dairy farm. Where market facilities are good, such types of cheese, made by trained men, can often be profitably manufactured and marketed.

Kinds of cheese. The most common type of cheese made in the United States is termed "Cheddar" or "American" cheese. It is the cheese commonly sold at the grocery store. In Wisconsin there is a locality where a fine grade of Swiss cheese is made. This particular section was thickly settled by people from Switzerland, and naturally they introduced the art of making Swiss cheese.

In other sections of Wisconsin are also manufactured what are termed "Brick" and "Limburger" cheese—these are soft cheeses, very popular with some people.

Good milk necessary. Successful cheese making depends upon the growth and development of favorable bacteria. It is very essential to have good milk, much more so than is the case where the fat in the milk is manufactured into butter. Hence, it follows, that while everything should be done to produce good cream for butter making, it is all the more necessary to produce excellent milk for cheese making if a high grade product is desired.

EXERCISES

1. Will the cream from stripper cows churn as readily as the cream from fresh cows? Why?
2. Is "Jersey" cream butter better than "Holstein" cream butter?
3. How many pounds of butter can be made from 380 pounds of 4 per cent milk?
4. Thirty years ago dairymen talked about "cheese" and "butter" cows. Why the distinction?
5. What states in the Union produce the most cheese? The most butter?

LABORATORY PROBLEMS

XXI. Churning

An interesting churning exercise can be given before the whole class if the facilities are available for making churning observations. The time required for such an exercise is usually two hours, provided everything is in readiness when the class meets.

It is rather difficult to give an outline that will serve all purposes during different seasons and under varying conditions, but the following suggestions may be of help to the instructor who desires to give such a demonstration.

1. The churn, ladles, worker, etc. should first be washed with scalding hot water and then thoroughly chilled with an ample supply of cold water.

2. Fill the churn about one-half full of cream. Add the butter color at the rate of from 40 to 50 c.c. of color per 100 pounds of fat. The amount of fat can be closely estimated by knowing the weight of the cream and its approximate test. It is not necessary to use butter color, but many prefer butter that is colored.

3. After giving the churn a few revolutions, open it to allow the "gas" to escape. It is necessary to do this but once or twice at the beginning of the churning.

4. Revolve the churn so that there will be a good "concussion." (About 50 revolutions per minute is usually sufficient.)

5. Observe the temperature of the cream. This, of course, will vary, depending upon such factors as richness of the cream, acidity of the cream, etc. Under summer conditions usually 52 to 54 degrees F. are the best temperatures; in winter, or when the cows are on dry feed, or when most of them are strippers, it may be necessary to use temperatures ranging from 58 to 60 degrees. It is not advisable, however, to employ temperatures much warmer than these.

6. While the churning is going on, some one can make a fat test of the cream. As a general rule the cream for churning should test from 25 to 35 per cent fat.

7. An acidity test should be made as a matter of information. Generally a slightly sour cream will make the kind of butter that the average consumer prefers. An acidity from .4 to .5 per cent is satisfactory.

8. The time required to churn varies, depending upon the temperature employed, acidity of the cream, etc. It should take from 30 to 45 minutes for the

butter to "gather." If it takes longer than this, then the cream should have been a trifle warmer. If it is finished sooner, however, a lower temperature should have been employed. It is very important that the cream should be kept at a temperature of from 52 to 54 degrees for at least two hours before putting it into the churn.

9. When the granules are as large as wheat kernels the churning should be stopped. This must be watched very closely, as a few revolutions too many at this time will result in overchurning the butter.

10. Draw off all the buttermilk and determine its temperature.

11. Wash the butter by adding about as much water as there is buttermilk drawn from the churn. The water should be clean and should have about the same temperature as the buttermilk. During the summer it is advisable to use water a few degrees colder than the buttermilk. Revolve the churn slowly for a few revolutions and then draw off the wash water.

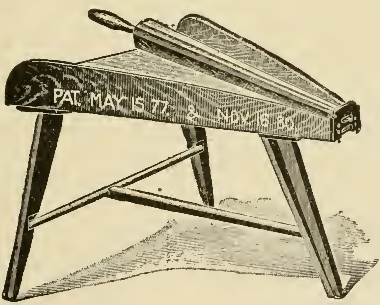


Fig. 35. A hand butter worker used in farm dairies.

12. Salt to suit the taste. About a pound of salt added to a pint of water will be sufficient to salt about

10 pounds of butter. Scatter the salt and brine over the butter and revolve the churn once or twice.

13. The butter can be worked by means of ladles while it is still in the churn. If a worker is available, the butter can be taken out of the churn and the working finished. It should be worked only enough to thoroughly knead the butter granules together and to get the salt uniformly distributed. It may be necessary occasionally to allow the salt to dissolve. Where "wet" salting is practiced the working can be finished at once. *Butter should not be worked too long, as overworking will cause it to become greasy.*

14. The butter should be weighed and the "overrun" computed. The following observations should be made by the students:

Name	Date ....
Kind of churn...........	Capacity ....
Amount of cream........	Temperature ....
Test of cream............	Acidity ....
Pounds of fat in cream...	Amt. of butter color used..
Time required to churn...	Temperature buttermilk...
Size of granules..........	Acidity of buttermilk......
Temperature wash water..	Fat test of buttermilk.....
Amount of salt used.....	Wet or dry...............
Pounds butter made......	Per cent overrun..........

CHAPTER XIV

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 dry fodder, and one or more silos in which to store a supply of palatable green food for the winter months.

The barn adapted to the needs of the farm. 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 some one to design a barn for him that will suit his own special needs better than any plan which can be suggested here. 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*.

Ventilation often neglected. 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

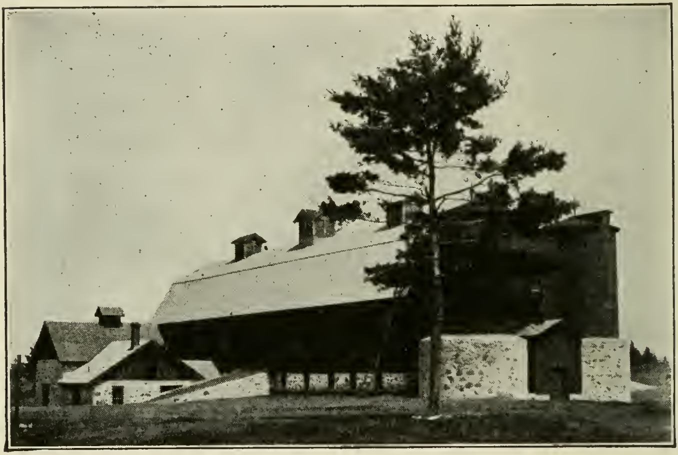
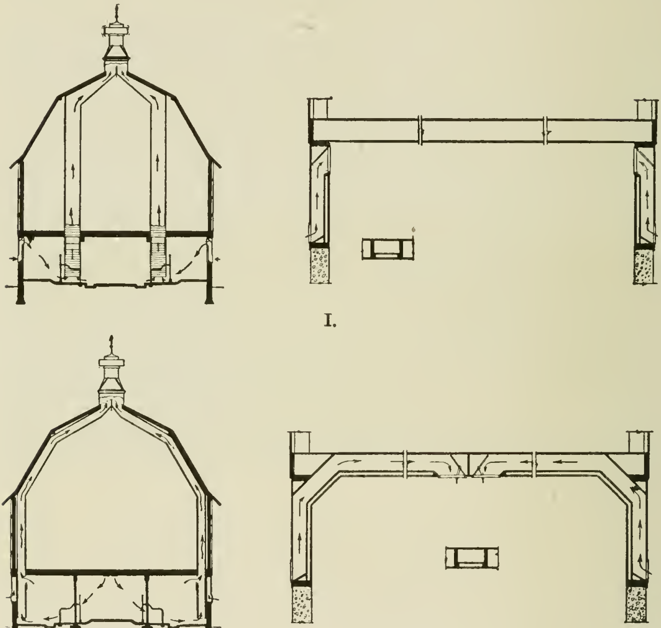


Fig. 36. A well-ventilated dairy barn with "twin" stave silos.

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.

The King system best for barns. In a well-ventilated barn the air is almost as pure and fresh and free from bad odors as it is in the most sanitary home. The most successful and most widely used method of ventilation in this country is known as the King system. 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.

The ventilating flues—how installed. 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 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



II.
Fig. 37. King system of ventilation.
I. Arranged for cows facing outward.
II. Arranged for cows facing center aisle.

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. In stone walls these are usually made of tile. If two or more smaller flues are used, which in the judgment of the writer are 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 the late Professor King (hence its name) and has found widespread adoption.

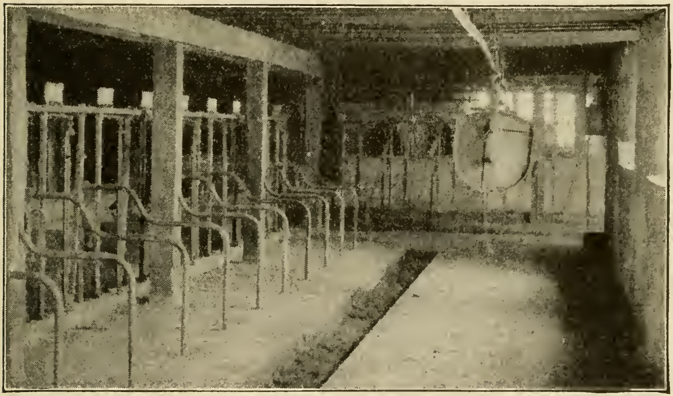


Fig. 38. Interior of modern dairy barn, showing sanitary construction and equipment.

Pure air and sunlight essential to high-class dairying. 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.

EXERCISES

1. Why is fresh air admitted into a barn near the ceiling? Why not open a window?

2. Why does the outlet flue extend to within one foot of the floor?

3. Why not admit fresh air under the door and draw off bad air from the ceiling?

4. Why not use the hay chutes for ventilating flues? Should hay chutes be open or closed while cattle are in the barn?

5. What provision do you have for ventilation in the home barn?

6. Would it be possible to install a ventilating system in your barn? If so, how?

LABORATORY PROBLEMS

XXII. To Determine the Per Cent of Water in Butter

According to a rule made by the Department of Agriculture at Washington, creamery butter containing 16 per cent or more of water is considered adulterated and is subject to a tax. It is therefore very important that butter should be made that will contain less than this amount of water. It is an easy matter to determine the water content of butter, but great care must be exercised to have the samples representative.

1. By means of a trier small lots of butter should be taken from different parts of the tub. These lots should be placed in a small, wide-mouthed, stoppered bottle. This butter should then be heated so as to

give it a creamery texture, *but it should not be melted.* It should then be thoroughly mixed while cooling under a water faucet.

2. Carefully weigh a small aluminum cup, which can be obtained at any "ten-cent store" for 10 cents. The cup should be thoroughly cleaned and dried over a flame. Cool before weighing.

3. Quickly weigh a small quantity of butter into a cup; 10 to 20 grams are sufficient.

4. Gently heat over a small alcohol lamp, keeping the cup in constant rotary motion. Care must be exercised to prevent spattering.

5. When the contents of the cup become a uniform brown color, it is an indication that the moisture has all been driven off.

6. Cool and weigh. The difference in weight represents the amount of water driven off.

7. Dividing the weight of water driven off by the weight of the original sample will give the per cent of moisture in the butter.

CHAPTER XV

THE SILO

The use of 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.

The four essentials of a good silo. 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

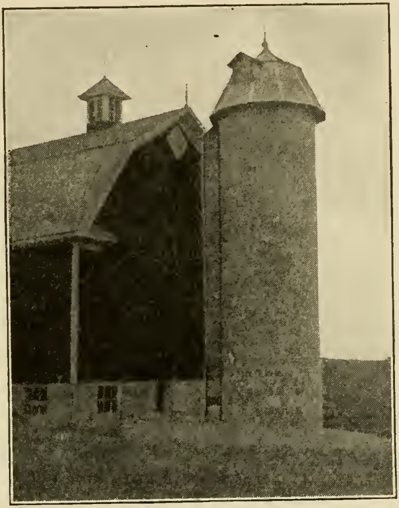


Fig. 39. An artistic tile silo with double air space in walls to keep out the cold.

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.

Silage a satisfactory feed. If this building is so constructed as to provide for sufficient ventilation and to prevent freezing, and if 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 carried on.

The five types of silos. There are five types of silos in common use; wood, brick, tile, 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 usually built of 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. The solid concrete silo is also rapidly coming into popular favor.

EXERCISES

1. Why should the hoops or reinforcing rods be closer together near the bottom of the silo than near the top?
2. Can silage be stored in a "square" silo?
3. Why not build a "square" instead of a "round" silo.
5. Why is a hollow wall silo to be preferred to one of solid concrete?
6. What kind of silo do you have on the home farm?
7. What kind of silo would be best for you to build? Give reasons for your choice.
8. How many silos are there within five miles of your home?

LABORATORY PROBLEMS

XXIII. To Determine the Fat Content of Skim-Milk, Buttermilk and Whey

Owing to the small amount of fat in skim-milk, it is necessary to use a specially constructed bottle for this work. The "double neck" bottle is generally used to determine the fat content of skim-milk, buttermilk and whey.

a. *To determine the fat content of skim-milk.* Transfer 17.6 c.c. pipetteful of skim-milk to a double neck bottle. Add about 20 c.c. of sulphuric acid. Mix well and test as in the case of milk, except that only one filling with water is necessary. The points to be observed in testing skim-milk are:

1. Use excess amount (or over 17.5 c.c.) of sulphuric acid.
2. Whirl a minute or two longer than in the case of whole milk test.
3. Do not allow mixture to cool.

b. *To determine the fat content of buttermilk.* Use double neck bottle, as in the case of testing skim-milk; also use excess amount of sulphuric acid.

c. *To determine the fat content of whey.* Because there is very little casein in whey, it is evident that it is not necessary to use so much acid as in the case of skim-milk or buttermilk; 12 to 14 c.c. are usually sufficient.

Note: It is very essential that the neck of the double neck bottle be perfectly clean and dry in order that the air may have free access.

CHAPTER XVI

FEED FOR THE COW

The cow a milk-making machine. 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.

A maintenance ration necessary. Investigators have found that the daily maintenance ration of a cow weighing about 1,000 pounds is: .7 pounds digestible protein, 8.0 pounds digestible carbohydrates, and 0.1 pound ether extract.

Granting that the above is true, we can easily see that a dairyman, in order to get a supply of milk from his herd, must give each cow more than the above maintenance ration before he can expect her to yield a satisfactory return. It would be a foolish engineer that would only turn on steam sufficient to keep his engine mov-

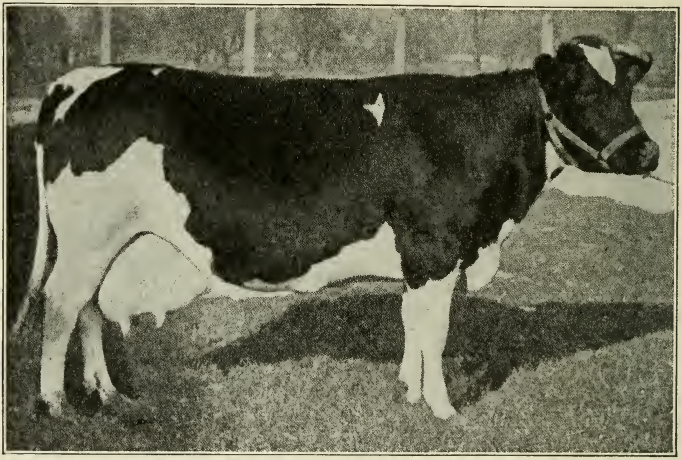


Fig. 40. Maplecrest Pontiac Flora Hartog.
The photograph shows how she appeared at the close of her great year's work—25,106.3 pounds milk ; 3.92 per cent fat.

ing when it is in his power to give it all the steam necessary to work it to its full capacity. The engineer, therefore, must take 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.

Uniform feeding impossible. Inasmuch as the individual requirements of the animal must be given consideration by a good dairyman, it is readily seen that feeding all animals the same amount of feed is neither advisable nor profitable. It would be unwise for a dairyman, if he expects to get the best results from his cows, to feed all the cows in the herd the same amount, regardless of whether they are giving 15, 20, or 30 pounds of milk per day. This may be best emphasized by calling attention to the standard rations used in this connection by scientific dairymen all over the world. These were suggested by the eminent German authorities, Wolff-Lehmann, as the result of their investigations.

WOLFF-LEHMANN MODIFIED STANDARDS FOR A ONE-THOUSAND-POUND COW

		Digestible Nutrients			
	Dry Matter Lbs.	Protein Lbs.	Carbohydrates Lbs.	Ether Extract Lbs.	Nutritive Ratio
1. When giving 11 lbs. of milk daily	25	1.6	10	.3	1: 6.7
2. When giving 16½ lbs. of milk daily	27	2.0	11	.4	1: 6.0
3. When giving 22 lbs. of milk daily	29	2.5	13	.5	1: 5.7
4. When giving 27½ lbs. of milk daily	32	3.3	13	.8	1: 4.5
Standard maintenance ration daily	18	.7	8	.1	1:11.8

Protein more important than carbohydrates. 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. In fact, the percentage of protein in a food determines its value for building the muscles of the body and supplying the casein of milk. 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.

The value of fat. Ether extract, so called because this element is extracted by ether when an examination of food is made by chemical analysis, is, in homely language, the fat of the feed. The principal function 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 power to produce 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.

How rations are compounded. In compounding a ration we first estimate the amount of dry matter in the feed; that is, the amount that the feed would weigh if all the water it contained were 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 considerable portion of the protein is not digestible and therefore the animal may be charged with receiving protein which she cannot use, as a comparison of the following tables will show.

(From Henry's "Feeds and Feeding"):

TABLE I

Water and total nutrients per 100 pounds feed

Feeding Stuffs	Water Lbs.	Protein Lbs.	Crude Fiber Lbs.	Nitrogen Free Extract	Ether Extract Lbs.
Roughage:					
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	7.9

TABLE II

Total digestible substances in 100 pounds

Feeding Stuffs	Total Dry Matter	Protein	Carbohydrates	Ether Extract	Nutritive Ratio
Roughage:					
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

The value of a feed is dependent upon digestible nutrients it contains. In the above, attention is 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 of this only 12.2 pounds are digestible, the amount of protein available for the animal.

Oat straw contains, as is shown in the first table, 4 per cent of protein. In the second table 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 should be noted 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 these feeds in order to furnish her sufficient nourishment to enable her to secrete twenty to twenty-four pounds of milk in a day. This, of course, is an impossibility. It is mentioned only to show that a cow cannot be turned out to a straw stack with the expectation that her flow of milk will be maintained.

June pasture ideal. On the other hand, it is well known that 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.

What is a balanced ration? When we speak of a balanced ration we mean a ration in which protein, carbohydrates, and ether extracts are combined in about the right proportion. Wolff and Lehmann adopted a standard by which every cow yielding 22 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.

How the nutritive ratio is found. The method of computing the nutritive ratio 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 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.

The Haecker standard. The Wolff-Lehmann standard has been largely superseded by American standards. The best one of these was given to us by Professor T. L. Haecker of Minnesota as a result of his investigation and varies with the amount and quality of milk a cow produces. He first establishes a maintenance ration (the amount of feed required to keep a dry cow at a constant weight), and to this he adds an additional ration necessary to produce the amount of milk which the cow is capable of producing, as will be observed from a study of the following table:

TABLE III

Showing maintenance rations for cows of different weights

Weight	Protein	Carbohydrates	Ether Extract
800	.56	5.6	.08
900	.63	6.3	.09
1,000	.70	7.0	.10
1,100	.77	7.7	.11
1,200	.84	8.4	.12
1,400	.98	9.8	.14
1,600	1.12	11.2	.16

How to use the Haecker standard. In practical feeding an allowance of .7 pounds digestible protein, 7 pounds digestible carbohydrates, and .1 pound ether extract per 1,000 pounds of live weight will suffice.

To the maintenance ration there should be added an amount of feed sufficient to produce the amount of milk which the cow is capable of yielding. Haecker has shown that this varies with the richness of the milk as well as with its quantity. An examination of the following table makes this apparent.

TABLE IV

Showing feed required for the production of 10 pounds of milk of varying richness

Per Cent Fat in Milk	Protein	Carbohydrates	Ether Extract
3.00	.47	2.00	.17
3.50	.49	2.21	.19
4.00	.54	2.42	.21
4.50	.57	2.64	.23
5.00	.60	2.84	.24
5.50	.64	3.00	.26

From the above table it is easily possible to calculate the amount of feed required by a cow of any given size to produce a given quantity of milk of any richness.

Feeding rules. Haecker's standards have been still further simplified for practical use by putting them in the form of the following rules for feeding grain and roughage:

Rule I. Feed as many pounds of grain daily as the cow produces pounds of fat per week with all the hay and silage she will eat.

Rule II. Feed one pound of grain daily for each three to four pounds of milk which the cow gives daily and all the roughage the cow will eat.

It must be understood that both of these depend upon the kind of grain and roughage to be fed, which must in themselves constitute a good dairy ration and must contain the right amounts of protein, carbohydrates, and fat in the right proportions. With oat straw as roughage and corn meal as grain the rules would be valueless, since neither is sufficiently rich in protein. On the other hand, alfalfa hay and bran fed according to the above rules would prove very expensive feeds. To apply the rules successfully the ration must be first compounded and balanced before being fed as directed in the rules.

Fig. 41. Spring balance. The best scales for use in keeping milk and feed records of individual cows.

A dairyman can easily compute the amount of feed that each cow should receive per day; and also compute the cost of this feed. By formulating several rations he can easily calculate the rations that will cost him the least. In this way he is able to save in the cost of feed, and thus produce milk most economically.

A study of feeds and feeding essential. 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. Some reliable text on feeds and feeding should be in the possession of those in any way connected with the feeding of dairy cows.

Herewith is appended a list of the common feeds found in America, with analysis of each. The table shows the dry matter and the digestible nutrients per 100 pounds feeding stuff. The data for the same is taken from Henry's "Feeds and Feeding":

TABLE VII

Concentrates:	Dry Matter Lbs.	Protein Lbs.	Carbohydrates Lbs.	Fat Lbs.
Corn, all analysis	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

TABLE VII—Continued

Concentrates:	Dry Matter Lbs.	Protein Lbs.	Carbo-hydrates Lbs.	Fat Lbs.
Brewers' 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
Beet, sugar	13.5	1.1	10.2	0.1

TABLE VII—Contir ued

Concentrates:	Dry Matter Lbs.	Protein Lbs.	Carbo-hydrates Lbs.	Fat Lbs.
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	..
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

EXERCISES

1. Calculate a ration for a dairy cow giving 22 pounds milk daily, using corn, clover hay, and wheat bran as feeds by the Wolff-Lehmann Standard.

2. Suppose the cow weighs 1,000 pounds, calculate the ration, using the Haecker standard.

3. Make a ration from the same feeds by using the two rules given above.

4. Now compare all these rations. How do they differ? Is this difference great or slight?

5. What rations do you feed on the home farm?

6. Can you calculate a better ration from the same feeds?

LABORATORY PROBLEMS

XXIV. To Determine the Per Cent of Fat in Cheese

a. Weigh about 5 or 6 grams of cheese into an 18-gram 30 per cent or 9-gram 50 per cent cream test bottle.

b. Add about 12 c.c. of boiling water.

c. Place the bottle in hot water for several hours to thoroughly emulsify the mixture. This can be hastened somewhat by adding four or five cubic centimeters of sulphuric acid. This is a slow process, as it takes considerable time for all the lumps to dissolve.

d. When thoroughly emulsified cool to room temperature before adding sufficient acid to dissolve all the solids not fat.

e. Test as in the case of milk.

f. Calculate the per cent of fat obtained by the following formula if an 18-gram bottle was used:

$$\frac{\text{Reading} \times 18 \times 100}{\text{Grams used}} = \text{per cent of fat in cheese.}$$

In case a 9-gram bottle was used, substitute the figure 9 for the figure 18.

Note: Care must be exercised to prevent the evaporation of water from the cheese before and during the weighing process.

CHAPTER XVII

CARE OF THE COW

Regularity the first essential to profitable dairying. 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 about six o'clock at night, the best results being obtained when the time between milkings is the same. It may be interesting to add that the records show that large cities receive their poorest milk on Monday. This is accounted for by the fact that the farmers are not so regular in their work on Sunday as they are during the rest of the week.

Changes of feed should be made gradually. 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 example: When it becomes necessary to begin the feeding of ensilage, a very small portion should be fed at the first feeding, 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 ill effects. This is due to their judicious method of feeding.

Kindness necessary. The real purpose of keeping cows is to make a profit, and he is indeed an unwise 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 milk cows.* He must remember that the cow is a brute and he is a man, and if she ill-behaves in any way it is because she is following the laws of nature and is trying to protect herself. A cow will hold up her milk because she is disturbed in some way; perhaps she is afraid of punishment. Some milker may have clubbed her with a milk stool or otherwise ill-treated her. Scolding or loud and excited talking also makes her nervous. It is needless to add 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.

The wise dairyman will provide his cows with clean, palatable food which they will eat with relish rather than with stale food. 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

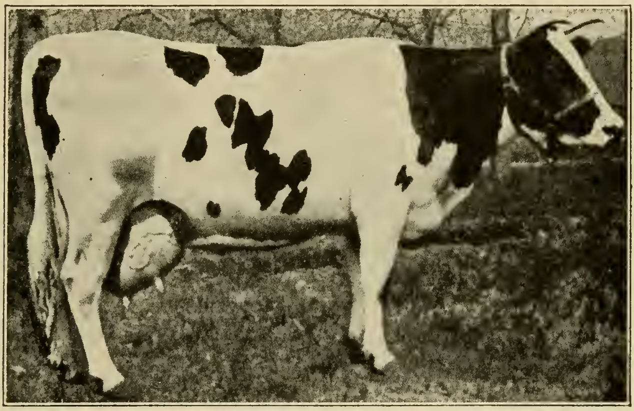


Fig. 42. Daisy Grace DeKol.
Good care enabled this cow to become one of the world's record cows.

warm the water rather than to send them to the pond where he has chopped a hole in the ice. Experiment stations have proven that the shrinkage in the milk flow is considerable when warm water is not supplied.

Dehorning. 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 no longer 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 horned cow is purchased, she should be dehorned as soon as possible, both as a protection for her owner and also for the other members of the herd. She may lose flesh at first, the flow of milk may be decreased, and the test will be likely to drop, but these results are only temporary; 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 are not 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 it should be generally practiced.

Shelter essential. In a previous chapter attention was called to the fact that a considerable portion of the food is used to provide heat and the maintenance for the body. It is therefore evident that if the body is not properly protected, more feed will be required to maintain a cow and, for this reason if for no other, she should be well sheltered. It must be remembered that a good dairy cow does not have 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 by experiment. The Indiana Experiment Station conducted a series of trials 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 $12.75, or $4.25 for each cow. This is a large 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. In another chapter the importance of a good barn is discussed, and also the necessity for providing sufficient fresh air and plenty of sunlight.

Dairy cows need exercise. 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 this rule: They allow their cows to go out of doors on days when it is comfortable for a man to walk about the yard for a short time in his shirt sleeves. On a cold, rainy, drizzling day there would not be much comfort in walking about the yard without a coat and therefore it would not be advisable to turn cows out at such times. If the cow is not protected from rain, it has been shown 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 show that it pays to protect cows from inclement weather.

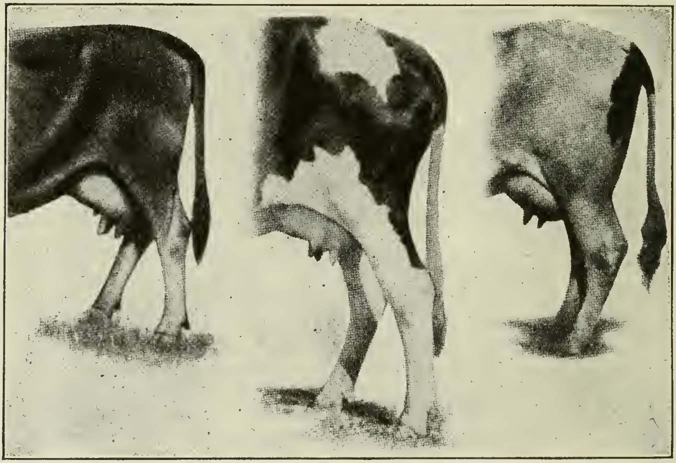


Fig. 43. Three types of bad rumps.
Cleanliness of the hind quarters is absolutely necessary for the production of pure milk.

Cows should be provided with shade in summer. In summer time cows 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. In case they are put in the barn, it is well to darken the windows to keep out the flies. All dairymen know that when flies appear there is a great loss of flesh and also a serious decrease in the flow of milk. For this reason it is well for the farmer to consider keeping his cows in the barn altogether during the fly season. It may cause extra work, but in the long run he will be amply repaid for the trouble.

EXERCISES

1. What do you understand by the term "off feed?"
2. How can cows be changed from one feed to another without showing any ill effects?
3. Do you keep the cows or do the cows keep you?
4. What is the best way to "break" in a cow to milk.
5. Can a cow "hold up" her milk?
6. In Europe they take better care of their cows than they do in America. Why?

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.

Tuberculosis the dangerous scourge. It is said that one out of every seven people who die fall victims of 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.

How tuberculosis spreads. 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

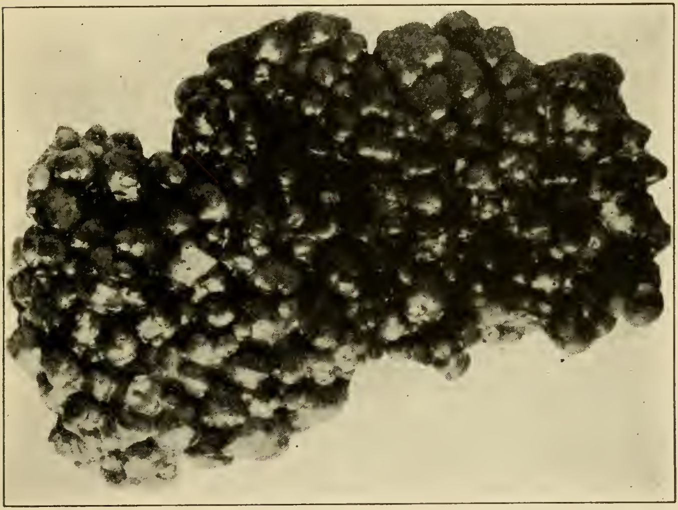


Fig. 44. Tubercular nodules from the abdominal cavity of a cow.

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.

How the germs are destroyed. 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 tuberculin test. The United States Department of Agriculture and some of the state experiment stations are engaged in preparing and distributing tuberculin, a coffee-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

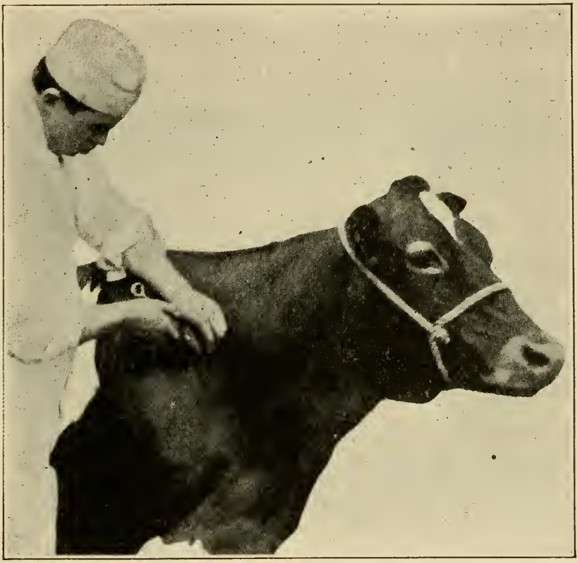


Fig. 45. This picture shows how tuberculin is injected under the skin in making the tuberculin test.

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.

Factors influencing the accuracy of the test. Since there are so many conditions which may affect the temperature of an animal during the progress of the test, it should never be undertaken except by an experienced tester or under supervision of a competent veterinarian if reliable results are to be expected.

Some of the factors that may cause a change in temperature are as follows:

1. Drinking a large amount of cold water will cause a *fall* in temperature.

2. Turning out in cold, raw weather will cause *fall* in temperature.

3. Confinement in a close, hot stable to which the animals are unaccustomed will cause a *rise* in temperature.

4. Nervous animals are likely to show a *rise* in temperature, especially if annoyed.

5. Annoyance by strangers or dogs may cause a *rise* in temperature.

6. Any slight sickness will cause a *change* in temperature.

How to prevent the spread of tuberculosis. 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. One of the greatest authorities on this subject in this country says in a recent bulletin:

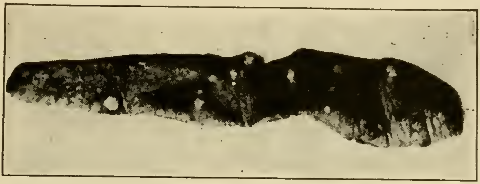


Fig. 46. A tubercular spleen, showing nodules.

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

"First. Find out the actual conditions 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 neces-

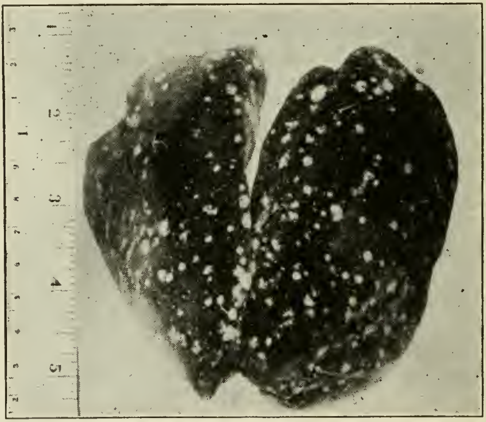


Fig. 47.—A chicken liver badly affected with tuberculosis.

sary to find out positively the condition of his 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."

EXERCISES

1. Why take several temperatures of an animal before injecting tuberculin?

2. Why are several temperatures taken after the injection is made?

3. What would be the effect of allowing a cow being tested for tuberculosis to have all the ice cold water she could drink?

4. Why not buy cattle that have not been tested for tuberculosis?

5. Did you ever test the home herd for tuberculosis?

6. Is there any possibility that you may have tuberculosis in your home herd?

LABORATORY PROBLEMS

XXV. To Test Milk Which Has Become Curdled

The difficulty in testing milk which has become curdled lies in the fact that it is very hard to sample such milk accurately.

a. Make a test of a well-mixed quantity of sweet milk and record the results in a notebook.

b. Set aside a small quantity of the same milk and allow it to curdle. Care must be exercised to prevent evaporation.

c. After it has curdled, add 10 c.c. of ammonia per 100 c.c. of sample to dissolve the curd. If this quantity of ammonia will not dissolve all the lumps, add a few more c.c. of ammonia.

d. Test as in the case of sweet milk. Great care must be exercised while adding the sulphuric acid. For this reason it is best to add only a cubic centimeter or two at first and then gently shake the mixture. After the alkali has been neutralized there is no more danger than in adding acid to any milk sample.

e. On account of diluting the milk with ammonia, the reading will be too low. It is necessary, therefore, to make proper correction. In order to do this it is very essential to note the quantity of milk in the sample and the number of cubic centimeters of ammonia added.

Note: In order to obtain accurate results great care must be employed in the working out of this experiment.

CHAPTER XIX

RELATION OF DAIRYING TO THE SOIL

Why dairying is better for the soil than grain farming. 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 50 cents worth of plant food from the farm." Since the price of fertilizers has advanced considerably since this statement was made, the figures now are much higher. A little calculation will show that the amount of fertilizer contained in the manure produced annually by a dairy cow is worth nearly

$20, if it is carefully saved and returned again to the land.

How dairying enriches the soil. Again, the wise 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 work of bacteria in the legumes. 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 the 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 barn-yard 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.

Other fertilizers necessary, however. 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.

What system of dairying to follow. 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 makes so little demand on the soil. Again, the skim-milk is available to feed on the farm, while whey has a much less feeding value.

The draft of dairying on the soil. 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

Fig. 48. A high-school class judging the leading breeds of dairy cattle.

is easily possible, and there are those who look forward to the time when there will be a cow to the acre on the 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 50 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.

The demands of other types of farming on the soil. 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....	$150
560 bushels of wheat containing worth of soil fertility...	145
600 bushels of rye containing worth of soil fertility.....	130
1,000 bushels of corn containing worth of soil fertility....	165
1,000 bushels of barley containing worth of soil fertility..	153
3,600 bushels of potatoes containing worth of soil fertility.	75

If tobacco is grown instead of these, with 1,000 pounds of this crop per acre, $300 worth of soil fertility is sold, and with ten tons of sugar beets per acre, a low estimate, $275 worth of soil fertility is removed annually.

Prices used in these calculations. These calculations are based on the average analysis of the above products, average yield for the United States, and the present price of commercial fertilizers, viz., nitrogen, 19 cents per pound, phosphoric acid, 5 cents per pound, and potash, 5 cents per pound.* It requires only 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

*At the time that this goes to press the price of potash has become almost prohibitive on account of the war in Europe.

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.

EXERCISES

1. What is meant by a three-year rotation?
2. Outline a five-year rotation.
3. Which removes the greatest amount of fertility value from the soil, oats or tobacco?
4. How do you dispose of your milk at home?
5. What is done with the barnyard manure?
6. What is done with the crop grown on the land?
7. Can you suggest a better way to keep up the fertility on the home farm?

LABORATORY PROBLEMS

XXVI. To Determine Whether "Souring" Has Any Effect on the Fat Content of Milk or Cream

Mix well a quantity of milk and sample into from 6 to 10 milk test bottles. Test two of the milk samples at once. Allow the other samples to "sour" for a week or two. Test them in duplicate at intervals of two weeks. Before adding the acid break up the curd by shaking the bottle. If the sample is very dry, add a few cubic centimeters of water. Add sulphuric acid in small quantities of five to six centimeters at a time.

Compare results obtained with those obtained when the fresh milk was tested.

LABORATORY PROBLEMS

XXVII. To Determine the Specific Gravity of the Sulphuric Acid Used

The specific gravity of sulphuric acid should be 1.82 to 1.83. It can be determined as follows:

a. Carefully weigh a perfectly dry, clean, 10 per cent milk bottle.

b. Fill the bottle with clean water up to the zero mark and weigh carefully.

c. Subtracting "a" from "b" will give the weight of the water.

d. After drying fill the same bottle with sulphuric acid to the zero mark and weigh.

e. Subtracting "a" from "d" will give the weight of the sulphuric acid.

f. Dividing the weight of the acid by the weight of the water will give the specific gravity of the sulphuric acid.

Note: If distilled water is available, it should be used in these determinations. If such water is not available, then good, clean water can be employed. Sensitive scales and accurate weights are very essential to obtain accurate results.

LABORATORY PROBLEMS

XXIV. To Determine the Lactometer Readings and Fat Content of Milk That Has Been Watered and Skimmed

1. Take samples that have been partially skimmed and add small quantities of water until the lactometer readings are approximately the same as those of the original sample.

2. Determine the fat content of these three lots of milk after they have been watered.

3. Judging from the results obtained, is it sufficient to take the lactometer reading only in order to determine whether or not a certain milk has been either watered or skimmed?

Note: The following may assist the student:

a. Normal per cent of fat (3.00 to 5.00 per cent) and a normal reading (29.0 to 33.0) indicate normal milk.

b. Below normal in fat and high in lactometer reading (above 33.0) indicate skimming.

c. Below normal in fat and low lactometer reading (below 29.0) indicate watering.

d. Below normal in fat and normal lactometer reading (29.0 to 33.0) indicate both skimming and watering.

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