DAIRY FARMING

MICHELS

Dairy Farming

BY

JOHN MICHELS, B. S. A., M. S.

PROFESSOR OF ANIMAL HUSBANDRY AND DAIRYING
IN THE STATE AGRICULTURAL COLLEGE
OF SOUTH CAROLINA

AUTHOR OF
CREAMERY BUTTER MAKING

ILLUSTRATED

CLEMSON COLLEGE, SOUTH CAROLINA
PUBLISHED BY THE AUTHOR
1907

PREFACE.

In the preparation of this work, the endeavor has been to arrange in a concise and systematic form the essential facts relating to the science and practice of dairy farming. It embodies the Author's twenty years' experience, both as a practical dairyman and as a student and teacher of dairy husbandry. Technical terms have been avoided as far as possible, in order that the book may not only meet the needs of the class-room, but also serve as a convenient and useful handbook for farmers not versed in the sciences.

Acknowledgements are due the following parties for their kindness in offering the loan of electrotypes: Creamery Package Mfg. Co., D. H. Burrell & Co., American Jersey Cattle Club, Guernsey Breeders' Association, Holstein-Friesian Breeders' Association, Ayrshire Breeders' Association, Drew Elevated Carrier Co., De Laval Separator Co., Sharples Separator Co., Empire Cream Separator Co., Vermont Farm Machine Co., and Star Milk Cooler Co.

JOHN MICHELS.

Clemson College, S. C.
May, 1907.

TABLE OF CONTENTS.

PART I. THE DAIRY HERD.

PART II. MILK AND ITS PRODUCTS.

PART I.

THE DAIRY HERD.

CHAPTER I.

DAIRY FARMING A PROFITABLE BUSINESS.

That dairy farming is a profitable business is fully attested by its unprecedented growth during the past decade and a half. No other branch of agriculture has ever witnessed such rapid development in a similar period of time. Its growth has not been confined to any particular section or sections of the country, but has been noticeable in all sections.

The profits that have prompted this rapid and general expansion of the dairy business have been derived from two sources: (1) direct profits realized from the sale of milk, cream, butter and cheese; (2) indirect profits accruing from an increased fertility of the land and the consequent increased productiveness of the same.

Direct Profits. It is pretty well conceded that in general dairy cows yield greater returns for feed consumed than either swine, sheep or beef animals. A good cow will yield not less than 300 pounds of butter a year, which, at 25 cents per pound, is worth $75. Adding to this the value of 6,000 pounds of skim milk at 20 cents per 100, and $10 as the value of the calf, we have a total income of $97 a year. Subtracting from this $50 as the average cost of the feed, we have $47 remaining to pay for the labor and interest on investments.

Where good milk and cream markets are available the income from the sale of milk and cream may be actually double that from butter at 25 cents per pound. Moreover, with cows of a higher productive capacity than that here considered, the profits would be more than proportionally increased.

Indirect Profits. The marvelous growth of the dairy industry has in part been necessitated by the need of conserving and increasing the fertility of lands that have been cultivated without due regard to maintaining soil fertility. The selling of raw products from the farm, such as hay and grains, has been a constant source of soil impoverishment. This method of robbing the soil of its natural plant food has made farming in many of the New England and Southern States well nigh impossible without the aid of commercial fertilizers. In some of these states as much as $7,000,000 is expended annually for these fertilizing materials.

By feeding the raw materials of the farm to dairy cows, we are not only manufacturing high priced products as compared with the value of the raw material, but we are retaining upon the farm that valuable by-product, the manure, which contains about 75% of the fertilizing constituents originally present in the feed. Where only butter is sold, practically all of the fertilizing ingredients of the feed are recovered, since butter contains scarcely any fertilizing material. Even where cream is sold about 95% of the fertilizing value of the feed is retained upon the farm.

CHAPTER II.

EVOLUTION OF THE DAIRY COW.

The dairy cow is one of the most useful as well as one of the most profitable of all our domestic animals. Her products not only supply an indispensable want in the human dietary, but they are also the source of much profit to her owner.

Comparing the modern cow with her primitive ancestors a most interesting and instructive evolution in her milk giving function is noted. In the wild or primitive state her milk production was confined to a short period following parturition and was barely sufficient for the support of the calf. In her present form the amount of milk necessary for the support of the calf constitutes but a small part of her total possible production and its secretion is almost incessant.

Like the race horse, the dairy cow has been bred and handled for a specific purpose for a number of centuries. Continued specialization has resulted not only in an enormous increase of milk and butterfat production, but as a result of such increased production there has been created a specific conformation known as the dairy type.

At no period in the development of the dairy cow have such great strides been made as in the past half a century. Indeed, the period of general and systematic improvement in the common stock may be said to date from the invention of the Babcock test. Fifteen years ago the average butter production was approximately 125 pounds per cow. To-day the average production appoximates 175 pounds per cow.

There are hundreds of herds scattered over the country that average 300 pounds of butter per cow and many herds exceed even the 400 pound mark. Scores of individual cows could be mentioned that have reached the 600 and 700 pound mark, and the world's champion cow holds the phenomenal record of an even 1,000 pounds of butter in one year.

Among the factors that have been instrumental in bringing about the remarkable evolution in the milk producing function of the cow, the following are the most important: (1) selection, or breeding only from the best milkers; (2) liberal and judicious feeding; (3) proper milking; (4) suitable environment, including conditions as to housing and sanitation; (5) good care and management. These factors will always continue the most important in the improvement of our modern herds, and will be discussed in the chapters which follow.

CHAPTER III.

SELECTION OF COWS.

Success in dairying depends in a large measure upon one's ability to select the right animals in starting and building up the herd. Unless adapted by nature for dairy purposes, cows will remain unprofitable in spite of the best feed and management. The first lesson the dairyman has to learn, therefore, is to know how to discriminate between good cows and poor cows. The cardinal points to consider in the selection of a cow are: (1) butterfat production; (2) type; (3) purity of breeding; (4) pedigree; and (5) health.

BUTTERFAT PRODUCTION.

The best guide in the selection of cows is the actual butterfat record as determined by a pair of scales and a Babcock tester. It is not enough to simply know the quantity of milk yielded by a cow; one must also know its fat content, for it is this that measures the value of milk for commercial uses as well as for butter and cheese production.

The method of determining the butterfat production of cows is treated in detail in chapter IX.

CONFORMATION OR TYPE.

All dairy experts recognize a definite type as associated with economical milk production. The judge in the show ring bases his judgment entirely upon type or conformation. While there still may be differences of opinion among breeders as to minor points, these are really of little consequence. The points that go to make up the ideal type will be treated under six heads: (1) dairy temperament; (2) feeding capacity; (3) constitution; (4) milk organs; (5) quality; and (6) pelvic region.

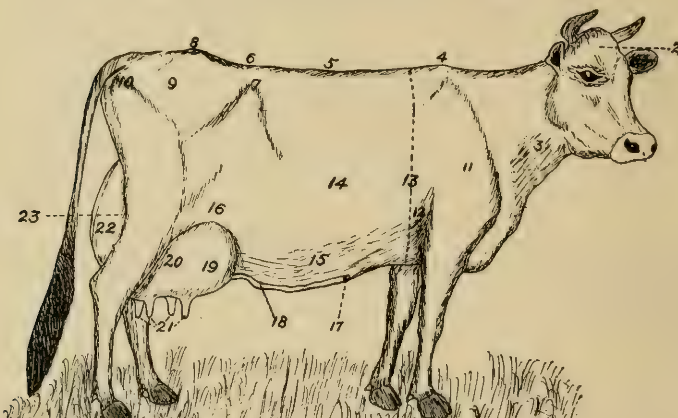


Fig. 1.—Points of a Dairy Cow.

1. Muzzle. 2. Forehead. 3. Neck. 4. Withers. 5. Back. 6. Loins. 7. Hip. 8. Pelvic arch. 9. Rump. 10. Pin bone. 11. Shoulder. 12. Chest. 13. Heart Girth. 14. Side. 15. Belly. 16. Flank. 17. Milk well. 18. Milk vein. 19. Fore udder. 20. Udder. 21. Teats. 22. Hind udder. 23. Thigh.

Dairy Temperament. This is indicated by a rather spare, angular form; large, bright, expressive eyes, far apart and placid; a rather long, clean face slightly dished; forehead wide and rather long; wide juncture of head and neck; a large, straight, prominent backbone with well defined spinal processes; ribs and vertebrae wide apart; sharp withers; spare, incurving thighs; and a high arching flank: all of which indicates strong nerve development, or power to do work.

Feeding Capacity. This is indicated by a long, broad, deep, capacious barrel, showing well sprung ribs diverging toward the rear; a broad muzzle; and a strong jaw.

Constitution. This is indicated by large, bright, clear eyes; large, open nostrils; wide, deep chest; strong navel development; strong abdominal walls; absence of extreme refinement; and a soft, pliable skin with plenty of secretion: all of which indicates strength and vitality.

A heavy milker is one of the hardest worked of all animals, and unless possessed of a strong constitution, she can never do her maximum work and an early breakdown may be expected.

Milk Organs. These include a large, evenly quartered, elastic udder, running well forward and well up behind; large, tortuous milk veins running well forward and branched; numerous, large, capacious milk wells; and medium sized teats, squarely placed, and far apart.

Large, *fleshy* udders are undesirable, as they possess a relatively small milk elaborating capacity, and are more subject to disorders than moderately large, *elastic* udders.

The milk veins, which carry the blood away from the udder, are deserving of careful attention. When the orifices (milk wells) through which they enter the body are large, the size of the milk veins may be taken as a fair indication of the amount of blood they carry.

A large flow of blood away from the udder presupposes a large flow into it, and since milk is secreted from the blood, the quantity which flows through the veins must be some indication of milk producing capacity.

Quality. This is indicated by a soft, oily, pliable skin, of medium thickness; short, soft silky hair; yellow secretion in the ears; fine textured bone; rather small and refined ears and horns; yellowish wax at the base of the horns; and a general absence of coarseness in any part.

Pelvic Region. This should be large to afford room for the calf, especially during its delivery. A good pelvic region is indicated by a high, long, broad rump, broad hips and loins, and good width between the pin bones.

Additional observations on type should be directed to the following: Shoulder, free from flesh and rather sharp at the withers; tail, long and refined; hocks, clean, well apart, and pointing straight backward, giving roominess for the udder; front legs, straight and well apart, with toes pointing directly forward.

The *escutcheon,* which refers to the rear portion of the animal where the hair turns up, was the subject of considerable study by a Frenchman named Quenon, who regarded the size and shape of it as the chief indication of merit in dairy cows. At the present time, however, very little importance is attached to this point.

PURITY OF BREEDING.

Selection is based upon the law that "like produces like." According to this law the characters of the parents are transmitted to the offspring with a greater or less degree of certainty. The purer the breeding of the parents the greater the certainty of such transmission. Thus, for example, one can figure with much certainty that the progeny of pure-bred parents of the same breed will resemble its parents in all essential characteristics. On the other hand, there is no certainty whatever that the off-spring of parents of promiscuous breeding will resemble its parents, either in important or unimportant particulars. It may be like them or it may be totally unlike them.

It is the long period of breeding along one line without admixture of foreign blood that gives the pure-bred animal the superior power of transmitting its qualities to its offspring, a power which is known as prepotency. In the building up of a dairy herd it is of the highest importance to have animals which transmit their qualities to their offspring with a high degree of certainty, and it is for this reason that pure-bred animals are so much preferred to those of promiscuous breeding.

PEDIGREE.

A pedigree is a recorded statement of the ancestry of an animal. It is furnished in many cases simply as a guarantee of purity of breeding. Its real value, however, is determined by the merit of the animals which it represents. A 300 pound butter cow with an unbroken list of noted dairy performers back of her is much to be preferred to a 300 pound cow among whose ancestors some inferior individuals are found, and especially if the inferior individuals are near ancestors.

While, generally, pedigreed animals are much to be preferred to those of promiscuous breeding, it by no means follows that *all* pedigreed animals are desirable. Far from it. There probably are now-a-days as many poor pedigreed dairy animals as good ones. "Scrubs" are found among pedigreed cows just as they are found among common or native cows, though of course far less frequently.

The reason of the existence of inferior individuals among pure-bred dairy animals is found in the fact that eligibility to registration in most cases is not based upon production or individual excellence, but upon purity of breeding. This fact has made it possible for many animals to enter the herd register which, by nature, were fit only for the shambles. In the purchase of pure-bred stock, therefore, no judicious selection can be made from a mere list of names of individuals, no matter how long this list is or how "high sounding" the names it contains may be. One must know the production and individual excellence of the animals represented in the pedigree. The greatest stress should be laid upon the near or immediate ancestry of the animal under consideration.

Fortunately there is what is known as an advanced registry, or register of merit, the basis of admission to which, in addition to pure breeding, is the merit of the individuals as dairy performers. It is much to be hoped that this method of registration will soon replace entirely the common method whose sole requisite for registration is purity of breeding.

HEALTH OF ANIMALS.

The prevalence of tuberculosis, contagious abortion, and other diseases, makes it imperative to make the matter of health an important consideration in the selection of dairy animals. Indeed diseased animals, no matter how valuable in other respects, should be rigidly excluded from the herd.

It is the height of folly to select dairy animals without making rigid inquiry as to their freedom from tuberculosis and contagious abortion. Yet there are many who do not even inquire about these and other diseases, much less make investigation such, for example, as a tuberculin test.

CHAPTER IV.

SELECTION OF DAIRY SIRES.

The importance of the dairy sire is recognized in the expression, "The bull is half the herd." Usually, however, the bull is more than half the herd, either for good or bad. In the case of common or grade cows, for example, the pure-bred bull may count for three-quarters or more of the herd, by reason of his greater prepotency. To so great an extent does the bull determine the improvement or deterioration of the herd as to call for the utmost caution in his selection, which should be based upon the following: (1) purity of breeding; (2) pedigree; (3) type; (4) prepotency; and (5) health.

Purity of Breeding. Under no circumstances should anything but pure-bred sires be used. The value of purity of breeding has already been discussed under the selection of the dairy cow. It should be understood, however, that purity of breeding is of greater consequence in bulls than in cows, for the reason that improvement in the herd is usually expected to be brought about through the dairy sire.

Pedigree. In the case of a dairy bull, especially a young bull, his chief value is determined by the performance of his ancestry. The points of greatest importance to consider in his pedigree are the following: (1) the merit of his mother and his sire's mother; (2) the merit of the daughters of his sire and grand sire; (3) the value of the daughters of his dam and his grand-dam;

(4) the value of his sisters, if he has any; and (5) the value of his own progeny, if he has any.

The further back consecutively good records can be traced the more valuable the animal. It should always be remembered, however, that near ancestors count for a great deal more than those more remotely related.

Type. The external qualities of a good sire are indicated by a masculine head and neck; bright, prominent eyes, far apart; a strong, sinewy jaw; broad muzzle; wide open nostrils; deep, broad chest; deep, capacious barrel; soft, loose, oily hide, of medium thickness; clean bone; large rudimentary teats, squarely placed and far apart; and a general spareness of flesh, especially in the region of the shoulders, thighs, and hips. Indeed, from the shoulders backward, the dairy bull should have the same general outline as that possessed by the dairy cow. He should have a strong, resolute appearance and an active style, showing that abundance of vigor so necessary in a good breeder.

Prepotency. It has already been stated that this term signifies the power which an animal possesses of transmitting its own qualities to its offspring. The possession of this power is of the highest importance in a dairy bull, for it matters little how good a pedigree or how fine an individuality he may have, if he lacks in the power of transmission he is a failure. Prepotency in an animal increases with the purity and closeness of breeding, and is indicated to some extent by a strong, resolute, vigorous appearance, reflecting a strong constitution and an abundance of nerve development.

The full extent, however, to which a sire is prepotent can be determined with certainty only from his offspring.

It is for this reason that a middle-aged bull is so much more desirable than a young, untried bull.

A bull with descendants is always the safest animal for the purchaser to buy. Nothing can speak more for a bull than the satisfactory performance of his offspring.

Health. Everything that has been said with reference to health in the selection of cows (p. 16) applies with equal force to dairy sires.

CHAPTER V.

BUILDING UP A DAIRY HERD.

I. PRINCIPLES INVOLVED.

Underlying Law. The success in building up a dairy herd depends to a great extent upon one's ability to select individuals with reference to the points considered in the preceding two chapters; that is, the ability to make a judicious selection of both males and females. To emphasize more fully the importance of rigid selection it should be remembered that all selection is based upon the law that "like produces like," or that the offspring will be like the parents. The essence of this law is that good milkers will produce good milkers and poor milkers will produce poor milkers.

The uniformity with which this law operates is dependent upon three things: (1) purity of breeding; (2) closeness of blood relationship; and (3) similarity of parents.

Purity of Breeding. The purer the breeding the greater the certainty with which animals will transmit their own characteristics to their offspring. See p. 14.

Closeness of Blood Relationship. The characters of parents of the same strain will reappear in the progeny with greater regularity than those of parents of different strains in the same breed. This fact is recognized in in-and-in breeding, which is an attempt to secure and speedily fix desirable characters by close breeding. In-and-in breeding can be practiced with success, however, only in the hands of skilled breeders.

In the case of crossing one breed upon another as, for example, a Holstein-Friesian upon a Jersey, it is often mistakenly supposed that the progeny of such a cross partakes equally of the characters of both parents. This may occur in some instances, but more often the offspring will resemble either one parent or the other, or neither. But even where the offspring does partake equally of the characters of both parents, such a cross is undesirable because the offspring is not capable of transmitting its characteristics with any degree of certainty. In the hands of the average dairyman transmission in crossing is uncertain and unsatisfactory, and for this reason crossing should not be attempted.

When a cow of nondescript or promiscuous breeding is bred to a pure-bred sire, the progeny will largely partake of the characters of the sire, by reason of his greater prepotency. With what degree of regularity and to what extent this occurs depends upon the degree of prepotency. The offspring of a highly prepotent sire and a common or native cow will take on nearly all the essential characteristics of the sire. In such a case it is plainly seen that the sire counts for a great deal more than half the herd.

In the case of grade cows the influence of the pure-bred bull becomes less the closer the grade approaches purity of blood. But only in the case where the cows are pure-bred, or more strictly of equal prepotency with the bull, can it be said that the bull is only half the herd.

Similarity of Parents. In mating animals it should always be remembered that the greater the similarity of all their characteristics the greater the certainty of transmission. Where animals of great extremes of size, conformation, function, disposition, or nervous organization, are mated, somewhat the same results may be looked for that are obtained in crossing animals of different breeds.

Mating animals of highly dissimilar characteristics is spoken of as violent mating and should be avoided. Where there is much similarity in the parents there is usually a satisfactory transmission of qualities and the mating is often referred to as good "nicking."

II. STARTING THE HERD.

Grade Cows and Pure-bred Sires. With the average farmer, the cheapest and most satisfactory way of starting a dairy herd is to select as foundation stock good grade cows and a pure-bred bull of one of the strictly dairy breeds. The grading up will be most rapid when the predominant blood in the grades corresponds with the blood of the sire.

A foundation of this kind, of course, does not produce stock that can be registered, but by continuing the use of good, pure-bred bulls of the same blood, stock is soon obtained which, so far as milk and butter production is concerned, very closely approaches in value that of pure breeding.

Pure-Bred Cows and Sires. To start with a pure-bred herd is practically beyond the means of the majority of farmers. Furthermore, there is an objection to placing well-cared-for, pure-bred cows under average conditions as to feed, care, and management, because under any such change the attainment of satisfactory results would be practically impossible. Where there is a gradual infusion of pure blood, as in the case of grading up a herd with pure-bred sires the new blood is gradually accustomed to the change of environment and the herdsman is given the necessary time to change his methods to meet the requirements of pure-bred cattle.

Where the dairyman understands the management of pure-bred stock and has the means with which to purchase the right kind, a pure-bred herd may be started to good advantage.

One of the chief dangers in starting with a pure-bred herd is the lack of funds to procure the right sort of animals. Instead of purchasing a pure-bred bull and a number of pure-bred cows of common merit, it is better policy to buy relatively cheap, grade cows, and to add the money thus saved to that originally set aside for the bull. This extra money is likely to be the means of securing a bull of outstanding merit.

III. BREEDING UP THE HERD.

Importance of Sire. Whether the cows be grades or pure-breds; it is of the highest importance in building up a dairy herd to secure a pure-bred bull of outstanding dairy merit. Unless the bull is descended from good milkers it is folly to expect him to produce good milkers, no matter how fine or ideal he may be as an individual.

It is, furthermore, of importance to remember that a herd cannot be successfully built up unless the bulls that are successively used belong to the same breed. If the grading up is begun with a Jersey bull the process must be continued uninterruptedly by the use of Jersey blood.

In the selection of a herd bull the points discussed in the preceding chapter should be carefully considered.

Selecting the Best Calves. With a first-class bull at the head of the herd, rapid improvement is effected by selecting and retaining calves from only the best milkers, at the same time culling out those cows whose records have not been satisfactory. This work cannot be done to best advantage unless records are kept of the quantity and quality of milk from each cow for a whole lactation period, as discussed in chapter IX.

Buying Cows. Where all of the cows in the foundation stock are grades, none of the calves, of course, can be registered. It is desirable, therefore, to add to the herd from time to time, as means permit, some good pure-bred cows of the same blood as the bulls that have been used. This has the advantage of enabling the owner to dispose of his calves to better advantage.

The purchase of cows, however, is always attended with the danger of introducing contagious diseases into the herd, especially tuberculosis and contagious abortion. For this reason the purchasing of cows should be carried on in a limited way only. It is, of course, always in order to buy cows when the object is to add to the herd pure-bred individuals of exceptional dairy merit. But the practice of buying cows should never be carried to the point of making it the principal means of replenishing the herd, especially since the latter can be accomplished much more satisfactorily by raising the calves from the best cows.

CHAPTER VI.

BREEDS OF DAIRY CATTLE.

JERSEY CATTLE.

The native home of this breed is the Island of Jersey, situated off the coast of France, and comprising 28,717

Fig. 2.—Typical Jersey Bull. Flying Fox's Foxhall.

acres. The climate is very mild and healthful, and the soil is very productive. Here the Jersey cattle have been bred pure for a number of centuries.

Fig. 3.—Typical Jersey Cow. Loretta D.

Characteristics. The color of Jerseys is usually some shade of fawn. Cream, dun and yellow are common, and these are frequently mixed with white. In form Jerseys are spare, possessing a rather large barrel, a refined head and neck, and fine, clean-cut limbs. In size they are small to medium, the average weight of cows being probably somewhat less than 900 pounds. The quantity of milk produced by Jerseys is, as a rule, not very large, but the milk is very rich, making them excellent butter producers. The color of the milk and butter is a pleasing, rich yellow.

GUERNSEY CATTLE.

The native home of this breed is the Island of Guernsey, situated near the Island of Jersey, and, like it, is one

Fig. 4.—Typical Guernsey Bull. Benjamin.

of the group of islands known as the Channel Islands. In size the Island of Guernsey ranks next to that of Jersey. Its climate is very mild and healthful and the soil is productive. Guernsey cattle have been bred pure for a long period of time.

Characteristics. Guernsey cattle are larger, stronger in frame and constitution, and in general more rugged than Jerseys. A noted characteristic of this breed is the very rich, yellow color of the milk and skin. Their predominant color is a reddish fawn, with more or less white

Fig. 5.—Typical Guernsey Cow. Glenwood Girl 6th.

markings. Colors bordering on a yellowish or brownish fawn with white markings, are also common. The cows average probably somewhat more than 1,000 pounds in weight. They average a fairly large yield of milk, which is practically as rich as that produced by Jerseys. Guernseys are also noted for their quiet, gentle disposition.

HOLSTEIN-FRIESIAN CATTLE.

The native home of this breed is Holland, where it has existed for many centuries. The low, level, rich lands reclaimed from the sea, furnish an abundance of grazing

Fig. 6.—Typical Holstein-Friesian Cow. Johanna De Pauline.

and have given rise to a large breed of cattle. The winters of Holland are rather cold but not severe.

Characteristics. The Holstein-Friesian cattle are white and black in color, have large, strong frames, and

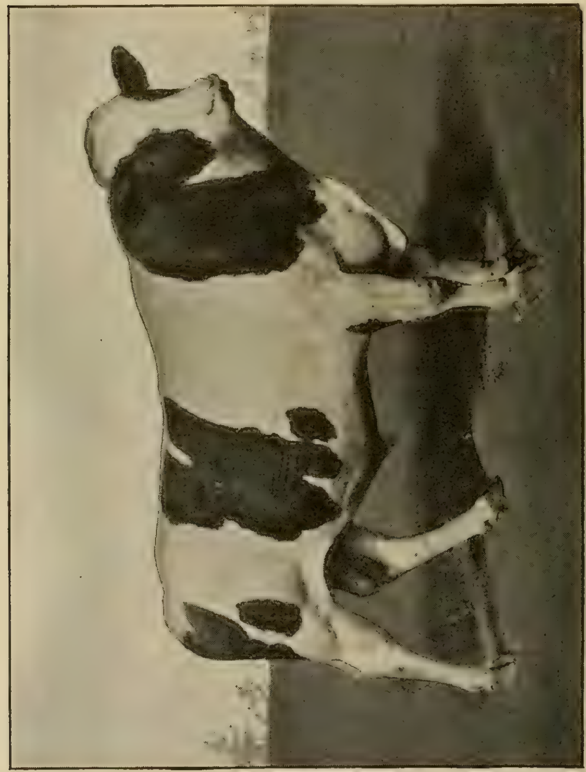


Fig. 7.—Typical Holstein-Friesian Bull. Earl Korndyke De Kol.

easily stand at the head in size and quantity of milk yielded. The average weight of the cows approximates 1,300 pounds. While noted for their phenomenal milk yields, the milk averages rather low in per cent of butterfat, being lower than that of any other dairy breed. The udders and milk veins in this breed are conspicuously large. The shoulders are rather prominent and the hind quarters as a rule, are rather thick and straight.

AYRSHIRE CATTLE.

The native home of this breed is Ayr county, Scotland, from which place the breed derives its name. The

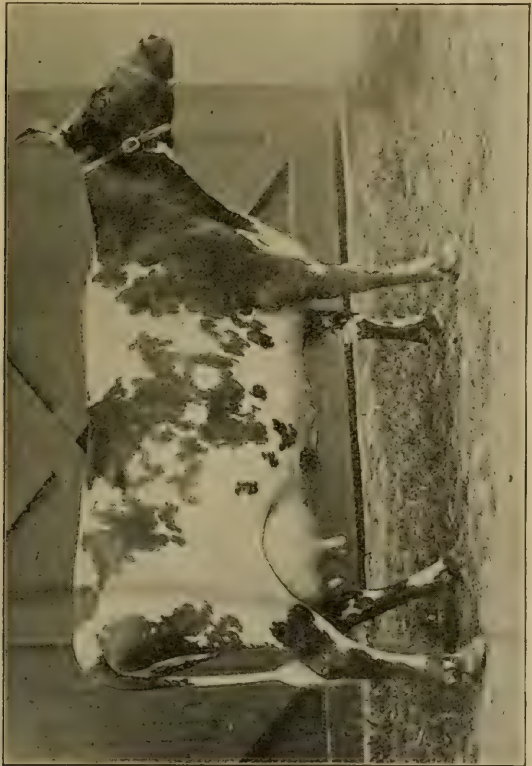


Fig. 8.—Typical Ayrshire Cow. Flora 3d of Bonshaw, Imp.

pastures are good, but the climate is rather severe and rough, giving this breed a high degree of hardiness.

Characteristics. The Ayrshire cattle are a rather hardy, rugged breed, of medium size, the average weight being about 1,000 pounds. They have a deep capacious barrel, and the hind quarters are inclined to be fleshy. In color they may be red, white, or brown, or a mixture of these, each color being well defined. The cows give a good yield of milk containing an average per cent of butterfat. Their udders possess a high state of perfection.

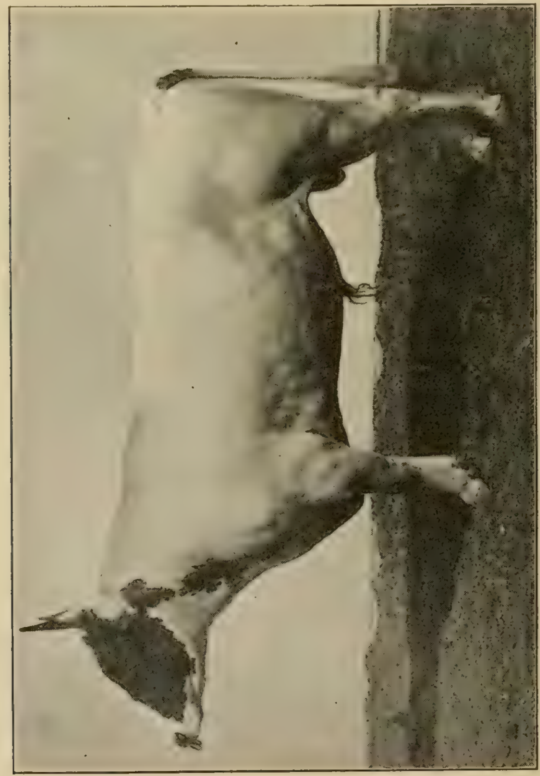


Fig. 9.—Typical Ayrshire Bull. Netherhall McDonald, Imp.

CHAPTER VII.

FEEDING THE DAIRY COW.

I. PRINCIPLES OF FEEDING.
II. PRACTICE OF FEEDING.
III. FEEDING TABLES.

I. PRINCIPLES OF FEEDING.

No phase of the dairy industry has received so much attention in recent years as that relating to the principles and practice of feeding. We have come to learn that certain underlying principles must be observed if anything like a full measure of success is to be achieved. The first lesson of the student in stock feeding concerns itself with the following particulars regarding feeds: (1) composition; (2) digestibility; (3) succulence and palatability; (4) proportion of nitrogenous and non-nitrogenous nutrients; (5) proportion of roughage* and concentrates†; and (6) fertilizing constituents.

Composition. A knowledge of the composition of feeds is necessary for two reasons: First, to enable the feeder to determine the relative value of the feeds at his disposal; and secondly, to assist in determining what quantity of feed is necessary to supply the required amount of nutrients.

In studying the composition of feeds we must first of all familiarize ourselves with three important groups of

---

*Roughage includes the coarser and less nutritious feeds, such as hay, straw, corn fodder, corn silage, etc.
†Concentrates include the more nutritious feeds, such as corn, wheat bran, cotton seed meal, etc.

nutrients found in all feed stuffs; namely, protein, carbohydrates and ether extract.

Protein is the nitrogenous part of feeds and is by far the most valuable of the different groups of nutrients. Its characteristic element is nitrogen. The white of egg is almost pure protein. Cottonseed meal and linseed meal are very rich in protein, and so are leguminous hays, such as clover, alfalfa and cowpea hay.

Carbohydrates contain no nitrogen but are made up of carbon, hydrogen, and oxygen, containing the latter two elements in the proportion to form water. Sugar and starch are almost pure carbohydrates. Crude fiber is another carbohydrate, which constitutes the woody, fibrous part of plants.

Ether extract is the part of feeds extracted by means of ether, and consists largely of fats or oils. This group of nutrients bears a close similarity to carbohydrates, both in composition and in function; but owing to its higher carbon content, its fuel value is 2.4 times that of carbohydrates. Cotton seed and flax seed are very rich in ether extract.

Dry matter, as the term signifies, is the feed minus its water.

The variation in nutrients in different feeds is illustrated in the following table:

TABLE I. Showing variation in nutrients in different feeds.

Feed.	Dry matter in 100 pounds.	Total nutrients in 100 pounds.		
		Protein. Lbs.	Carbo-hydrates. Lbs.	Ether extract. Lbs.
Wheat bran	88.1	15.4	62.9	4.0
Cottonseed meal	91.8	42.3	29.2	13.1
Corn	89.4	10.3	72.6	5.0
Corn silage	20.9	1.7	17.0	0.8
Corn stover	59 5	3.8	52.2	1.1
Clover hay (red)	84.7	12.3	62.9	3.3

The table shows that feeds differ very widely in the amount of nutrients they contain, especially in protein, the most valuable portion of feeds.

Digestibility. While the total nutrients give some idea as to the relative value of different feeds, it is of far greater importance to know the total digestible nutrients as determined by actual digestion experiments with animals. That feeds differ widely in degree of digestibility is shown in the following table which contains the same list of feeds given in Table I.

TABLE II. Showing variation in the digestibility of different feeds.

Feed.	Dry matter in 100 pounds.	Total digestible nutrients in 100 pounds.		
		Protein. Lbs.	Carbo-hydrates. Lbs.	Ether extract. Lbs.
Wheat bran....	88.1	12.2	39.2	2.7
Cottonseed meal....	91.8	37 2	16.9	12.2
Corn....	89.1	7.9	66.7	4.3
Corn silage....	20.9	0.9	11.3	0.7
Corn stover....	59.5	1.7	32.4	0.7
Clover hay (red)....	84.7	6.8	35.8	1.7

Comparing this table with Table I, we note that the digestibility of the protein, for example, in corn stover, clover hay and cottonseed meal is 44%, 55% and 88% respectively. These figures suffice to show the need of knowing, not so much the total nutrients, as the total digestible nutrients in feed stuffs.

Succulence and Palatability. The amount of digestible nutrients does not always measure the feeding value of feed stuffs. Palatability must also be considered. Moreover, experience has amply demonstrated that for best results in milk production, a certain amount of succulent feed must be fed as a part of the ration. Corn silage, which is so highly prized by dairymen, probably owes its high rank as a dairy feed nearly as much to its succulence and palatability as to the nutrients which it contains.

Proportion of Nitrogenous to Non-Nitrogenous Nutrients. In the production of milk, only the protein or nitrogenous part of the feed can be utilized for the production of the protein or nitrogenous part of the milk. The non-nitrogenous constituents of the milk are largely, if not entirely, produced from the non-nitrogenous constituents of the feed, namely, the carbohydrates and ether extract.

From this it must be obvious that the best results in feeding can be obtained only from a proper balancing of the nutrients fed. Moreover, since the different nutrients are largely to be converted into milk, it is evident also that the quantity which can be advantageously fed must be gauged by the quantity and quality of milk produced. Hence feeders have come to adopt what is known as balanced rations or feeding standards.

Feeding Standards. These refer to the amount of digestible nutrients required per 1,000 pounds of live weight in twenty-four hours. They recognize that the nutrients fed must be in proportion to the quantity and quality of milk yielded. This is shown by the Wolff-Lehman standards presented in the following table:

TABLE III. Showing Wolff-Lehman feeding standards.

Ration.	Daily milk yield. Average quality.	Dry matter.	Digestible nutrients per 1,000 pounds live weight.		
			Protein.	Carbohydrates	Ether extract.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
No. 1...........	11.0	25	1.6	10.0	0.3
No. 2...........	16.6	27	2.0	11.0	0.4
No. 3...........	22.0	29	2.5	13.0	0.5
No. 4...........	27.5	32	3.3	13.0	0.8

The standard that has generally been used as a guide by feeders is that for ration No. 3. Researches during recent years have shown, however, that the Wolff-Lehman standard calls for too much protein. These researches make it quite clear that the amount of protein required for 22 pounds of average quality milk is nearer two pounds than two and a half pounds, and until the matter is definitely settled, it may be well to adopt two and one-fourth pounds of protein as the standard for the milk yield referred to.

Feeding Standards as Guides. Standards for balanced rations should always be used with considerable flexibility. They should be looked upon only as guides and as such are exceedingly useful. Every practical feeder knows that the influence of individuality counts for much in the feeding of dairy cattle. A ration that may be satisfactory for one cow may not be suited to another.

We have also to consider the source of the nutrients. It is known that the digestible nutrients in coarse feeds yield smaller returns, pound for pound, than those in grains. Then again the matter of proportioning the quantity of nutrients to the weight of the animal can at best give only approximate results. The actual milk and butterfat production must always remain the principal factor in determining the quantity of nutrients required by the dairy cow.

Calculating Rations. By a *ration* is meant the amount of feed required by an animal in twenty-four hours. The method of compounding rations consists in selecting from the feeds at our disposal such quantities as will contain the amount of nutrients called for by the standard. To illustrate, let us make up a ration for a cow yielding daily 22 pounds of milk of average quality, using the Wolff-Lehman standard (p. 37). The feeds at our disposal are wheat bran, cottonseed meal, corn meal, corn silage, corn stover and clover hay.

By a number of trial calculations we find that the required nutrients are obtained by selecting 9 lbs. of wheat bran, 4 lbs. of corn, 1 lb. of cottonseed meal, 5 lbs. of corn stover, 5 lbs. of clover hay and 30 lbs. of corn silage. The calculation is made from Table II (p. 35) in the manner shown below:

	Amt. in 100 lbs.	
Protein in 9 lbs. bran	= 12.2 x .09	= 1.098 lbs.
Protein in 1 lb. cotton seed meal	= 37.2 x .01	= 0.372 lbs.
Protein in 4 lbs. corn	= 7.9 x .04	= 0.316 lbs.
Protein in 30 lbs. corn silage	= 0.9 x .30	= 0.270 lbs.
Protein in 5 lbs. corn stover	= 1.7 x .05	= 0.085 lbs.
Protein in 5 lbs. clover hay	= 6.8 x .05	= 0.340 lbs.
	Total protein	= 2.481 lbs.
	Standard	= 2.50 lbs.

	Amt. in 100 lbs.	
Carbohydrates in 9 lbs. bran	= 39.2 x .09	= 3.528 lbs.
Carbohydrates in 1 lb. c. s. meal	= 16.9 x .01	= 0.169 lbs.
Carbohydrates in 4 lbs. corn	= 66.7 x .04	= 2.668 lbs.
Carbohydrates in 30 lbs. corn silage	= 11.3 x .30	= 3.390 lbs.
Carbohydrates in 5 lbs. corn stover	= 32.4 x .05	= 1.620 lbs.
Carbohydrates in 5 lbs. clover hay	= 35.8 x .05	= 1.790 lbs.
	Total carbohydrates	=13.165 lbs.
	Standard	=13.00 lbs.

	Amt. in 100 lbs.	
Ether extract in 9 lbs. bran	= 2.7 x .09	= 0.243 lbs.
Ether extract in 1 lb. c. s. meal	= 12.2 x .01	= 0.122 lbs.
Ether extract in 4 lbs. corn	= 4.3 x .04	= 0.172 lbs.
Ether extract in 30 lbs. corn silage	= 0.7 x .30	= 0.210 lbs.
Ether extract in 5 lbs. corn stover	= 0.7 x .05	= 0.035 lbs.
Ether extract in 5 lbs. clover hay	= 1.7 x .05	= 0.085 lbs.
	Total ether extract	= 0.867 lbs.
	Standard	= 0.50 lbs.

To make the above calculation perfectly plain it should be noted that the table on page 35 says that 100 lbs. of bran contain 12.2 lbs. of protein. If 100 lbs. contain 12.2 lbs., 9 lbs. of bran will contain nine hundredths of 12.2 lbs. or .09 x 12.2, which equals 1.098 lbs. of protein. The method is the same in the remaining computations.

Nutritive Ratio. In speaking of rations, the terms "wide" ration and "narrow" ration are frequently used. The terms refer to the proportion of nitrogenous to non-nitrogenous matter in the ration. This proportion is spoken of as the nutritive ratio, which is obtained by dividing the digestible carbohydrates plus 2.4 (heat equivalent of carbohydrates) times the digestible ether extract, by the digestible protein. In the ration calculated above the nutritive ratio equals $(13.17 + 2.4 \times .87) \div 2.48 = 6.1$; that is the nutritive ratio in this case is 1:6.1.

When the amount of nitrogenous matter is small as compared with the non-nitrogenous matter, the ration is said to be "wide." When the reverse is true, the ration is said to be "narrow."

Proportion of Roughage and Concentrates. According to our feeding standard, a cow yielding 22 pounds of milk requires a ration containing 16 pounds of digestible nutrients and a total of 29 pounds of dry matter (digestible and indigestible). This amount of dry matter means that the ration must have a fairly definite bulk. Where the ration contains a great deal of rich concentrates in proportion to roughage, it is apt to lack in bulk. On the other hand a ration containing a large proportion of corn stover, oat straw and similar roughage, is likely to make the ration so bulky as to make it impossible for a heavy producer to consume enough of it to obtain the required nutrients.

In the ration calculated on page 38 the proportion of roughage and concentrates is about right. Under average conditions a cow yielding 22 pounds of milk should have a ration composed of about two-thirds roughage and one-third concentrates. For greater yields it is best, as a rule, to increase only the concentrates to meet the requirements of the additional flow of milk, thus making the proportion of concentrates to roughage greater the larger the yield of milk.

Fertilizing Constituents of Feed. These are nitrogen, phosphoric acid, and potash. Feeds rich in these constituents will produce manure correspondingly rich in them. In the selection of feeds, therefore, some attention should be given to their manurial value, especially since feeds differ so widely in this respect.

An illustration of the extent to which feeds differ in their fertilizing or manurial constituents is given in the following table, which shows the amount of nitrogen, phosphoric acid and potash contained in corn and cotton seed meal. The table also shows the value of these constituents, which was obtained by rating the nitrogen at 15 cents per pound, and the phosphoric acid and potash at 4½ cents per pound.

TABLE IV. Showing fertilizing constituents in corn and cottonseed meal.

Feed.	Fertilizing constituents in one ton.			
	Nitrogen. Lbs.	Phosphoric acid. Lbs.	Potash. Lbs.	Total value.
Corn	36.4	14.0	8.0	$6.45
Cotton seed meal	135.8	57.6	17.4	23.75

The table shows that the fertilizing value of a ton of cottonseed meal exceeds that of a ton of corn by $17.30, an amount that certainly must appeal to the man who is dairying on a business basis.

II. PRACTICE OF FEEDING.

Frequency of Feeding. The main part of the ration should be supplied in two feeds; one in the morning and the other in the late afternoon. It is desirable to feed some dry roughage at noon, especially when the roughage in the morning and evening consists of silage. The cow, on account of her large store room, the paunch, is capable of storing up a large quantity of feed and, therefore, does not require as many feeds as some other farm animals.

Order of Feeding Concentrates and Roughage. As a rule it is best to feed the concentrates just previous to milking and the roughage immediately thereafter. The grain helps to attract the cows to their stalls, and, by feeding the roughage after milking, we avoid tainting the milk with undesirable odors when the roughage contains these. When corn silage, for example, is fed immediately before milking, its odor is always perceptible in the milk. When fed after milking, the odor is never detected. It is believed also that feeding the concentrates by themselves will result in a more thorough mixing of saliva with them and thus increase their digestibility. Furthermore, a great deal of dust can be avoided by feeding the roughage after milking, particularly when the roughage consists of hay or dry fodder.

A prevailing opinion that heavy concentrates will form an injurious, pasty mass in the cow's stomach does not seem to be well founded. When the concentrates are fed directly before milking and the roughage directly after, there will be sufficient mixing in the paunch before the contents pass into the stomach proper. The author for several years, has successfully followed the practice of feeding concentrates and roughage separately when the former consisted of as much as five pounds of cottonseed meal per day.

Feeding Before and After Calving. Toward the close of the lactation period, the grain ration should be gradually reduced, either because of the reduced flow of milk, or on account of the desirability of drying up the cow so that she may have a month's rest before calving. It should be remembered, however, that even while the cow goes dry she still requires nutritious feed to properly nourish the foetus within her. The requirements as to feed at this time call for plenty of succulent roughage, and some grain which is rich in ash and protein, at the same time laxative in character.

If the cow is feeding on good pasture the grain may be entirely withheld a month previous to calving. Indeed, if pasture is luxurious, it is desirable to restrict the time during which she is allowed to graze lest she overfeed and invite milk fever. When no pasture is available, a ration consisting of corn silage, good hay and about four pounds of grain will answer very satisfactorily. A desirable grain ration is made up of linseed meal, wheat bran and ground oats, using these feeds in the proportion of about one pound of linseed meal and one and a half pounds each of bran and oats. This ration not only supplies the proper nutrients for the development of the foetus, but owing to its laxativeness, keeps the cow in the best physical condition.

A few days before and after calving the grain is preferably supplied in the form of a warm mash. Warm water should also be freely supplied at this time. Three to six days after calving the grain should be gradually increased until the maximum amount consistent with economical production has been supplied.

If the cow has been properly nurtured previous to calving, she will have stored up a considerable amount of reserve material which she draws on immediately after calving, thus making a heavy grain ration at this time not only not desirable but entirely unnecessary.

Feeding Silage. The cheapest and most satisfactory roughage that can be produced upon most farms, is corn silage. Its succulence and palatability make it an ideal feed for milk production. This feed should be available upon the farm the larger portion of the year. In winter it takes the place of summer pasturage; during the late summer and fall it is needed to supplement the shortage of pasturage which usually occurs about this time.

An average cow in full flow of milk will consume 40 pounds of silage daily to good advantage. This amount of silage combined with 8 or 10 pounds of dry fodder or hay makes a good combination of roughage for a dairy cow.

Feeding Grain. It should be remembered that silage contains a large amount of water, and where this feed constitutes the main part of the roughage of the ration, a considerable amount of grain must be fed to supply the required nutrients of a heavy milk producer. The amount of concentrates to be fed is, of course, largely dependent upon the amount of milk and butterfat produced by the cow.

Water. An abundance of pure water is a prime necessity with a dairy cow. This is to be expected from the fact that milk is largely composed of water. Where cows have no access to flowing water, they should be watered regularly morning and night; and during hot weather a third watering at noon is desirable. The fact that milk is composed so largely of water should emphasize the importance of supplying only pure water. We may reasonably expect the same bad effect on the health of the cow and the flavor of the milk from stale, impure water which is noticeable from the feeding of stale, odoriferous feeds.

Salt. Cows should have daily access to all the salt they care to lick. Either common granular salt or rock salt will answer the purpose satisfactorily.

Feeding According to Flow. In the economical production of milk, it is absolutely essential to feed cows according to their productive capacity. Just what this productive capacity is can be determined only by keeping a careful account of the feed consumed and the milk and butterfat yielded by each cow individually. Such a record will soon show to what extent cows will profitably respond to the feed given them.

Importance of Feeding a Full Ration. According to the German feeding standard, a cow weighing 1,000 pounds requires for body maintenance 0.7 pound of digestible protein, 8 pounds of digestible carbohydrates and 0.1 pound of digestible ether extract. This shows that about half the nutrients called for in a ration for an average milker are used to sustain the body so that it will neither gain nor lose in weight; the other half being used to form milk. Returns for feed can, therefore, be expected only from about 50% of the total nutrients required by the cow. This means that a cow on a full ration will yield practically twice as much milk as she would on three-fourths of a ration. Yet there are thousands of dairymen who fail to supply the last quarter of a ration and thus bring ruin upon themselves and their business.

III. TABLE GIVING COMPOSITION OF FEEDS.

At the beginning, it was stated that a knowledge of the composition of feeds was necessary for two reasons: First, to enable the feeder to determine the relative value of the feeds at his disposal; and second, to assist in determining what quantity of feed is necessary to supply the required nutrients. To afford the feeder as wide a choice as possible, a long table of feeds is herewith presented, showing not only the digestible, organic nutrients, but also the fertilizing constituents. This table is taken from Henry's "Feeds and Feeding," by permission of the author.

TABLE V. Average digestible nutrients and fertilizing constituents in American feeding stuffs.

Name of feed.	Dry matter in 100 pounds.	Digestible nutrients in 100 pounds.			Fertilizing constituents in 1,000 pounds.		
		Protein.	Carbo-hydrates.	Ether extract.	Nitrogen.	Phosphoric acid.	Potash.
	Lbs.	Lbs.	Lbs.	Lbs	Lbs.	Lbs.	Lbs.
CONCENTRATES.							
Corn, all analyses............	89.1	7.9	66.7	4.3	18.2	7.0	4.0
Dent corn....................	89.4	7.8	66.7	4.3	16.5	.....	....
Flint corn....................	88.7	8.0	66.2	4.3	16.8	.....	....
Sweet corn.	91.2	8.8	63.7	7.0	18 6	.....	....
Corn cob.....................	89.3	0.4	52.5	0.5	5.0	.6	6.0
Corn and cob meal.........	84.9	4.4	60.0	2.9	14.1	5.7	4.7
Corn bran....................	90.9	7.4	59.8	4.6	16.3	12.1	6.8
Gluten meal..................	91.8	25.8	43.3	11.0	50.3	3.3	0.5
Germ meal....................	89.6	9.0	61.2	6.2	26.5	8.0	5.0
Starch refuse................	91.8	11.4	58.4	6.5	22.4	7.0	5.2
Grano-gluten.................	94.3	26.7	38.8	12.4	49.8	5.1	1.5
Hominy chops................	88.9	7.5	55.2	6 8	16.3	9.8	4.9
Glucose meal.................	91.9	30.3	35.3	4.5	57.7	.....	....
Sugar meal...................	93.2	18.7	51.7	18.7	36.3	4.1	0 3
Gluten feed..................	92.2	20.4	48.4	8.8	38.4	4.1	0.3

TABLE V. Digestible nutrients and fertilizing constituents.–*Con.*

Name of feed.	Dry matter in 100 pounds.	Digestible nutrients in 100 pounds.			Fertilizing constituents in 1,000 pounds.		
		Protein.	Carbo-hydrates.	Ether extract.	Nitrogen.	Phosphoric acid.	Potash.
	Lbs.	Lbs	Lbs.	Lbs.	Lbs.	Lbs.	Lbs
Wheat	89.5	10.2	69.2	1.7	23.6	7.9	5.0
High-grade flour	87.6	8.9	62.4	0.9	18.9	2.2	1.5
Low-grade flour	87.6	8.2	62.7	0.9	28.9	5.6	3.5
Dark feeding flour	90.3	13.5	61.3	2.0	31.8	21.4	10.9
Wheat bran	88.1	12.2	39.2	2.7	26.7	28.9	16.1
Wheat bran, spring wheat	88.5	12.9	40.1	3.4	.....	.....	....
Wheat bran, winter wheat	87.7	12.3	37.1	2.6	.....	.....	....
Wheat shorts	88.2	12.2	50.0	3.8	28.2	13.5	5.9
Wheat middlings	87.9	12.8	53.0	3.4	26.3	9.5	6.3
Wheat screenings	88.4	9.8	51.0	2.2	24.4	11.7	8.4
Rye	88.4	9.9	67.6	1.1	17.6	8.2	5.4
Rye bran	88.4	11.5	50.3	2.0	23.2	22.8	14.0
Rye shorts	90.7	11.9	45.1	1.6	18.4	12.6	8.1
Barley	89.1	8.7	65.6	1.6	15.1	7.9	4.8
Malt sprouts	89.8	18.6	37.1	1.7	35.5	14.3	16.3
Brewers' grains, wet	24.3	3.9	9.3	1.4	8.9	3.1	0.5
Brewers grains, dried	91.8	15.7	36.3	5.1	36.2	10.3	0.9
Oats	89.0	9.2	47.3	4.2	20.6	8.2	6.2
Oat meal	92.1	11.5	52.1	5.9	23.5	.....	....
Oat feed or shorts	92.3	12.5	46.9	2.8	17.2	9.1	5.3
Oat dust	93.5	8.9	38.4	5.1	21.6	.....	....
Oat hulls	90.6	1.3	40.1	0.6	5.2	2.4	5.2
Rice	87.6	4.8	72.2	0.3	10.8	1.8	0.9
Rice hulls	91.8	1.6	44.5	0.6	5.8	1.7	1.4
Rice bran	90.3	5.3	45.1	7.3	7.1	2.9	2.4
Rice polish	90.0	9.0	56.4	6.5	19.7	26.7	7.1
Buckwheat	87.4	7.7	49.2	1.8	14.4	4.4	2.1
Buckwheat hulls	86.8	2.1	27.9	0.6	4.9	0.7	5.2
Buckwheat bran	89.5	7.4	30.4	1.9	36.4	17.8	12.8
Buckwheat shorts	88.9	21.1	33.5	5.5	.....	.....	....
Buckwheat middlings	87.3	22.0	33.4	5.4	42.8	21.9	11.4

TABLE V. Digestible nutrients and fertilizing constituents.—*Con.*

Name of feed.	Dry matter in 100 pounds.	Digestible nutrients in 100 pounds.			Fertilizing constituents in 1,000 pounds.		
		Protein.	Carbo-hydrates.	Ether extract.	Nitrogen.	Phosphoric acid.	Potash.
	Lbs	Lbs.	Lbs.	Lbs.	Lbs	Lbs.	Lbs.
Sorghum seed	87.2	7.0	52.1	3.1	14.8	8.1	4.2
Broom-corn seed	85.9	7.4	48.3	2.9	16 3	.....	....
Kaffir corn	84.8	7.8	57.1	2 7	....	......	....
Millet	86.0	8.9	45.0	3.2	20.4	8.5	3.6
Flax seed	90.8	20.6	17.1	29.0	36.1	13.9	10.3
Linseed meal, old process	90.8	29.3	32.7	7.0	54.3	16.6	13.7
Linseed meal, new process	89.9	28.2	40.1	2.8	57.8	18.3	13.9
Cotton seed	89.7	12.5	30.0	17.3	31.3	12.7	11.7
Cotton-seed meal	91.8	37.2	16.9	12.2	67.9	28.8	8.7
Cotton-seed hulls	88.9	0.3	33.1	1.7	6.9	2.5	10.2
Cocoanut meal	89.7	15.6	38.3	10.5	32.8	16.0	24.0
Palm-nut meal	89.6	16.0	52.6	9.0	26.9	11 0	5.0
Sunflower seed	92.5	12.1	20.8	29.0	22.8	12.2	5.6
Sunflower-seed cakes	91.8	31.2	19.6	12.8	55.5	21.5	11.7
Peanut meal	89.3	42.9	22.8	6 9	75.6	13.1	15.0
Rape-seed meal	90.0	25.2	23.7	7.5	49.6	20.0	13.0
Peas	89.5	16.8	51.8	0.7	30.8	8.2	9 9
Soja (soy) bean	89.2	29.6	22.3	14.4	53 0	18.7	19.0
Cowpea	85.2	18.3	54.2	1.1	33.3	.....	....
Horse bean	85.7	22.4	49.3	1.2	40.7	12.0	12.9
ROUGHAGE.							
Fodder corn.							
Fodder corn, green	20.7	1.0	11.6	0.4	4.1	1.5	3.3
Fodder corn, field-cured	57.8	2.5	34.6	1.2	17.6	5.4	8.9
Corn stover, field-cured	59.5	1.7	32.4	0.7	10.4	2.9	14.0
Fresh grass.							
Pasture grasses (mixed)	20.0	2.5	10.2	0.5	9.1	2.3	7.5
Kentucky blue grass	34.9	3.0	19.8	0.8	.....	....	....
Timothy, different stages	38.4	1.2	19.1	0 6	4.8	2.6	7.6
Orchard grass, in bloom	27.0	1.5	11.4	0.5	4.3	1.6	7.6
Redtop, in bloom	34.7	2.1	21.2	0 6	....	......	....
Oat fodder	37.8	2.6	18.9	1.0	4.9	1.3	3.8

TABLE V. Digestible nutrients and fertilizing constituents.-*Con.*

Name of feed.	Dry matter in 100 pounds.	Digestible nutrients in 100 pounds.			Fertilizing constituents in 1,000 pounds.		
		Protein.	Carbo-hydrates.	Ether extract	Nitrogen.	Phosphoric acid.	Potash.
	Lbs	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Rye fodder	23.4	2.1	14.1	0.4	3.3	1.5	7.3
Sorghum	20.6	0.6	12.2	0.4	2.3	0 9	2.3
Meadow fescue, in bloom	30.1	1.5	16.8	0.4	.....	.....	....
Hungarian grass	28.9	2.0	16.0	0.4	3.9	1.6	5.5
Green barley	21.0	1.9	10.2	0.4	.....	.....	....
Peas and oats	16.0	1.8	7.1	0.2	.....	.....	....
Peas and barley	16.0	1.7	7.2	0.2	.....	.....	....
Hay.							
Timothy	86.8	2.8	43.4	1.4	12.6	5.3	9.0
Orchard grass	90.1	4.9	42.3	1.4	13.1	4.1	18.8
Redtop	91.1	4.8	46.9	1.0	11.5	3.6	10.2
Kentucky blue grass	78.8	4.8	37.3	2.0	11.9	4.0	15.7
Hungarian grass	92.3	4.5	51.7	1.3	12.0	3.5	13.0
Mixed grasses	87.1	5.9	40.9	1.2	14.1	2.7	15.5
Rowen (mixed)	83.4	7.9	40.1	1.5	16.1	4.3	14.9
Meadow fescue	80.0	4.2	43.3	1.7	9.9	4.0	21.0
Soja-bean hay	88.7	10.8	38.7	1.5	23.2	6.7	10.8
Oat hay	91.1	4.3	46.4	1.5	.....	.....	....
Marsh or swamp hay	88.4	2.4	29.9	0.9	.....	.....	....
Marsh or swamp hay	92.1	3.5	44.7	0.7	.....	.....	....
White daisy	85.0	3.8	40.7	1.2	.....	.....	....
Straw.							
Wheat	90.4	0.4	36.3	0.4	5.9	1.2	5.1
Rye	92.9	0.6	40.6	0.4	4.6	2.8	7.9
Oat	90.8	1.2	38.6	0.8	6.2	2.0	12.4
Barley	85.8	0.7	41.2	0.6	13.1	3.0	20.9
Wheat chaff	85.7	0.3	23.3	0.5	7.9	7.0	4.2
Oat chaff	85.7	1.5	33.0	0.7	.....	.....	....
Fresh legumes.							
Red clover, different stages	29.2	2.9	14.8	0.7	5.3	1.3	4.6
Alsike, bloom	25 2	2.7	13.1	0.6	4.4	1.1	2.0
Crimson clover	19.1	2.4	9.1	0.5	4.3	1.3	4.9
Alfalfa	28.2	3.9	12.7	0.5	7.2	1.3	5.6
Cowpea	16.4	1.8	8.7	0.2	2.7	1.0	3.1
Soja bean	24.9	3.2	11.0	0.5	2.9	1.5	5.3

TABLE V. Digestible nutrients and fertilizing constituents.-*Con.*

Name of feed.	Dry matter in 100 pounds.	Digestible nutrients in 100 pounds.			Fertilizing constituents in 1,000 pounds.		
		Protein.	Carbo-hydrates.	Ether extract.	Nitrogen.	Phosphoric acid.	Potash.
	Lbs	Lbs.	Lbs.	Lbs	Lbs	Lbs.	Lbs
Legume hay and straw.							
Red clover, medium	84.7	6.8	35.8	1.7	20.7	3.8	22.0
Red clover, mammoth	78.8	5.7	32.0	1.9	22.3	5.5	12.2
Alsike clover	90.3	8.4	42.5	1.5	23.4	6.7	22.3
White clover	90.3	11.5	42.2	1.5	27.5	5.2	18.1
Crimson clover	90.4	10.5	34.9	1.2	20.5	4.0	13.1
Alfalfa	91.6	11.0	39.6	1.2	21.9	5.1	16.8
Cowpea	89.3	10.8	38.6	1.1	19.5	5.2	14.7
Soja-bean straw	89.9	2.3	40.0	1.0	17.5	4.0	13.2
Pea-vine straw	86.4	4.3	32.3	0.8	14.3	3.5	10.2
Silage.							
Corn	20.9	0.9	11.3	0.7	2.8	1.1	3.7
Clover	28.0	2.0	13.5	1.0	....	....	....
Sorghum	23.9	0.6	14.9	0.2	....	....	....
Alfalfa	27.5	3.0	8.5	1.9	....	....	....
Grass	32.0	1.9	13.4	1.6	....	....	....
Cowpea vine	20.7	1.5	8.6	0.9	....	....	....
Soja bean	25.8	2.7	8.7	1.3	....	....	....
Barn-yard millet and soja bean	21.0	1.6	9.2	0.7	....	....	....
Corn and soja bean	24.0	1.6	13.0	0.7	....	....	....
Roots and tubers.							
Potato	21.1	0.9	16.3	0.1	3.2	1.2	4.6
Beet, common	13.0	1.2	8.8	0.1	2.4	0.9	4.4
Beet, sugar	13.5	1.1	10.2	0.1	2.2	1.0	4.8
Beet, mangel	9.1	1.1	5.4	0.1	1.9	0.9	3.8
Flat turnip	9.5	1.0	7.2	0.2	1.8	1.0	3.9
Ruta-baga	11.4	1.0	8.1	0.2	1.9	1.2	4.9
Carrot	11.4	0.8	7.8	0.2	1.5	0.9	5.1
Parsnip	11.7	1.6	11.2	0.2	1.8	2.0	4.4
Artichoke	20.0	2.0	16.8	0.2	2.6	1.4	4.7

TABLE V. Digestible nutrients and fertilizing constituents.—*Con.*

Name of feed.	Dry matter in 100 pounds.	Digestible nutrients in 100 pounds.			Fertilizing constituents in 1,000 pounds		
		Protein.	Carbo-hydrates.	Ether extract.	Nitrogen.	Phosphoric acid.	Potash.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
MISCELLANEOUS.							
Cabbage	15.3	1.8	8.2	0.4	3.8	1.1	4.3
Spurry	20.0	1.5	9.8	0.3	3.8	2.5	5.9
Sugar-beet leaves	12.0	1.7	4.6	0.2	4.1	1.5	6.2
Pumpkin, field	9.1	1.0	5.8	0.3	.....	.....	....
Pumpkin, garden	19.2	1.4	8.3	0.8	1.1	1.6	0.9
Prickly comfrey	11.6	1.4	4.6	0.2	4.2	1.1	7.5
Rape	14.0	1.5	8.1	0.2	4.5	1.5	3.6
Acorns, fresh	44.7	2.1	34.4	1.7	.....	.....	....
Dried blood	91.5	52.3	.0	2.5	135.0	13.5	7.7
Meat scrap	89.3	66.2	.3	13.7	113.9	7.0	1.0
Dried fish	89.2	44.1	.0	10.3	77.5	120.0	2.0
Beet pulp	10.2	0.6	7.3	....	1.4	0.2	0.4
Beet molasses	79.2	9.1	59.5	.0	14.6	0.5	56.3
Cow's milk	12.8	3.6	4.9	3.7	5.3	1.9	1.8
Cow's milk, colostrum	25.4	17.6	2.7	3.6	28.2	6.6	1.1
Skim milk, gravity	9.6	3.1	4.7	0.8	5.6	2.0	1.9
Skim milk, centrifugal	9.4	2.9	5.2	0.3	5.6	2.0	1.9
Buttermilk	9.9	3.9	4.0	1.1	4.8	1.7	1.6
Whey	6.6	0.8	4.7	0.3	1.5	1.4	1.8

CHAPTER VIII.

SILOS AND SILAGE.

A silo is an air-tight receptacle for preserving green feeds in a succulent condition. Feed thus preserved is known as silage. Clover, cow-peas and other forage crops have been successfully made into silage, but experience has shown that the cheapest and most satisfactory silage is made from corn cut in the denting or glazing stage.

Silage is now universally recognized as one of the cheapest and most indispensable feeds in economical milk production. With the studious dairyman, it is no longer a question of, "Can I afford to build a silo," but, "Can I afford to be without one?"

Advantages of Silage. The advantages of feeding silage may be briefly stated as follows:

1. It furnishes the cheapest roughage available upon the farm.

2. It furnishes roughage, which, in degree of succulence and palatability, more nearly approaches green pasturage than anything else to be had upon the farm.

3. Owing to its kinship to grass in succulence and palatability, it can readily be substituted for the latter during periods of drought and during late summer and fall when pasturage is nearly always inadequate.

4. It has made winter dairying a feasible and profitable business, because the silage readily takes the place of summer pasturage.

5. It furnishes a uniform feed and makes uniformly

good feeding a possibility the year round.

6. It permits the storage of a large amount of feed in a comparatively small space.

7. Where the silo adjoins the barn it makes feeding easy.

8. It permits housing the corn crop regardless of the condition of the weather.

9. There is practically no waste in feeding.

10. It yields the largest amount of feed possible from the corn plant.

Size of Silo. The size of the silo is determined by the number of cattle to be fed. In general, a cow will consume about 40 pounds of silage daily; and, if fed silage 180 days in the year, she will consume a total of 7,200 pounds. At this rate 20 head of cattle would consume 72 tons. But it should be remembered that it requires a silo of not less than 80 tons' capacity to hold 72 tons of well made silage. A cylindrical silo of this capacity will measure about 14 feet in diameter and 28 feet in height.

A good rule to follow in determining the size of a silo is to estimate the amount of silage that is to be fed during the year and assume a weight of 40 pounds for every cubic foot of silage.

Location of Silo. For convenience of feeding, the silo should be as near the manger as possible. It is preferably joined to the barn at one end by means of a chute, so that one can step into the silo without leaving the barn. Where the silo is thus located, it is necessary to prevent the escape of silage odors at milking time, by providing doors for closing up the chute leading to the silo.

Construction of Silo. Silos should be round, having the appearance of a cylinder whose height is about twice its diameter. They may be built of wood, stone, brick, concrete, or a combination of two or more of these. As a rule, the choice is determined by the relative cost and availability of the materials mentioned.

In building a silo four things must be kept in mind. First, it must be air-tight. Second, it must have sufficient strength and rigidity to enable it to withstand the pressure of the silage without yielding. Third, it must have a smooth inside surface to permit the silage to settle readily. And, fourth, it must be deep so that the weight of the silage will give compactness sufficient to expel the air which is held between the particles of silage.

It is desirable that the total depth of the silo be at least 30 feet. Where the ground is dry, five or six feet of this depth may be underground. When 30 feet is selected as the fixed depth, the silo can be made of the desired capacity by selecting the proper diameter, which may vary from 12 to 24 feet.

For want of space we shall attempt to describe briefly only one type of silo, one which has proven very satisfactory, both in efficiency and in cheapness of construction. This is known as the Gurler silo, a detailed description of which is given in Bulletin No. 125 of the Wisconsin Experiment Station. Fig. 10 shows a vertical section through this silo.

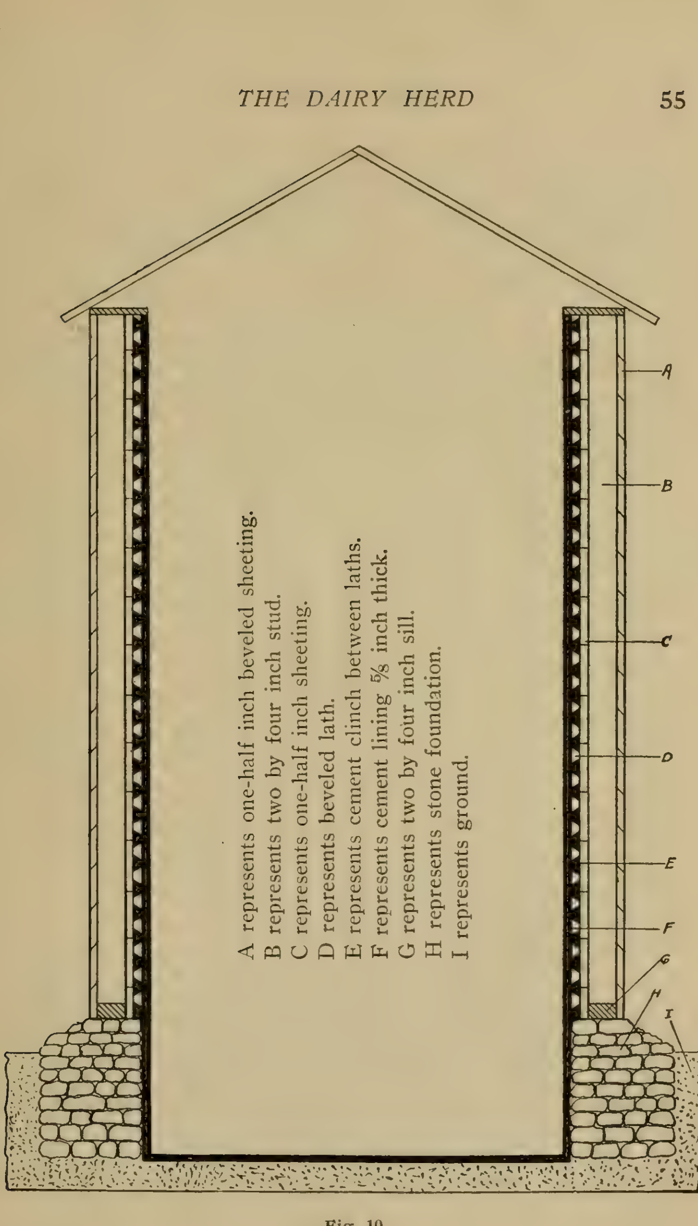

A represents one-half inch beveled sheeting.
B represents two by four inch stud.
C represents one-half inch sheeting.
D represents beveled lath.
E represents cement clinch between laths.
F represents cement lining ⅝ inch thick.
G represents two by four inch sill.
H represents stone foundation.
I represents ground.
A
B
C
D
E
F
G
H
I

Fig. 10.

The 2 by 4 studding are set 12 inches apart on a circular foundation, and the ½ inch sheeting is nailed on horizontally as shown in the illustration. The inside, including the floor, is cemented, using two parts of sand to one of cement.

Ventilation of the wall is necessary to preserve the silo. This is secured by leaving a small open space at the top on the inside between the lining and the plate, and boring holes near the sill through the outside sheeting, covering them with wire gauze to keep rats and mice out.

Any roof that sheds water is suitable for a silo, as the top need not and should not be tight. In fact, it is well to have a small opening in the roof to provide ventilation.

For convenience the door of the silo should be continuous, extending from top to bottom. Short pieces of matched planks are commonly used for a continuous door. These are put in one by one as the filling of the silo progresses; the ends being, however, first covered with a paste of clayey mud to assist in rendering the door air-tight. Heavy building paper tacked on the inside of the door will also help to exclude the air. The break or weakness in the silo wall caused by the continuous door is overcome by running iron rods horizontally across the door at short intervals, fastening the ends to the studding on either side of the door.

Cutting the Corn. Corn for the silo should not be cut until nearly mature. This is desirable for several reasons. First, and most important, is the fact that corn at maturity contains about five times as much dry matter as it does at the tasseling stage. This rapid increase in nutrients from the tasseling stage on is forcibly shown by the following figures obtained at the New York (Geneva) experiment station:

Table VI—Showing nutrients in corn plant at different stages of growth.

Stage of growth.	Dry matter, per acre (tons)
Fully tasseled	0.8
Fully silked	1.5
Kernels watery to full milk	2.3
Kernels glazing	3.6
Ripe	4.0

This table teaches an important lesson, and should discourage farmers from cutting young, immature corn, either for silage or soiling purposes.

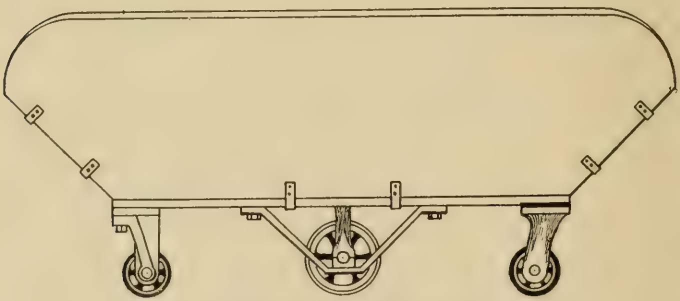
Postponing the cutting until the corn has reached the denting or glazing stage also makes silage of better quality. At this stage the plant is less watery and the sugar has been largely converted into starch, thus preventing excessive fermentation and the formation of an undue amount of acid in the silage.

Filling the Silo. When the corn reaches the right stage of maturity, it should be cut at once and hauled from the field to the silo, where the entire plant, ears and all, is run through an ensilage cutter or shredder, cutting it into pieces from ½ to 1 inch long. The ensilage cutters are provided with carriers which carry the silage to any height desired in the silo.

Where silos are rapidly filled, not less than two men should remain constantly in the silo, leveling and distributing the silage. This is necessary to insure uniform silage and an even settling. The silage should also be tramped, especially along the edge of the silo where, owing to the friction of the wall, it will not settle as readily as elsewhere.

In case of rapid filling it is best also to leave the silage to settle a day or two and then refill. After such settling there will be room for considerably more silage.

Covering for Silage. The floor and walls of the silo are air tight by construction, and where the silage has been thoroughly packed, none should spoil at these places. At the top, however, where the silage is exposed to the air and where it is less solidly packed some of it will naturally spoil. To reduce this loss of silage to a minimum, some cheap material that will pack well, such as old, wet hay, for example, should be placed on top of the silage immediately after filling, and this should be followed by a thorough wetting so as to hasten the settling and matting process. Usually a dozen barrels of water may be run over the top of the silage to good advantage.



SILAGE TRUCK.

Depth of Silage that Must Daily Be Removed from Top. Owing to the constant contact of the air with the top layer of silage, it is necessary to remove a horizontal layer of silage to a depth of not less than 1½ inches daily to prevent any from spoiling. If this fact is kept in mind when building a silo, its diameter can be made such as to make possible the feeding of a layer of this depth daily.

Cost of Silos and Machinery. The cost of silos varies with the cost of materials and the method of construction. An 80-ton silo of the Gurler type can be built for about $150. Other silos of the same capacity, but made of different materials may cost double this amount.

A moderate sized ensilage cutter that would answer for an 80-ton silo would also cost about $150.

Where some form of power must be purchased a gasoline engine is recommended because of the many other uses it may serve on a dairy farm. (See Chap. XV.)

A moderate sized ensilage cutter when not too heavily fed can be operated satisfactorily with an eight horse power gasoline engine. The cost of such an engine is about $325.

CHAPTER IX.

METHOD OF KEEPING RECORDS OF INDIVIDUAL COWS.

Necessity of Keeping Records. Through the efforts of experiment stations, private individuals, and Hoard's Dairyman in particular, tests have been made of hundreds of herds throughout the country, only to find that in practically all of them some cows are kept at an actual loss to their owners. The failure on the part of the owners to detect the unprofitable cows may be traced to three causes: (1) it may be the result of reckoning with the herd as a whole, rather than the individual members composing it; (2) it may be the result of ignoring the quality of the milk; or (3) it may be due to attempts to estimate the value of the individual members by *guessing* at the flow of milk for a week or two when the cows are doing their best.

The lack of business method in reckoning with the herd as a whole, rather than with the individuals composing it, is too apparent to need further explanation. The same may be said with reference to the practice of ignoring the quality of the milk. Where the owner guesses the annual yield from the quantity of milk produced for a week or two during the lactation period, he is likely to err in three important respects: (1) guessing in itself is bound to lead more or less frequently to grossly erroneous estimates; (2) yearly estimates based upon a few weeks' production ignore the fact that some cows yield milk eleven or twelve months of the year, while others produce only seven or eight months; and (3) estimates of this kind fail to consider that some cows that yield heavily for a short time and then drop off to a medium flow, may be exceeded in total production by others that never yield heavily at any period, but whose flow is quite steady from beginning to end of the lactation period.

Fig. 11.—Milk Scales. Weigh 0.1 to 30 pounds.

It is evident from what has been said that there is but one method by which we can tell with certainty the value of the individual cows in a herd, and that method consists in weighing and testing the milk and keeping a record of the feed consumed for the entire period of lactation.

Daily Record of Milk. Keeping a daily record of the weight of the milk of each cow is a very simple and inexpensive task. All that is necessary is to have some form of scales and a ruled sheet of paper upon which to record the weights of milk morning and night. Fig. 11 shows a cheap and convenient scales which weigh from one-tenth pound to 30 pounds. A convenient milk record sheet is shown below.

The daily weighing of the milk from each cow is valuable also in serving as a check upon the work of the milkers. A rapid shrinking in the milk is easily detected on the milk sheet and may be entirely due to

Milk Record for Month of..............................190

Date.		Name of Cow.													
		Belle.	Daisy.	Jenny.											
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs	Lbs.	Lbs	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1	A. M.														
	P. M.														
2	A. M.														
	P. M.														
3	A. M.														
	P. M.														
4	A. M.														
	P. M.														
5	A. M.														
	P. M.														
6	A. M.														
	P. M.														
7	A. M.														
	P. M														
8	A. M.														
	P. M.														
9	A. M.														
	P. M.														
10	A. M.														
	P. M.														
11	A. M.														
	P. M.														
12	A. M.														
	P. M.														
13	A. M.														
	P. M.														
14	A. M.														
	P. M.														
15	A. M.														
	P. M.														
16	A. M.														
	P. M.														
17	A. M.														
	P. M.														
18	A. M.														
	P. M.														
19	A. M.														
	P. M.														
20	A. M.														
	P. M.														
21	A. M.														
	P. M.														
22	A. M.														
	P. M.														
23	A. M.														
	P. M.														
24	A. M.														
	P. M.														
25	A. M.														
	P. M.														
26	A. M.														
	P. M.														
27	A. M.														
	P. M.														
28	A. M.														
	P. M.														
29	A. M.														
	P. M.														
30	A. M.														
	P. M.														
Total															

careless milking. Great daily fluctuations in the yield of milk are also in most cases the result of indifferent and inefficient milkers.

Collecting Samples of Milk for Testing. The milk from each cow should be tested about once a month during the whole period of lactation. A satisfactory way of doing this is to collect what is known as a composite sample, which consists in securing about one-half ounce of milk from each of six consecutive milkings and placing this in a half pint composite sample jar (Fig. 12) con-

Fig. 12.—Composite Sample Jar.

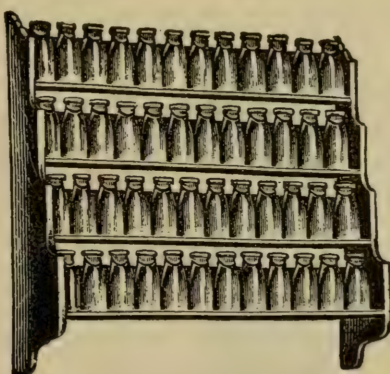


Fig. 13.—Test Bottle Rack.

taining a small amount of preservative. A test of this composite sample will represent the average per cent of butterfat for the period during which the sample was taken and will serve with sufficient accuracy as the average test for the entire month.

Each composite sample jar should be carefully labeled by placing the name or number of the cow upon it. A convenient rack for these jars is shown in Fig. 13.

Sampling and Samplers. Immediately after milking the milk is poured from one pail into another several times and then sampled at once. The sampling may be done by either of two methods: (1) by means of a one-half or one ounce dipper shown in Fig. 14; or (2) by means of a narrow tube shown in Fig. 15.

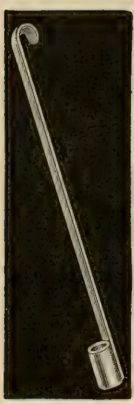


Fig. 14.—Dipper Sampler.

Fig. 15.—Thief Sampler.

The dipper furnishes the simplest and easiest means of sampling milk. Where the milk is thoroughly mixed and where the quantity is practically the same morning and night, this method of sampling is accurate.

With the tube method the sample is always proportionate to the quantity of milk and it will draw a representative sample even when the milk has stood undisturbed a few minutes. This method of sampling should be employed, therefore, where there is much variation in the quantity of night's and morning's milk, or where the milk is not apt to be thoroughly mixed before sampling.

Preservatives. Milk can not be satisfactorily tested after it has soured, owing to the difficulty of securing an accurate sample. This makes it necessary to place a small amount of preservative in the composite sample jar before the sampling is begun.

The best preservatives for this purpose are corrosive sublimate, formalin and bichromate of potash. All of these are poisons and care must be taken to place them where children and others unfamiliar with their poisonous properties, can not have access to them. For convenience, the bichromate of potash and corrosive sublimate have been put up in tablet form, each tablet containing enough preservative to keep a pint of milk sweet from one to two weeks. The bichromate of potash can be procured from all druggists, and a quantity not to exceed the size of a pea should be added to each pint composite jar. A larger quantity is liable to interfere with the testing.

Testing With the Babcock Test. The method of operating the Babcock test is explained in detail in chapter XVIII.

Calculating Butterfat and Butter Yield. The monthly butterfat yield of each cow is determined by multiplying the total pounds of milk for the month by the per cent of butterfat it contains. For example, if cow No. 1 produced 850 lbs. of milk testing 4.2% fat, the total fat in this milk would equal 850 × 4.2, or 37.70 pounds.

Since butter contains salt, water, casein and only about 83% butterfat, it is to be expected that the yield of butter will exceed that of butterfat, provided the losses in skimming and churning are normal. The general rule in estimating the butter yield is to increase the butterfat by one-sixth. Thus the estimated butter yield of the 37.70 pounds of fat given above would equal 37.70 × 1 1-6, or 43.98 lbs. The difference between the butter fat and the actual butter yield is known as the "overrun."

Estimating the Cost of Feed. The final test of the value of a cow is the economy of production. In addition, therefore, to knowing the butterfat yield, we must also know the cost of the feed she consumed in producing it. Obviously a daily weighing of the feed, especially as concerns roughage, is not practical upon most dairy farms. If the feed which each cow receives is weighed about twice a month an approximate estimate of the feed consumed can be obtained by considering the weighed amount of feed as the average daily consumption for the month. To illustrate, let us suppose that cow No. X is doing full work on a ration consisting of 8 pounds of wheat bran, 2 pounds of cotton-seed meal, 40 pounds of corn silage and 8 pounds of corn stover. By carefully observing the volume of the weighed amounts of each feed, approximate quantities may be measured for two weeks, after which a day's feed is again weighed and the measuring continued for the remainder of the month. In this way an approximate estimate of the quantity of feed consumed for the month can be obtained with a small amount of labor. By multiplying the total quantities of the different feeds fed during the month, by their respective values per ton, we obtain an approximate cost of the feed fed each cow during that period.

Yearly Record of Milk, Butterfat and Feed. At the end of each month a record of each cow's milk, butterfat test, and butterfat production, as well as an estimate of the cost of feed, should be entered upon a yearly record sheet like that shown below.

HERD RECORD FOR YEAR 190 ...

	NAME OF COW				NAME OF COW			
Month	Milk, lbs.	Test, Per Cent	Butter Fat, lbs.	Estimated Feed, Cost	Milk, lbs.	Test, Per Cent	Butter Fat, lbs.	Estimated Feed, Cost
....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....
Total								

CHAPTER X.

MILKING.

Importance of the Milking Process. The profits from a dairy herd are far more largely dependent upon the conditions under which the milk is drawn than dairymen are commonly led to believe. For example, hundreds of instances could be mentioned where milk drawn under cleanly conditions has been sold for one hundred per cent more than that drawn under uncleanly conditions. But milking from the standpoint of cleanliness is discussed in the chapter on sanitary milk production and will, therefore, not be considered here. The conditions that will be treated in the following pages are those which have a direct bearing upon the yield of milk and butterfat, and which are no less important in determining the profits from the herd than are those concerning cleanliness.

Milk Function Controlled by Nervous System. The various factors bearing upon the secretion of milk are readily understood when it is remembered that the production of milk is closely associated with the nervous organization of the cow. Whatever reacts upon her nervous system will react in like degree upon the secretion of milk.

Value of Kind and Gentle Treatment. It is owing to her high nerve development that a cow is so very sensitive to excitement, boisterousness, unkindness, rough treatment and other allied abuses which always react so unfavorably upon the production of milk and butterfat. Especially disastrous are the effects of abuses administered just previous to or during milking. Yet how frequently are dogs allowed to chase the cows to the stable, and how often are attendants seen with clubs which they use as aids in getting the cows into their proper places! In addition, the language and boisterousness that accompanies all this leaves no doubt that the animals are treated as offending brutes, instead of willing, sensitive mothers who are scarcely any less sensitive to harsh words than are human mothers. Make pets out of your cows by kind treatment, for kindness is never without compensation, no matter how, when or where applied.

Elaboration of Milk During Milking, If, in addition to what has been said, it will be remembered that the larger portion of the milk is secreted during the process of milking, the importance of giving a cow the very best care and treatment at this time will be fully apparent. Furthermore, the fact that most of the milk is formed during milking, materially assists in explaining why different milkers secure such varying quantities of milk and butterfat from the same cow.

Effect of Change of Milkers. From what has been said it is easily seen that frequent changes of milkers are certain to react unfavorably upon the milk and butterfat production. A cow that has become thoroughly accustomed to a certain milker will feel restless and uneasy with a new milker, which is nowhere more plainly indicated than on the milk sheet. A change of milkers, furthermore, always means a change in the manner of milking, and, therefore, a change in the stimulation of the udder. Since the stimulation of the udder by the milker is the cause of milk secretion, it is evident that a change in the method of stimulation will result in a reduction of milk and butterfat production. The wise dairyman will therefore avoid changing milkers as far as possible, and will insist that the same milker always milk the same cows.

Fast Versus Slow Milking. The larger yields are secured from fast milking. This may possibly be explained upon the basis of udder stimulation. The fast milker will stimulate the udder to a greater degree than the slow milker, and the extra stimulus thus given evidently favors the secretion in the milk glands, as indicated by the actual increased production.

Importance of Withdrawing All the Milk. One of the most important factors in milking is securing all the milk at each milking; that is, milking a cow dry. Whatever milk is left in the udder from one milking to another is not only lost to the milker, but actually acts as a check upon further secretion, so that the habitual practice of not milking cows "clean" or "dry" results in a gradual shrinking of the milk flow and an early "drying up" of the cow. Furthermore, the loss of the strippings means the loss of the very best milk. The first milk drawn from a cow usually contains less than 1% fat, while the strippings may contain as much as 14%.

Regularity of Milking and Feeding. The man who is looking for satisfactory returns from his dairy must make *regularity* a watchword. Cows must be milked regularly at a fixed time morning and night. Milking half an hour sooner or later than the fixed time interfers much more seriously with the milk yield than is commonly supposed. Not only does irregularity of *milking* reduce the yield of milk and butterfat, but irregularity in feeding leads to the same result. If, for example, cows that have been accustomed to receive their concentrates before milking, should receive them at times after milking, a reduction in the yield would be at once noticed. This is just what might be expected. Withholding the concentrates occasionally, will make the cows restless and discontented, which will sufficiently jar their nervous system to cause a perceptible drop in the milk flow. Sudden changes of feeds will act in a similar manner.

Time Between Milkings. The periods between milkings should be as nearly equal as possible. For example, if cows are being milked at six o'clock in the morning, they are also preferably milked at six o'clock at night. The more uniform the periods between milkings, the more uniform the secretion of milk, and consequently the greater the production. The time between milkings also influences the richness of the milk. If the two milking periods are not equal, it will be found that the milk of the shorter period will be the richer.

Frequency of Milking. As a rule nothing is gained by milking a cow three times instead of twice daily. In the case of exceptionally heavy milkers whose udders become unduly distended, there is, however, a distinct advantage in milking three times daily. The fact that milk from the shorter intervals between milkings has been found richer than that from the longer intervals, has driven some to the practice of milking average producers three times a day, with the hope of permanently increasing the test. While under such circumstances the test may be raised somewhat, the raise is only a temporary one.

The Value of a Good Milker. From what has already been said, it is evident that the milker plays an important part in the milk and butterfat production of cows. The following data secured by H. B. Gurler from his own herd fully illustrate the importance of a good milker. As a result of two winters' tests, Mr. Gurler found that the cows milked by the poorest milker had fallen off 9.5 pounds per head in three months, while the shrinkage of the cows milked by the best milker during the same period was only 1.88 pounds per head, a difference at the end of three months of 7.62 pounds of milk per cow daily in favor of the best milker. This fully explains why some milkers are cheap at $40 per month, while others are really expensive at less than half this amount.

The Milk Scales and Babcock Tester as a Teacher of Correct Milking. The strongest searchlight used for the discovery of leaks in the dairy herd consists of a pair of scales and a Babcock tester. These will not only tell which cows are profitable and which are not, but, if rightly employed, will also tell which milkers are paying for their salaries and which are not. Milkers should be paid according to the quality of their work, and not, as is commonly the case, according to the number of hours' service.

Milking Machines. Whether the milking machine may be considered an unqualified success can not be positively stated at the present time. More time and tests are needed to warrant a positive statement. It may be stated, however, that many of our foremost dairymen have endorsed the milking machine as a successful milker, and this, too, after apparently thorough tests extending over periods of many months. Experiment stations also report favorable results from machine milking.

CHAPTER XI.

HERD MANAGEMENT.

Winter Dairying. Producing the bulk of milk during the winter has four distinct advantages: (1) prices for butter and cheese are higher at this time of the year; (2) cows will milk longer when calving in the fall than in the spring; (3) labor is more plentiful at this time of the year; and (4) it is possible to feed cows cheaper during the winter than summer.

1. As a rule prices for butter are from 50 to 75 per cent higher in winter than in summer. Prices for cheese average about 50 per cent higher in winter. Indeed prices for milk in general are higher in winter than summer. It is evident that from the standpoint of higher prices alone, it is the part of wisdom to produce the bulk of the milk during the winter.

2. When cows calve in the spring, they usually have pasturage enough for a good flow of milk until about August. At this time pastures as a rule get short and cows rapidly fall off in milk. By the time stable feeding begins they have dropped off so much that they can not be brought back to a fair flow of milk even on good feed. The result is a reduced yield of milk and an early "drying up" of the cows.

When cows calve in the fall the expectation is to produce the main flow of milk during the winter and consequently the cows are well supplied with feed until they are turned out on good pasturage in the spring. In this way the cows maintain a good flow of milk until the best period of grazing is over. The inevitable result is an extension of the period of lactation and a greater total production of milk. An increased production is also favored by the fact that cows yield the greater share of their milk during a time when they are least troubled with flies and excessive heat.

3. It is an important advantage to be able to do most of the milking when other farm duties demand least attention. By having the cows calve in the fall, most of the milking is done during the winter.

4. An acre of land planted to corn ordinarily yields as much feed as two or three acres in pasturage. When the cows calve in the fall there is bound to be more silage produced than when the cows calve in the spring, and in so far as this is true, the cost of feed is lessened. In the case of high priced land, the saving effected by reducing the acreage one-half or two-thirds by feeding a great deal of silage in place of pasturage must be evident.

Feeding the Bull. During the early life of the bull when he is reasonably tractable, there is no better place for him than a strongly enclosed pasture. This will supply him with the right kind of feed, give him plenty of fresh air and sunshine, and afford him needful exercise. When stall-fed, he is preferably supplied with nitrogenous roughage, such as good clean clover hay. When the roughage consists of corn stover or oat straw, the bull should be given a fair allowance of wheat bran, oats or similar concentrates. It is always desirable to supply a stall-fed bull a moderate amount of succulent roughage, such as roots and silage.

Management of Bull. A bull should never be allowed to run with the herd, but is preferably kept where he is in sight of the cows. He should have a ring placed in his nose when ten or twelve months old. As a rule it is best not to tie him by the ring, but to give him the freedom of a box stall. He should be given enough exercise to keep him tractable and in good breeding condition. By all means have him dehorned.

Never trifle with a bull. He should be treated gently yet firmly. He must know he has a master. It is

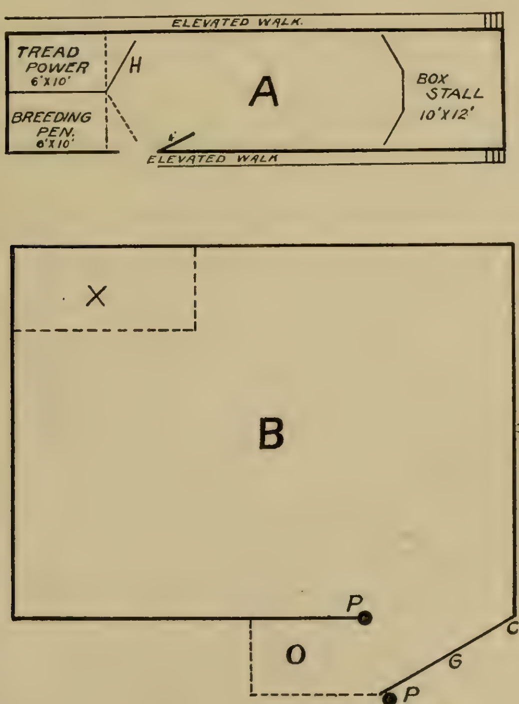


Fig. 16. Bull Pens.

important to teach him early to be led with a staff fastened to the ring in his nose.

It is a great misfortune to have so many valuable bulls disposed of at the first signs of unruliness. When a bull has proven his value as a breeder by his own offspring, he should be, and can be, retained even though his disposition becomes threatening, by quartering him as shown in Fig. 16.

B shows a yard or pasture recommended by Hoard's Dairyman. To quote description of this yard: "It should contain (or be connected with) a strong box stall. X shows where the bull may be fed, sheltered and, if need be, confined. O represents a service pen or chute and should be, say 5 feet wide and 8 or 10 feet long. PP are strong posts and G is a gate, hinged at C and swinging between PP. The outer post should be so set that the gate cän not, by any possibility, swing past it."

It is evident from the description that such a yard can be used with absolute safety.

A represents a yard or pen essentially as recommended by the Illinois Station. At one end of the yard is located a box stall in which the bull is fed and sheltered. The other end is divided into two compartments, one containing a tread power, the other serving as a breeding pen. The gate H may be turned to the right or to the left, closing either of the two compartments as may be desired.

The tread power furnishes the means of exercising the bull. When he is wanted on the tread power, a rope is attached to his ring while he is at the manger and the attendant, who walks over the elevated narrow walk, leads him onto the power and shuts the gate behind him. While the bull is taking his exercise the attendant cleans and prepares his stall. When the bull is wanted in the breeding pen he is similarly led along the other side of the yard. Water and feed can be supplied from the outside.

It is evident that a yard of this kind guarantees absolute safety, provides good exercise for the bull, which at the same time furnishes the power to pump water, separate the milk, and do other useful things.

An important matter in the management of a bull is to prevent excessive service. A bull should be over one year old before he is allowed to serve and the services the first season should be limited to 10 or 15, depending upon the strength and vigor of the bull. The second season he may serve 25 cows. And while some bulls have apparently successfully served as many as 40 or more cows in a season, it will be found good policy, as a rule, to restrict the number of services as much as possible, especially if the usefulness of the bull is to be preserved for a long time.

Breeding Rack. When heifers or small cows are bred to heavy bulls, a breeding rack should be used. This may be constructed as follows: Place two posts in the ground 3¾ feet high and about 1½ feet apart. In a line parallel with these posts and 8 or 9 feet away, place two more posts 1½ feet high and 20 to 22 inches apart. Connect the short and long posts with 2x12 inch planks, leaving a space of 18 inches wide between the planks at the higher end, and 20 to 22 inches wide at the lower end, which serves as the entrance. This space will fit most cows, but it is desirable to have the planks adjustable so that the space between may be increased or decreased according to the size of the cows. The arrangement as described permits the bull's front feet to rest on the planks during service. The planks should be provided with cleats and must be strongly supported at the middle. An adjustable stanchion is used to hold the cow in position.

Age to Breed Heifers. Heifers should be bred to drop their calves when about two years old. In cases where there is a particular lack of development in growth and general vigor, it would doubtless be a distinct advantage to have heifers drop their calves at 26, 28 or even 30 months of age.

Early breeding has the effect of stunting the growth of the animal, and thus making maximum development impossible. The heifer that is bred at one year of age is obliged to turn a portion of the feed that is naturally intended for her own development to that of the foetus. After the calf is dropped a still larger portion of the feed intended for her own development is utilized for the production of milk.

While the stunting effect from early breeding has its drawback, there is also danger in delaying the breeding too long. It is doubtless correctly maintained that early breeding has the advantage of early stimulating the milk giving function of the animal, and that heifers that drop their calves at, say three years old, are apt to develop a beefy tendency at the expense of the dairy tendency.

It is evident that this matter calls for a great deal of judgment. If a heifer leans toward the beefy tendency, doubtless it is policy to breed her rather young. If, on the other hand, there is a complete absence of a beefy tendency and an indication of a slow development and delicacy, no one would question the wisdom of breeding such an animal relatively late.

Record Date of Service and Calving. This is important for three reasons: (1) it enables one to confine cows in box stalls about a week before calving; (2) it enables one to tell the exact length of time cows have carried their calves, and therefore makes possible the detection of premature births and abortions; (3) one knows the exact length of the lactation period of each cow.

1. Where the date of service is not known, it frequently happens that cows are obliged to calve in their stalls or stanchions. Such unfortunate occurrences should be prevented by confining cows in roomy box stalls not less than a week before they are due to calve.

2. In case the date of service is not known, it is perfectly possible for cows to drop living abortions which the owner may mistake for mature calves. Where the abortion is of a contagious nature the danger of mistakes of this kind is too evident to need further explanation.

3. Most dairymen appreciate the value of persistent milkers, yet comparatively few are able to tell, even approximately, the length of the lactation period of the different cows in the herd. The only certain way of knowing how long each cow produces milk after calving is to record the date of calving.

"Drying Off" Cows. As a rule it is desirable to have cows "go dry" at least a month before calving. This has the effect of increasing the supply of nutrients for the development of the foetus, as well as enabling the cow to store up some reserve energy which will put her in better physical condition for the act of parturition and the period immediately following.

Where it is desirable to hasten the "drying off," the following method will be of value. Start drying off by not milking the cow clean. This will quickly reduce the flow to a point where it is safe to skip every other milking. After a few days, or perhaps a week, the milk will be sufficiently reduced to warrant milking only every other day. A very short time after this, as a rule, it will be found safe to stop milking entirely.

In case of very persistent milkers, it is better to milk them close up to, if not up to, calving, rather than force the "drying off" process too much.

Dehorning. The advantage of dehorning is now pretty generally recognized. The absence of horns makes cows more quiet and docile, and saves them many tortures that are ordinarily inflicted when the horns are retained.

The horns may be removed either by sawing them off or by cutting them off with an instrument known as a clipper. The simplest and most humane method of removing horns, however, is the use of caustic potash soon after the calf is born. The Author has dehorned a great many calves by this method which is briefly described as follows:

When the calf is 24 to 36 hours old, clip the hair from the invisible horns or buttons and rub them with a stick of caustic potash. The potash should be kept in an air-tight bottle until ready for use. As soon as removed from the bottle, the upper part of the stick should be wrapped with a piece of paper to prevent its burning the hand. After a few minutes' exposure to the air the stick becomes moist. As soon as this becomes noticeable, rub the exposed end of the stick over each button for a minute or two, or until the spot begins to look reddish or sore. If the calf is examined twelve hours later, a scab will be found where the potash was applied, showing that the potash has gradually eaten its way into the button and thus destroyed it. Care should be exercised not to allow the potash to touch any part but the miniature horn, as a drop on the flesh would cause unnecessary pain.

Cleanliness, Regularity and Kind Treatment. The subject of cleanliness is fully discussed in the chapter on Sanitary Milk Production. The importance of regularity and kind treatment are fully considered in the chapter on Milking.

Warm Housing. On account of their general spareness of flesh, cows have little protection for their vital organs and are therefore peculiarly susceptible to cold. For this reason, warm housing during the winter season is a matter of the highest importance. It matters little how good a dairy machine a cow may be or how well she may be fed, the returns from her will be unsatisfactory if she is compelled to shiver in her stable the larger portion of the winter and is possibly even denied the protection of a stable during the cold drizzling rains which usually precede and follow the severe cold of the winter.

Cows in Heat. Cows, while in heat, should be kept separate from the rest of the herd to avoid the usual disturbances incident to keeping them with the herd.

CHAPTER XII.

REARING THE DAIRY CALF.

Prenatal Development. The making of a strong, vigorous, healthy calf begins before it is born. Unless the pregnant mother is furnished with a sufficient amount of good, wholesome feed, rich in ash and protein, the foetus must necessarily suffer retarded development. Not only should the pregnant cow be supplied with the proper nutrients for the development of bone and muscle in the foetus, but the ration should be such as will keep her in the best physical condition, which requires some succulent roughage and grain rather laxative in character. (See page 42.)

Time the Cow Should Suckle the Calf. As a rule it is best to remove the calf from its mother before it is three days old. The early removal of the calf has several important advantages: (1) it prevents to a great extent the excitement attendant on separating an older calf from its mother; (2) it renders it easier to teach the calf to drink from a bucket; (3) it permits regularity of milking from the start; and (4) it makes possible at the outset to milk the cow "clean" at each milking. Calves never feed regularly, nor do they suck heavy milkers dry at any time. The result is a continual residue of milk in the udder which acts as a check to the secretion of this substance and leads to an early shrinkage in the milk yield.

In cases of caked and inflamed udders it is best, however, to allow the calf to suckle the cow longer than the time stated, since this has a tendency to hasten the disappearance of such trouble.

Feeding the Young Calf. The first milk drawn after calving has purging properties which nature has provided for the purging of the calf. It is important, therefore, that the calf receive this milk which is known as colostrum.

As soon as removed from the cow, the calf should be taught to drink from a clean bucket. It should be aided in this for a day or two by holding the tip of a finger in its mouth. The milk should be fed as near body temperature as possible. During the first two weeks the calf should be fed not less than three times a day, receiving eight to ten pounds of milk daily the first week, and ten to twelve pounds the second week. After the second week skim milk may be gradually substituted for whole milk, bringing the calf to a full skim milk

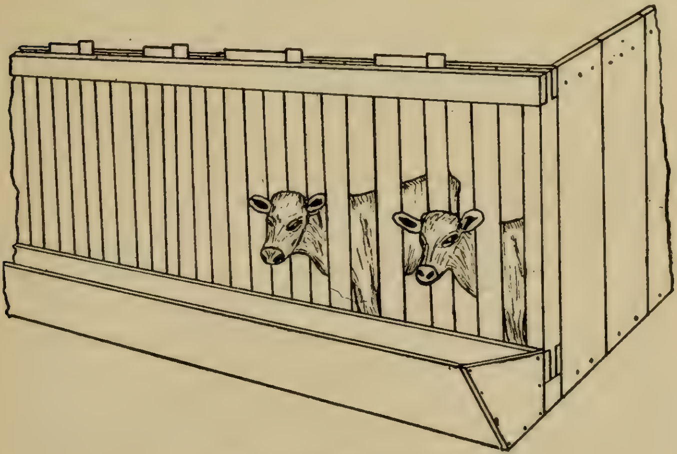


Fig. 17.—Calf Stanchions.

feed at the end of four weeks. Beginning with the substitution of skim milk, the calf should be fed a handful of ground oats, corn meal, or linseed meal after each milk feed. At the age of one month, when feeding wholly on skim milk, one-half pound of grain may be fed daily to good advantage, and access should be given to good clean hay. The feed should be gradually increased with the growing needs of the animal.

Calf Stanchions. The feeding of milk to calves becomes a comparatively easy task when the calves are confined in cheap, rigid stanchions like those shown in Fig. 17. When so confined one person can feed half a dozen or more calves at the same time, and can do this with less labor than is ordinarily required to feed one calf. It is well, however, not to keep the calves in the stanchions too long at any one time, because of the rigid confinement. Calves that have formed the "sucking" habit may be confined to advantage in these stanchions during the night, especially when no small separate pens are available.

Importance of Correct Feeding. A young calf has a delicate stomach, which is peculiarly liable to be upset by the injudicious feeding of milk and skim-milk. In this respect it differs little from the very young child. The effect that usually follows the injudicious feeding of milk is a case of scours. This trouble can be obviated in a large measure by strictly observing the following precautions: First, never feed calves cold milk, but have it as near blood heat as possible; second, feed milk as fresh as possible and under no circumstances feed it when sour; third, feed milk only from vessels that have been thoroughly cleaned and scalded; and fourth, carefully avoid over-feeding. Scours or diarrhea is one of the commonest ailments of calves and one that leaves a great stunting effect upon their development.

While great importance attaches to the correct feeding of the calf in its early life, an ample allowance of feed of the right kind should be supplied at all times. Fattening feeds should always be avoided.

General Care of the Calf. Calves should be given all the outdoor exercise, fresh air and sunshine possible. During cold and rainy weather they should be confined in clean, dry stables with plenty of bedding. All the comfort possible should be provided for calves at all times. It is important also to see that they are not too much annoyed by flies during the summer. When changed from dry feed to pasture the change should be made gradually, or trouble from scouring is likely to be encountered. Plenty of good, pure water should be provided. The skim-milk feeding may be continued with profit for at least six months. When no pasture is available, it is desirable to feed a liberal amount of good, nitrogenous hay and only a small amount of grain. This will furnish the necessary nutriments for growth, at the same time the large amount of roughage tends to develop a large paunch in the young animal.

CHAPTER XIII.

DAIRY BARN AND MILK HOUSE.

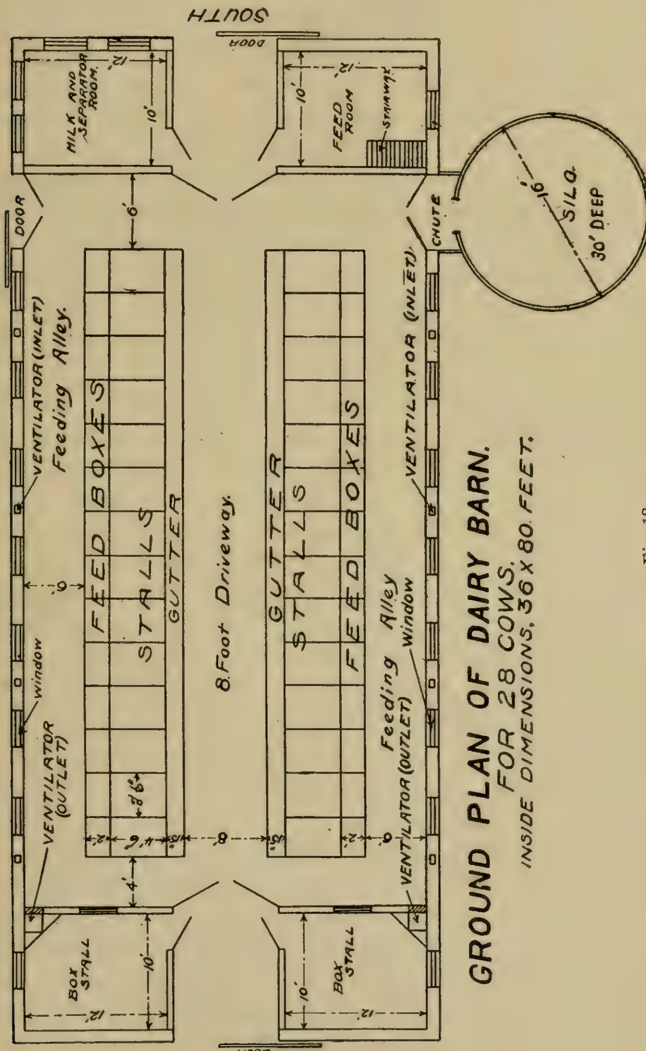
THE DAIRY BARN.

A Place Where Human Food is Prepared. In building a dairy barn it should be remembered that one is providing a place where human food is to be produced. Sanitary features should, therefore, have first consideration. Among the most important of these are abundance of light, ample ventilation and general regard to cleanliness.

Contrary to general belief, a sanitary barn is not necessarily an expensive barn. Indeed where everything is considered, a sanitary barn is certain to prove actually cheaper in the long run than one in which sanitation is made an entirely secondary matter.

General Plan of Barn. This is illustrated in Fig. 18. The plan shows two box stalls at the north end, which are intended primarily for confining cows that are about to calve, but may also be used for bulls. The front end of the barn contains a milk and separator room, and a feed room. The latter contains stairs leading to the second story, which is used as a storage for hay and fodder, and also contains storage boxes for concentrates, which communicate with the feed room below by means of 8x8 inch shafts.

The stalls are arranged to have the cows face out, that is, away from each other. This has several advantages over the common plan of having the feeding alley



GROUND PLAN OF DAIRY BARN.
FOR 28 COWS.
INSIDE DIMENSIONS, 36 X 80 FEET.

Fig. 18.

in the middle of the barn. In the first place it is more sanitary. Where the two rows of cows face each other the foul breath from each must necessarily pass from one side to the other, thus causing the cows to breathe more or less impure air. When the cows face out the exhaled air is more equally distributed through the barn and in so far reduces the amount of impurities in it immediately in front of the cows. Another advantage in facing cows out is the fact that the head is placed nearest the wall where the temperature is lowest, leaving the portion of the animal that must be most protected from the cold in the warmer part of the stable.

The silo is placed where it is most convenient for feeding. Fresh air inlets are built in the wall of the barn and two main air outlets are placed in the two box stalls, with a third at the ceiling in the middle of the barn. The driveway is such as to permit a team and wagon to enter one end of the barn and pass out at the other.

Foundation and Floor. The barn should rest upon a substantial foundation constructed of stone or concrete. On the outside of the foundation and a little below it should be placed tile drains to prevent any water from working its way under the foundation.

For sanitary reasons, only concrete floors should be permitted in a dairy barn. While the original cost may be somewhat high, in the long run they are cheapest. Aside from being easily cleaned, they also make possible the saving of all the liquid manure, an important item to consider in the management of a dairy. To prevent the dampness commonly associated with a concrete floor it should be constructed on a cobble stone and cinder foundation underlaid with drain tile. The finish of the floor should be rather rough to prevent cows slipping on it.

The feeding alleys, that is, the part of the floor between the mangers and the walls, should be about three inches higher than the platforms on which the cows stand. Moreover they should slope slightly toward the mangers. The platforms and driveway should also slope very slightly toward the gutters.

Light. Sunlight, because of its disinfectant action, is of prime importance in making a stable sanitary. There should be not less than four square feet of window space per cow.

Walls. Cheap and reasonably air-tight walls are secured by nailing matched lumber over good building paper on both the inside and outside of the studding, except the lower inside six feet. From the floor to a height of six feet, nail cheap one-inch lumber over building paper and put lath and concrete on this as a finish. This makes the lower portion of the wall readily cleanable as it should be. The portion of the wall above the concrete, as well as the entire ceiling, should be frequently whitewashed. The air space in the wall should be filled with some good non-conducting material. Dry straw answers this purpose very satisfactorily.

Ceiling. This should be boarded on the inside with matched lumber. The outside, or hay floor above, may be built of common, cheap lumber. When, however, no hay is stored above, the ceiling should have a dead air space, which is secured by using matched lumber and paper, both inside and outside, and filling the space between with dry straw.

Stalls and Ties. These should be arranged and constructed with the following points in view: (1) keeping the cows clean; (2) giving them as much comfort as possible; (3) preventing cows from stepping on each

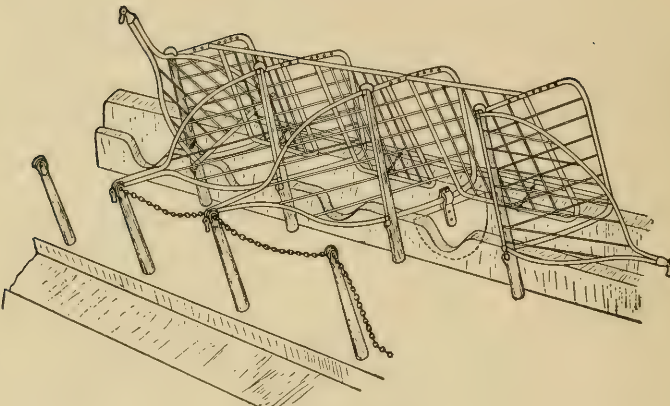


Fig. 19. –Drown Stall.

other's teats; (4) giving the milker comfort during milking; (5) having a minimum amount of surface for lodgment of dust; and (6) saving of time in tying.

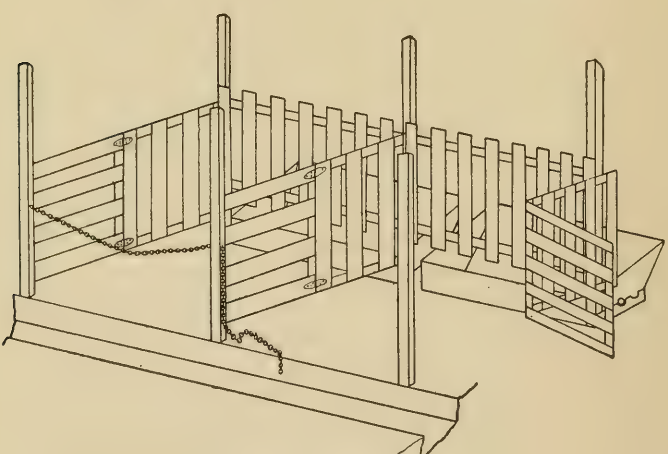


Fig 20. Bidwell Stall.

To keep cows clean the stall must be of such length as to place the hind feet near the edge of the gutter. In order to have comfort, cows should not be confined in rigid stanchions, nor should the stalls be too narrow. The stepping of cows on their neighbors' teats can be prevented only by using some form of partition between

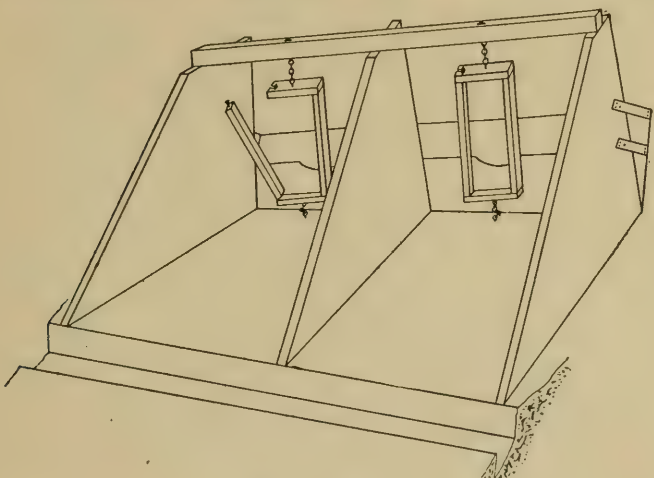


Fig. 21.—Half Stall.

them. To provide a reasonable amount of comfort for the milker the stalls must have ample width and the end posts of the partitions should set at the edge of the gutter. Solid wood partitions or closely meshed wire and iron partitions, afford too much surface for lodgment of dust. Moreover, solid wood partitions obstruct a free circulation of air. The simpler the partition the more desirable.

Stalls and ties like those shown in Figs. 19 and 22 answer all the requirements in a satisfactory manner.

The stalls shown in Figs. 21 and 20 are used by many with much satisfaction, but are somewhat open to the objection of having too much surface for lodgment of dust.

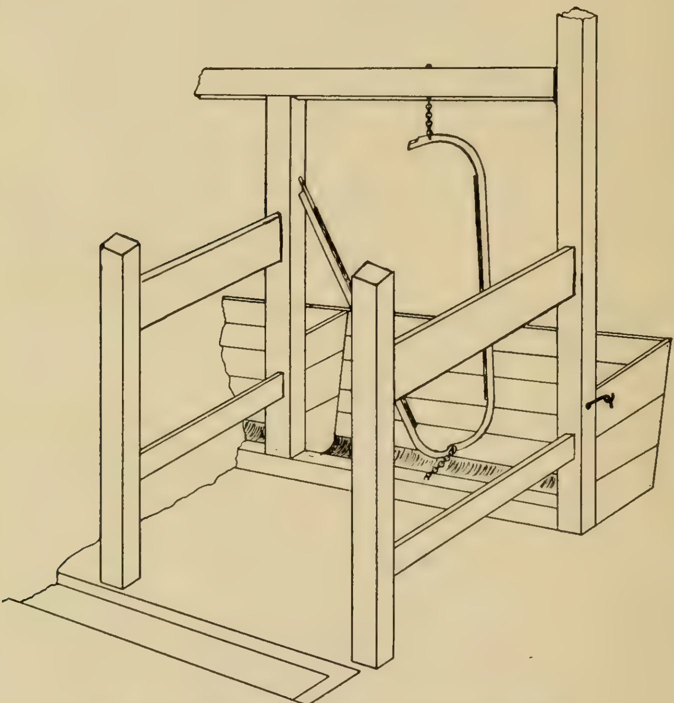


Fig. 22.—A Cheap and Satisfactory Cow Stall and Manger.

Rigid stanchions mean rigid confinement and should therefore never be used. Various forms of swinging stanchions, like those shown in Figs. 21 and 22, are used with much satisfaction. Movable halter ties, like that shown in Fig. 23, are used in many leading dairy barns.

The rope or chain is so fastened as to prevent forward or backward movements by the cows but permits free movement up and down.

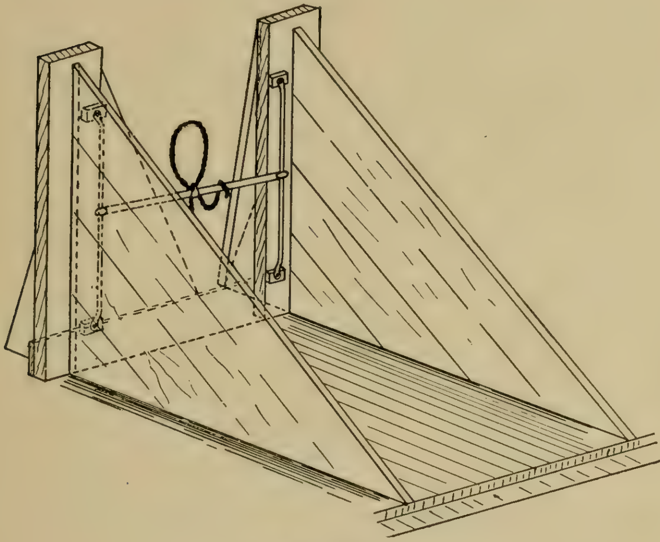


Fig. 23.—Baker Tie.

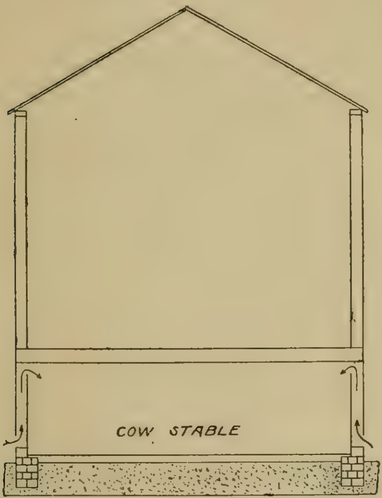
Stalls like the Drown and Bidwell have the advantage of being adjustable. The front is movable, thus permitting the stall to be shortened or lengthened, according to the size of the cow. On the other hand, the swing stanchions, in dispensing with the front end, reduce the amount of stall surface, which is particularly noticeable in the stall shown in Fig. 22.

In a cold climate, it is desirable to cover the concrete floor on which the cows stand with a movable wood platform. This may be the means of preventing udder troubles and is certain to increase the comfort of cows during the cold season.

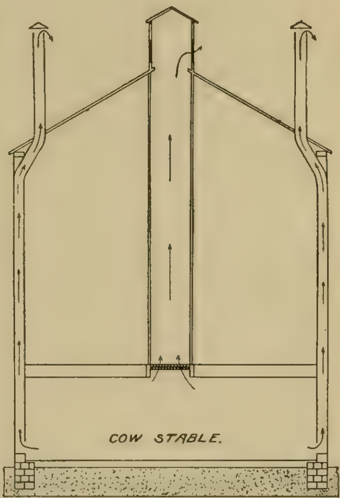
Size of Stalls. An average-sized cow requires a stall 3½ feet wide and 4½ feet long. In nearly all herds, however, there are some cows larger and some smaller than the average. It is important, therefore, that one row of stalls be made to taper somewhat from one end to the other. For example, the stalls at one end may have dimensions 3'x3'10", which would nicely accommodate two-year-old Jersey heifers. From this end the dimensions may be gradually increased until they reach 4'x4'10" at the opposite end. The latter dimensions would accommodate large Holstein-Friesian cows.

Mangers. These should be constructed with four points in view: (1) they should be easily cleanable; (2) they should be provided with movable partitions so as to prevent cows from stealing feed from each other; (3) they should be large enough to prevent cows from scattering their feed over the barn floor; and (4) the top should be below the cows' noses so as not to interfere too much with the circulation of the air in front of the cows.

All of the above features are embodied in the manger illustrated in Fig. 22. This manger the Author has had placed in the college dairy barn and has found it highly satisfactory in all respects. The aim was to secure a thoroughly efficient manger with as small an outlay of capital as possible. Its construction is as follows: The lower three inches are built into the concrete floor. The superstructure, which is 20 inches high, 18 inches wide at the floor and 36 inches wide at the top, is built of ¾-inch matched lumber, except the partitions which are built of 1½-inch lumber. Both sides of the lumber are planed. The partitions fit snugly into the 3-inch concrete depression, and the entire manger is built in movable sections, each 21 feet long. The sections are held in place by means of a small hook at each end, which is fastened to the stanchion supports.



CROSS-SECTION OF BUILDING SHOWING VENTILATOR (INLET)
Fig. 24.



CROSS-SECTION OF BUILDING SHOWING VENTILATOR (OUTLET)
Fig. 25.

The three-inch concrete depression makes it possible to water the cows in their stalls. When it is desired to clean the manger, the hooks are unfastened and the sections turned over, thus leaving the entire manger clear for cleaning.

Gutters. These should be about 15 inches wide and four inches deep. A greater depth is liable to injure the cows when they happen to slip into the gutter. Moreover any extra depth means just so much more lifting in removing the manure. Gutters should be perfectly tight to prevent loss of liquid manure.

Ventilation. The best method of stable ventilation is that devised by F. H. King. The essential features of this method are the admission of the fresh air near the ceiling, and the withdrawal of the impure air from near the floor, as illustrated in Figs. 24 and 25. The object of admitting the cold, fresh air near the ceiling is to warm it before reaching the cows, by contact with the warm air at the ceiling. By having the main air exits near the floor, less heat will be lost than would be the case if the exits were placed at the ceiling; besides it is argued that a considerable amount of the impurities of the air are found at the floor to which the cows' breath is constantly directed. Recent experiments seem to indicate, however, that at least so far as carbonic acid gas is concerned, most of this gas is found at the ceiling.

Whether most of the impurities are found at the ceiling or at the floor, it seems advisable to reinforce the exits at the floor, by placing a ventilator opening provided with a register at the middle of the ceiling so that some air may be withdrawn from this point. During very cold weather it may be desirable to reduce this exit to a minimum by closing the register, but during warm weather, or when it is desired to lower the barn temperature, it should be opened entirely. By having one large opening at the middle of the ceiling, there is less likelihood of removing any fresh, incoming air than would be the case if numerous smaller exits were placed near the wall and opening into the same shaft that takes up the floor air, an arrangement not infrequently recommended and used.

The number and location of inlets and outlets (except the outlet at the ceiling) are shown in Fig. 18. Numerous small inlets have the advantage of causing a better distribution of the cold, incoming air than could be secured by fewer, but larger openings.

On the other hand, the outlets should be few and comparatively large, which will aid in creating draft.

The fresh air intakes consist of air-tight shafts with cross-sectional areas of about 50 square inches. The shafts are built right in the wall, and open near the floor on the outside and near the ceiling on the inside. It is absolutely necessary to have the outside openings at least several feet below the inside openings, otherwise the warm inside air would rush out instead of the cold, outside air going in.

The main air outlets may be placed where they are least troublesome. In the barn plans herewith presented, they are placed in the box stalls and communicate with the main barn floor by means of registers in the wall. The size of these registers is that of the cross-sectional area of the shafts.

To secure effective work with the King system of ventilation three things are essential: (1) to have the ventilating shafts air-tight; (2) to have the outlet shafts extend to the highest point of the barn; and (3) to have the barn as nearly air-tight as possible.

Hay Loft. With a perfectly tight ceiling and with the hay chute in the feed room, there is no objection whatever to having a loft above the stable for the storage of roughage. Indeed such a loft has two distinct advantages: it helps to keep the stable warm and reduces the labor in feeding.

Doors. Two doors should be provided at either end of the barn, as shown in Fig. 18. The outside doors may be of the roller type, but on the inside it is desirable to have swing doors. The latter fit tighter and thus aid in making the barn warmer during the winter.

DAIRY HOUSE.

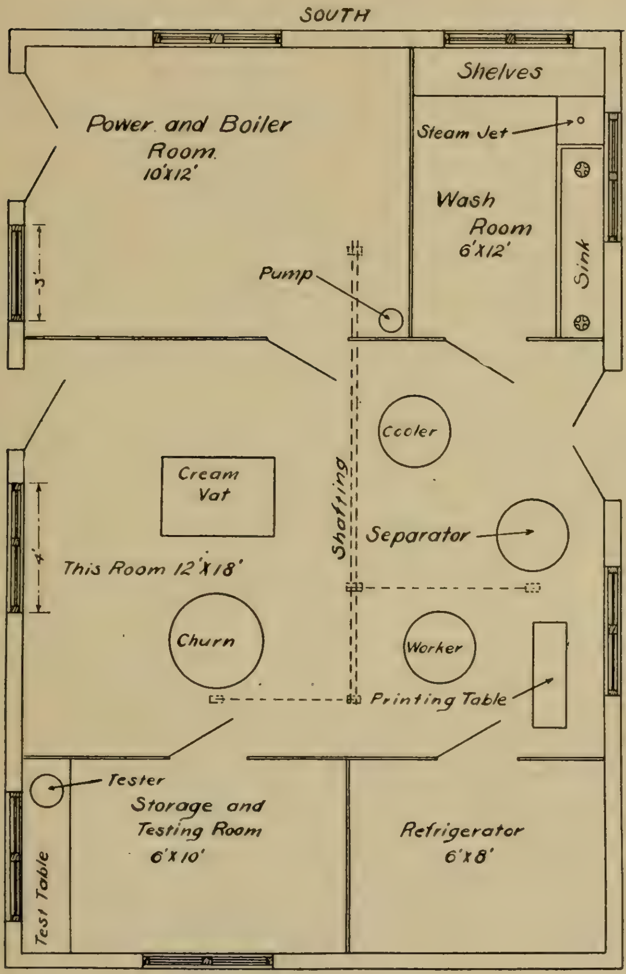
Where Needed. Milk producers who patronize creameries and cheese factories do not require a special dairy house. For such producers the milk room illustrated in Fig. 18 will answer. But where butter is made upon the farm or where the cream and milk are retailed, it is essential to have a rather small building devoted exclusively to dairy purposes.

Location. The dairy house should be located upon a well drained spot and as conveniently as possible. The surroundings for some distance should be clean and entirely free from bad odors.

General Plan. This is fully illustrated in Fig. 26. A boiler is needed to supply the necessary hot water and steam for cleaning as well as for heating purposes. For power either a gasoline engine, steam engine or tread power may be used. (See Chapter XV.)

The wash room is provided with a wash sink, a place for steaming cans, pails, etc., and shelves upon which the utensils are inverted immediately after scalding. The shelves are arranged in front of a large window facing south so that everything placed upon them will receive the disinfectant action of sunlight.

In the 12x18 foot space, which constitutes the main work room, such apparatus is placed as is required for the particular purpose. There is room for apparatus not shown in the illustration, such as ice cream freezer, milk bottle filler, etc. The illustration shows a separate churn and butter worker, but for large dairies having



GROUND PLAN FOR DAIRY HOUSE 18'x28'

Fig. 26.—Plan for Dairy House.

40 or more cows, a *combined* churn and worker of suitable capacity is recommended.

A store room is essential for the storage of butter packages, butter wrappers, salt, milk bottles, sulphuric acid, and reserve supplies of various kinds, such as strainers, dippers, pails, cans, Babcock glassware, etc. A testing table may be placed in this room as indicated in Fig. 26. Steam and the odors from the sulphuric acid must be strictly avoided in this room. All waste from the test bottles should be promptly removed from the building.

Construction. In the construction of a dairy house sanitary features should be made paramount. The floor should be built of concrete, and it is desirable to have the lower four or six feet of the wall finished with cement. Indeed it is a distinct advantage to have the entire walls covered with hard finish of some kind to make them readily cleanable. The ceiling should be about 12 feet high and made of well matched ceiling lumber. A ventilating shaft should extend from the middle of the ceiling to the top of the roof to carry off vapors and impure air. Ample light should be provided, especially in the wash room where a great deal of sunlight is needed. A strong foundation constructed of stone, concrete or brick is important. The foundation should extend well above ground to preserve the lumber resting on it from decay. It is essential also to have air-tight walls to eliminate extremes of temperature. A high degree of insulation necessitates two dead air spaces in the wall.

Ice House. As a rule it is best to provide a separate ice house; and every dairyman located near one of nature's ice factories should lay in an abundant supply of ice.

CHAPTER XIV.

HANDLING FARM MANURE.

Value of Manure Per Cow. The value of the manure from a cow depends primarily upon the character of the feed supplied her. Feeds rich in fertilizing constituents will produce manure correspondingly rich in them. On an average 75% of the fertilizing constituents in feeds are recovered in the manure. The Cornell station finds that the value of the manure from cows averaging 1000 pounds live weight, is $29.27 per cow per year. This may be regarded as a very fair average.

Relative Value of Liquid and Solid Manure. The urine, as a rule, is much richer in fertilizing constituents than the dung. It contains more than half the nitrogen and nearly all of the potash voided by the animal. Practically all of the phosphoric acid, however, is found in the solid excreta. The fact that the larger portion of the fertilizing constituents is found in the urine, emphasizes the importance of carefully saving all this portion of the voidings.

How to Save the Urine. To save all of the liquid manure, it is necessary, in the first place, to have watertight gutters and floors. Nothing is better in this respect than concrete.

The next requirement is a sufficient amount of clean, porous bedding to absorb all of the liquid. Straw, especially if cut up somewhat, makes excellent bedding material. It is clean and holds a great deal of moisture. Planer shavings also answer the purpose satisfactorily.

In addition to this it is desirable to use some powdered absorbents like ground phosphate rock and gypsum. These materials not only absorb moisture but also absorb ammonia as it is liberated from the manure, thus saving valuable volatile manurial constituents and at the same time purifying the air of the barn.

Sources of Loss of Manurial Constituents. Losses of manurial constituents may be considered under two heads: (1) those occasioned by leaching, and (2) those caused by bacterial action or fermentation processes. Where no precaution against leaching and fermentation are taken, more than half the value of the manure is easily lost.

Loss Through Leaching. Experiments have shown that manure as ordinarily placed in a pile will lose about 50% of its value when left exposed to the weather for a period of six months. Every rain washes a certain percentage of the soluble manurial constituents away from the pile. That heavy losses occur in this way is evident from the dark liquor which runs away from a manure heap that has been exposed to the rain. Frequently for convenience of handling, the manure is piled close to the barn and directly under the eaves drops, where the amount of water that pours over it becomes very considerable.

Losses from leaching can be entirely avoided by placing the manure in a shallow concrete pit provided with a roof. Even the concrete floor may be done away with if the ground is clayey, closely packed and so sloped that no water from without can drain into the pit. No farmer can afford to be without a covered storage for manure.

Losses Through Fermentation. Manure is a medium exceedingly rich in bacterial* life. Many species of bacteria are at work decomposing the organic matter, breaking up higher compounds into lower compounds and accomplishing what is ordinarily designated the rotting of the manure. In the fermentation or rotting process the nitrogen compounds are broken up into ammonia, which readily escapes from the manure pile. Evidence of such escape is found in the ammoniacal odors that emanate from loosely packed manure, such, for example, as that procured from horses.

This ammoniacal fermentation can be largely reduced by packing the manure tight so as to exclude the air as much as possible. Most of the bacteria concerned in the liberation of ammonia must have air for their development, and hence their action is reduced in proportion as the air is excluded from the manure heap.

On the other hand, some species of bacteria concerned in the liberation of nitrogen, namely, the denitrifying bacteria, require no air for their growth and development. Yet the loss from this class of bacteria is relatively so small that, while the exclusion of air favors their development, every effort should be made to keep the manure heap as air-tight as possible, so as to minimize the loss from the air-loving bacteria.

Ammonia or Nitrogen "Fixers." While the loss of ammonia from the manure heap can be materially reduced by tight packing, more or less of it is bound to be formed under the best packing possible. To prevent the escape of this ammonia it is necessary to add to the manure something which will "fix" or hold the ammonia. Materials used for this purpose are known as nitrogen or am-

* For definition of bacteria, see page 146.

monia fixers. Ground phosphate rock and gypsum are excellent materials to use for this purpose. These materials should be added to the gutter in the barn, since they not only act as ammonia fixers, but are also excellent absorbents. On the whole the ground phosphate rock is preferable to the gypsum. The latter is sulphate of lime, and is commonly known as land plaster. Dry earth containing a great deal of humus is also valuable as an absorbent and ammonia fixer.

Hauling Manure Directly Upon the Land. If the manure can be hauled upon ground where there is no danger of its being washed away, the most economical plan is to spread it upon the land as quickly as it is formed. Under such conditions there will be practically no loss from leaching and fermentation, and, moreover, what is of no little importance, the manure is handled with the least amount of labor. As a rule it is safest to spread the manure upon some growing crop.

Manure Carriers. A convenient and labor-saving piece of apparatus upon a dairy farm is an elevated manure carrier like that shown in Fig. 27. This carrier

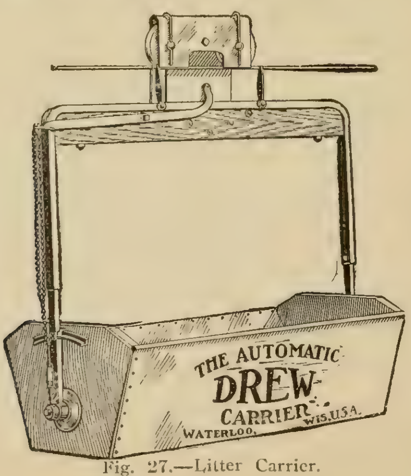


Fig. 27.—Litter Carrier.

is suspended from a steel rope, and by a push of the hand it can be sent a distance of several hundred feet to unload itself and to return unaided to the barn. The unaided return is made possible by slanting the rope somewhat toward the barn. It dumps itself by means of an automatic attachment placed at the point where it is expected to unload. The convenience afforded by such a carrier is especially great during the winter, when the stable may be cleaned without leaving the barn. The carrier cable should be placed between the two rows of cows extending the full length of the stable.

CHAPTER XV.

POWER ON THE FARM.

The use of some form of power upon farms has frequently been recommended in the past, but never before has its use been more urgent than at the present time. The increasing scarcity of labor, the rapid increase of hand separators and silos, and the general convenience it affords, have made power an actual necessity upon progressive dairy farms.

The kind of power needed upon a dairy farm depends upon certain conditions. If a tread power is used for exercising the bull, this will serve satisfactorily for separating milk, pumping water, and doing other light work. Where a milk house is used and butter is made upon the farm a small steam engine may be made to do any light work economically. But the use of either the tread power or the small steam engine fails to provide the necessary power for cutting corn for the silo, sawing wood, grinding feed, or doing other heavy work.

Every modern dairy farm must have a silo, and it is at silo filling time that we usually experience the greatest need for some form of power. With none of our own we are obliged to hire or borrow, a practice which often compels us to wait till the corn is past its prime. Moreover it is frequently impossible to hire power, no matter how much we may wish to do so. Where good silage is desired it should be made at the proper time, and this can be done with certainty only when we own the power.

Where power for the heavier work can not be conveniently hired or borrowed, it is believed that the best solution for the farm power problem is the gasoline engine. Such an engine can be used for a great variety of purposes and practically every day of the year.

Besides running the ensilage cutter, cream separator and possibly a milking machine, the engine may be used to pump water, to run the washing machine, corn sheller, grindstone, saw, churn and grist mill. When placed as

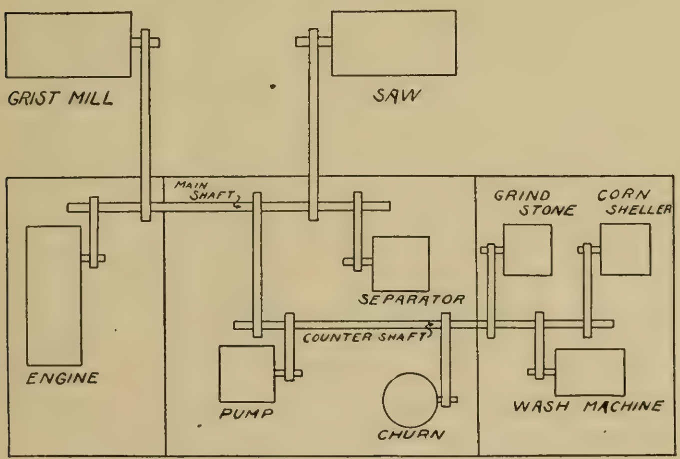


Fig. 28.—Possible Uses of Gasoline Engine.

shown in Fig. 28 several of these machines may be run at the same time.

Many dairy farmers have felt justified in going to the expense of purchasing gasoline power solely for running the cream separator. For this purpose a two-horse power engine suffices; but it would be greater economy to increase the original outlay somewhat and secure an eight-horse power engine, one that could be used for the heavier work of cutting ensilage and corn stover, as well as running a saw and grist mill.

This is an age of machinery, and we believe the time is not far distant when the farmer will make use of power whenever this can be made to take the place of hired labor. Power will not only afford greater convenience but will curtail the running expenses of the farm.

If, for example, we assume that one hour is required daily in running the separator, and another in pumping water for stock, the total time consumed in this work in one year would be 730 hours, or 73 days of 10 hours each. At $1 a day, the cost of separating and pumping would amount to $73 a year. With a gasoline engine running the pump and separator at the same time, this work could be done in 365 hours. Allowing 6c per hour for gasoline and oil, which is a high estimate, the cost of doing the above work with an engine would be $21.90, or less than one-third of what it can be done for with hired labor. This saving is equivalent to about 25 per cent on the investment of the engine, if used for no other purpose than separating milk and pumping water.

At silo filling time the engine should be mounted on a suitable base near the silo, where it is expected to remain only during the filling of the silo. The remainder of the year it may be placed as indicated in the above illustration.

There are plenty of simple and smooth-running gasoline engines upon the market, and in purchasing care should be taken to get one in which these two qualities are most conspicuous.

A possible objection to the use of gasoline engines for dairy purposes is the trouble from gas odor where there is any tendency to laxness in the care of machinery. Where precautions are taken against leakage of gas or gasoline, and where the exhaust is properly conducted away, there should be no trouble from gas odors.

The fuel cost of running a gasoline engine may be stated as follows: When gasoline is worth 10c per gallon, gasoline power will cost 1c per brake horse power per hour.

CHAPTER XVI.

DISEASES AND AILMENTS OF DAIRY CATTLE.

Prevention. The old adage, "An ounce of prevention is worth a pound of cure," is as true to-day as ever. The common ailments with which cattle are afflicted can be largely prevented by correct feeding, comfortable and sanitary housing, gentle treatment, and by using every precaution possible against infection from contagious diseases.

Digestive disorders are the result of injudicious feeding, and these may be the forerunner of a retinue of various other disorders. Exposure to severe cold and cold rains, and confinement in foul and unventilated stables are predisposing causes to various diseases. Many ailments are caused, either directly or indirectly, by allowing cows to lie on cold concrete floors, by chasing with dogs and by compelling them to walk and stand on slippery, highly inclined floors.

Great aid has been rendered in the prevention of diseases through the rapid development of medical science in pointing out the nature and causes of the various diseases with which cattle are afflicted. Every dairyman should have an intelligent understanding of the role which bacteria (for definition of bacteria see p. 146) play in the dissemination of diseases which could be largely avoided by proper quarantine and methods of disinfection.

Quarantine and Disinfection. By quarantining is meant the separation of the diseased from the undiseased animals. If an animal is known to be affected with some transmissible disease, its prompt removal will usually spare the rest of the animals in the herd from the disease, especially if such removal is accompanied by proper methods of disinfection. The latter refers to the destruction of the causal agents of the disease by the use of germicides or disinfectants, substances which have the power of killing bacteria and allied organisms.

Disinfectants. The following is a list of well-known disinfectants:

1. Boiling water applied for 20 minutes.
2. A 5 per cent solution of carbolic acid.
3. A 2 per cent solution of zenolium.
4. A 2 per cent solution of chloro-naptholeum.
5. A 5 per cent solution of copper sulfate.
6. A solution of 1-2000 of mercuric chloride.
7. A 2 per cent solution of creolin.
8. A 1-1000 solution of chlorid of zinc

Purgatives. A purgative is a substance used to induce action of the bowels. Among the common purgatives the following may be mentioned: 1 to 2 pints of raw linseed oil; a mixture of 1 pound of Epsom salts and 1 to 2 ounces of ginger, dissolved in 2 pints of warm water; 1 pound of Glauber salts dissolved in water; and 1 pint of castor oil.

As a rule the best thing to do at the first signs of illness, such as loss of appetite, failure to chew the cud, dull eyes, dry muzzle, parched skin, rough coat, etc., is to administer a good purgative. This alone is frequently sufficient to relieve the trouble.

MILK FEVER.

Causes. Overfeeding, lack of exercise, impure air, constipation, and drinking cold water are common causes of milk fever. Withdrawing all the milk from the udder during the first 24 hours after calving is claimed to be conducive to the disease. Furthermore, heavy milkers are far more subject to the disease than medium or small milkers.

Symptoms. Restlessness followed by a weakening of the muscles, causing the animal finally to stagger and fall. The cow usually lies on her breast bone with her head completely drawn around to one side. The udder becomes soft and empty, pulse weak and rapid, the temperature falls below normal, and the animal may become completely unconscious.

Treatment. Fortunately there is available now a very simple, sure, and inexpensive treatment for milk fever. The treatment consists in filling the udder with sterile air by means of a syringe which draws the air through a tube containing absorbent cotton. Such a syringe can be obtained at very small cost from the manufacturers who advertise extensively through the dairy press, and every dairyman should possess one so as to be prepared to meet emergencies promptly.

Before injecting the air, the hands, teats, udder, and the tube that is to be inserted into the teats, should be carefully disinfected. This done, each quarter of the udder is thoroughly inflated with air, kneading and rubbing the udder as much as possible during the process to secure a thorough and rapid diffusion of the air. As soon as each quarter is filled, a wide band is tied around the top of the teat to prevent leakage of air. These bands should not be drawn any tighter than necessary and may be removed soon after the cow gets on her feet. Repeat the treatment if necessary.

The treatment above described usually brings relief within a few hours. In a number of emergencies cows have been successfully treated by pumping unfiltered air into the udder with a bicycle pump; but this is liable to result in serious infection of the udder and should be practiced only in an emergency.

The injection of a gallon of warm, soapy water into the rectum is also desirable. Never administer drenches when the animal is partially unconscious.

ABORTION.

By abortion is meant the premature birth of the calf. Two forms of this ailment are common: (1) contagious abortion caused by bacteria; and (2) accidental abortion caused by a serious nervous shock. The latter may result from external or internal injuries, drinking cold or stagnant water, bad nutrition, exposure to inclement weather, impure atmosphere, and various constitutional diseases. Whenever abortions occur apparently without cause, they should be treated as contagious.

Contagious Abortion. This is a very menacing disease among dairy cattle. It is caused by bacteria which find their way into the reproductive organs. The disease can be successfully combatted only by rigid methods of disinfection and prompt quarantining of the aborting animals. The dead offspring, afterbirth, and stable litter should at once be burned, or buried and covered with quick lime. The stalls and walls should be washed with a 1-1000 solution of corrosive sublimate, while the floor may be disinfected with a liberal amount of quick lime.

The vagina and uterus should be thoroughly disinfected daily with chlorid of zinc, creolin, or corrosive sublimate solution of proper strength until the cow ceases discharging. The same antiseptic treatment should be applied frequently to the external genitals and adjacent region of uninfected cows. If the afterbirth is retained longer than 24 hours it should be removed by hand.

Cows that have aborted should not be bred until they have ceased discharging, and it is important to keep them from the rest of the herd until they have dropped a full-grown calf.

A prolific means of spreading the infection of this disease is the bull. A bull that has served infected cows will infect other cows he serves unless his penis and sheath have been thoroughly disinfected. One to two quarts of 2 per cent coal tar disinfectant worked up into the sheath will answer the purpose satisfactorily.

GARGET.

Causes. Injuries of the udder, overfeeding, exposure to severe cold, overcrowding of the udder by skipping a milking, and germ infection.

Symptoms. Watery, stringy milk, frequently containing blood; swelling and hardening of one, two, or all quarters of the udder, which has a more or less reddish, inflamed appearance; and the formation of pus in the more advanced stages.

Treatment. Give 1¼ pounds of Epsom salts and 1 ounce of ginger, dissolved in a quart of tepid water. Support the udder by means of a wide bandage tied at the top line of the animal, and pack a layer of bran between the bandage and the diseased portion of the udder. Heat the bran by pouring hot water over it. The hot water treatment should be repeated at short intervals and should be followed by thorough rubbing of the udder with lard or raw linseed oil, a treatment which may be continued to advantage for 20 minutes. The rubbing materially relieves the swelling and stimulates the secretion of milk. It is important also to milk the diseased quarter or quarters clean at short intervals. The air treatment for milk fever has also been recommended for garget.

NON-INFECTIOUS "CALF SCOURS."

Causes. Feeding cold, dirty, old, or too much, milk; drinking cold or impure water; irregularities in feeding; feeding from unscalded buckets; and confinement in dark, cold, or filthy stalls.

Treatment. Reduce the amount of milk; feed the milk fresh and at body temperature; feed not less than three times a day, and use only clean, sterilized milk buckets. Give only pure water at body temperature, and add formalin to the milk in the proportion of one part formalin to 4,000 parts of milk until the diarrhea or "scours" is checked. The scouring is usually due to the action of fermentative or putrefactive bacteria which are killed or checked by the action of the formalin.

INFECTIOUS "CALF SCOURS."

This disease is commonly known as white scours and is caused by bacteria. It affects calves usually from a few hours to a few days old, and is very fatal. The discharges are usually of a rather light color and have an offensive odor. Medicine is of little avail. The disease must therefore be combatted by methods of prevention. Washing the vagina of the cow with disinfectant solution shortly before calving, disinfecting the navel of the new-born calf at short intervals for a few days, and placing the calf in a disinfected stall, are good measures of prevention.

INDIGESTION.

Causes. Overfeeding; feeding too much coarse, indigestible feed; sudden changes of feed; stale, moldy, frosted or decomposing feeds; irregularities of feeding; and lack of exercise.

Symptoms. Loss of appetite, suspended rumination, dull, sickly appearance, and usually constipation.

Treatment. Feed light ration containing laxative and green feeds, such as linseed meal, pasture, roots, silage, etc. Supply plenty of water and give 1 to 1½ pounds of Epsom salts and 1 ounce ginger, or 1 to 2 pints of raw linseed oil, according to the degree of constipation.

RETENTION OF AFTERBIRTH.

If the afterbirth does not come away within 48 hours it should be removed by hand. Carefully disinfect the hand and arm, grease the same and insert into the womb, where the afterbirth must be carefully loosened from the button-like projections to which it is attached. As soon as removed, flush out the vagina and womb with warm disinfectant solution.

When cows are provided with laxative feed and warm water shortly before and after calving, the afterbirth will almost always drop away in due time. If the bowels are not perfectly loose at calving time, administer a purgative.

The retention of the afterbirth for a longer period than 48 hours will cause it gradually to decompose and slough off, causing a foul discharge from the vagina and seriously impairing the health of the animal. Blood poisoning may also result from the prolonged retention of the afterbirth.

INVERSION OF THE WOMB.

Severe straining after calving may cause the further portion of the womb to protrude through the opening leading into it, thus causing an inversion of the organ. In this inverted condition a portion or all of it may pass out of the vagina. As soon as this is noticed, wash and disinfect the protruded portion and push it back into its normal position. This done, apply a truss or pessary to hold the womb in position until the straining or expulsive movements cease.

TUBERCULOSIS.

Cause. This disease is caused by a specific organism known as the tubercle bacillus. The germs are commonly inhaled, though they may also be taken into the body through the food. Unsanitary stabling, lack of nourishment, and inherent constitutional weakness, are greatly responsible for the prevalence of this disease.

Symptoms. A short cough, enlargement of the lymph glands at the throat, emaciation, and a general unthrifty appearance. In its early stages it is difficult, however, to detect the disease except by the tuberculin test.

The Tuberculin Test. The usefulness of this test as a diagnostic agent rests upon the fact that when a substance called "tuberculin" is injected under the skin of an animal, the injection is followed by a rise of temperature in infected animals, while in those unaffected the temperature remains the same. It must be added, however, that in the last stages of the disease, tuberculin fails as a diagnostic agent, but this is of little consequence since the disease is readily recognized in these stages by a physical examination.

Method of Making the Tuberculin Test. In making this test the following particulars must be observed:

1. Secure the necessary tuberculin from the government.
2. Secure a clinical thermometer, a sharp, hollow needle, and a graduated, hypodermic syringe from dealers in veterinary instruments.
3. Make the test during the cooler season of the year.
4. Do not test cows shortly before or after calving.
5. Do not test cows that are in heat, or suffering from garget or other diseases.
6. Do not allow cows to drink very cold water.
7. Keep the animals in a normal condition as to feed, confinement, etc., during the test.
8. Do not test animals which show a temperature as high as 103° F.

Proceed with the test as follows: First ascertain the normal temperature of the cows by holding a clinical thermometer in the rectum for about five minutes. Three observations are necessary: One at 6 a. m., another at noon, and the last at 6 p. m. At 10 p. m., the same day, inject under the skin at the neck or shoulder, 2 cubic centimeters of tuberculin for animals of about 1,000 pounds live weight and proportionally more for heavier cows. At 6 o'clock the next morning take the temperature again as before, but at intervals of two hours until five or six readings have been taken. If the maximum temperature after the injection is two or more degrees higher than it was before the injection of the tuberculin, the animal is considered tuberculous. If the rise of temperature is one and a half degrees, the case may be considered suspicious.

The needle and place of injection should be disinfected, and care should be exercised not to excite the cows during any period of the test. Do not retest for tuberculosis within 60 days. As a rule every cow in the herd should be tested once a year for tuberculosis.

BARRENNESS.

Causes. Lack of exercise, improper feeding, in-and-in breeding, closing of the mouth of the womb, and an acid condition of the vagina.

Treatment. If overfat reduce the amount of feed and give plenty of exercise. If the mouth of the womb is closed, open by inserting the forefinger or by applying solid extract of Belladonna to the part. An acid condition of the vagina may be overcome by thorough syringing with 2 per cent solution of bicarbonate of soda a few hours previous to service. A treatment much recommended lately is known as the yeast treatment and is used as follows : Dissolve an ordinary compressed yeast cake in a cup of warm water and allow to ferment. Add this to a quart of warm water and use to wash out the vagina some hours before service. The vagina should be washed out with soapy water just previous to the injection of the yeast solution.

BLOAT OR HOVEN.

Causes. Overeating, suddenly turning cows on rich, green feed, like clover pasture, and fermentation of the feed. There is as a rule a great deal of gas produced, causing a great distention of the left side.

Treatment. Immediately place a gag in the mouth, and in mild cases, give an ounce of spirits of turpentine and one-half pint of raw linseed oil. Keep the animal moving and pour cold water on the loins. When relief comes, administer a purgative.

In severe cases tap the left side (paunch) with a slender knife or a trocar. Tap at a point equidistant from the point of the hip, the last rib, and the spinal column.

TEAT TROUBLES.

Hard Milkers. Hard milking is caused by too small an opening in the teat. Enlarge the opening by using a teat bistoury when the cow is in full flow of milk.

Sore or Chapped Teats. Due to exposure to cold, wet weather and rough handling. Treat with lard or vaseline.

Warts. May be removed by applying lunar caustic.

Closed or Obstructed Teats. Caused by injury or clotted milk. Keep open by inserting a milk tube.

Leaky Teats. Prevent unusual distention by milking three or four times daily. If this is not sufficient, a fairly tight fitting bandage, like the finger of a glove, may be placed around the teat.

STRINGY OR ROPEY MILK.

This is due to certain species of bacteria which find their way into the udder through the teats. These bacteria are associated with filth and the trouble must be overcome by keeping cows away from filthy places. This trouble should not be confused with garget.

BLOODY MILK.

This is usually due to an injury to the udder. Bathe the udder with hot water and apply lard.

SELF-SUCKING COWS.

Prevent by putting a halter on the cow with a strong, stiff piece of leather running over the nose. Fill this strip of leather with sharp nails.

LICE.

Two per cent coal tar disinfectants are usually used for killing lice. The Oklahoma station recommends a "kerosene emulsion," which is made by using ½ pound hard soap, 2 gallons of a cheap grade of kerosene and 1 gallon of water. Cut up the soap and dissolve in hot water; then add the kerosene and thoroughly mix. Before applying to the animals dilute this mixture with 7 gallons of water. Apply by means of a sponge, brush, or spray pump.

WARBLES OR GRUBS.

These are found just below the skin in the backs of cattle and constitute the larval form of the ox bot-fly or heel-fly. As they develop they cause swellings in the back and are thus easily recognized. Wherever there is a swelling there is also an opening in the skin through which the grubs may be easily squeezed and killed. They may also be destroyed by the application of kerosene.

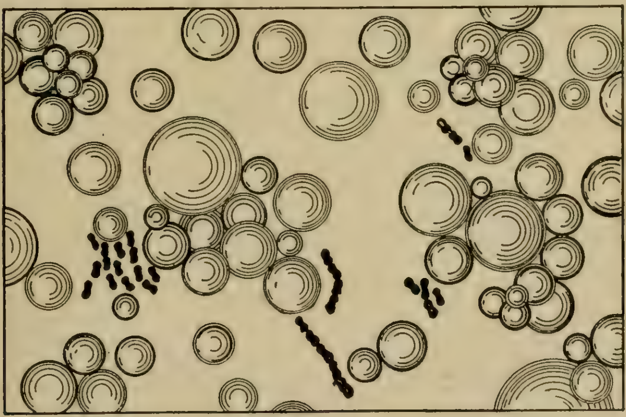
PART II.

MILK AND ITS PRODUCTS.

CHAPTER XVII.

MILK.

Milk, in a broad sense, may be defined as the normal secretion of the mammary glands of animals that suckle their young. It is the only food found in Nature containing all the elements necessary to sustain life. Moreover it contains these elements in the proper proportions and in easily digestible and assimilable form.



Microscopic appearance of milk showing relative size of fat globules and bacteria.—Russell's Dairy Bacteriology.

Physical Properties. Milk is a whitish opaque fluid possessing a sweetish taste and a faint odor suggestive of cows' breath. It has an amphioteric reaction, that is, it is both acid and alkaline. This double reaction is due largely to acid and alkaline salts and possibly to small quantities of organic acids.

Milk has an average normal specific gravity of 1.032, with extremes rarely exceeding 1.029 and 1.033. After standing a few moments it loses its homogenous character. Evidence of this we have in the "rising of the cream." This is due to the fact that milk is not a perfect solution but an *emulsion.* All of the fat, the larger portion of the casein, and part of the ash are in suspension.

In consistency milk is slightly more viscous than water, the viscosity increasing with the decrease in temperature. It is also exceedingly sensitive to odors, possessing great absorption properties. This teaches the necessity of placing milk in clean pure surroundings.

Chemical Composition. The composition of milk is very complex and variable, as will be seen from the following figures:

Average Composition of Normal Milk. A compilation of figures from various American Experiment Stations.

Water	87.1%
Butter fat	3.9%
Casein	2.9%
Albumen	.5%
Sugar	4.9%
Ash	.7%
Fibrin	Trace.
Galactase	Trace.
	100.0%

The great variations in the composition of milk are shown by the figures from Koenig, given below:

	Maximum.	*Minimum.*
Water	90.69	80.32
Fat	6.47	1.67
Casein	4.23	1.79
Albumen	1.44	.25
Sugar	6.03	2.11
Ash	1.21	.35

These figures represent quite accurately the maximum and minimum composition of milk except that the maximum for fat is too low. The author has known cows to yield milk testing 7.6% fat, and records show tests even higher than this.

BUTTER FAT.

This is the most valuable as well as the most variable constituent of milk. It constitutes about 83% of butter and is an indispensable constituent of the many kinds of whole milk cheese now found upon the market. It also measures the commercial value of milk and cream, and is used as an index of the value of milk for butter and cheese production.

Physical Properties. Butter fat is suspended in milk in the form of extremely small globules numbering about 100,000,000 per drop of milk. These globules vary considerably in size in any given sample, some being five times as large as others. The size of the globules is affected mostly by the period of lactation. As a rule the size decreases and the number increases with the advance of the period. In strippers' milk the globules are sometimes so small as to render an efficient separation of the cream and the churning of same impossible.

The size of the fat globules also varies with different breeds. In the Jersey breed the diameter of the globule is one eight-thousandth of an inch, in the Holstein one twelve-thousandth, while the average for all breeds is about one ten-thousandth.

Night's milk usually has smaller globules than morning's. The size of the globules also decreases with the age of the cow.

The density or specific gravity of butter fat at 100° F. is .91 and is quite constant. Its melting point varies between wide limits, the average being 92° F.

Composition of Butter Fat. According to Richmond, butter fat has the following composition:

Butyrin	3.85	Soluble or volatile.
Caproin	3.60	
Caprylin	.55	
Caprin	1.90	Insoluble or non-volatile.
Laurin	7.40	
Myristin	20.20	
Palmitin	25.70	
Stearin	1.80	
Olein, etc.	35.00	

This shows butter fat to be composed of no less than nine distinct fats, which are formed by the union of glycerine with the corresponding fatty acids. Thus, butyrin is a compound of glycerine and butyric acid; palmitin, a compound of glycerine and palmitic acid, etc. The most important of these acids are palmitic, oleic, and butyric.

Palmitic acid is insoluble, melts at 144° F., and forms (with stearic acid) the basis of hard fats.

Oleic acid is insoluble, melts at 57° F., and forms the basis of soft fats.

Butyric acid is soluble and is a liquid which solidifies at —2° F. and melts again at 28° F.

Insoluble Fats. A study of these fats is essential in elucidating the variability of the churning temperature of cream. As a rule this is largely determined by the relative amounts of hard and soft fats present in butter fat. Other conditions the same, the harder the fat the higher the churning temperature. Scarcely any two milks contain exactly the same relative amounts of hard and soft fats, and it is for this reason that the churning temperature is such a variable one.

The relative amounts of hard and soft fats are influenced by:

1. Breeds.
2. Feeds.
3. Period of lactation.
4. Individuality of cows.

The butter fat of Jerseys is harder than that of Holsteins and, therefore, requires a relatively high churning temperature, the difference being about six degrees.

Feeds have an important influence upon the character of the butter fat. Cotton seed meal and bran, for example, materially increase the percentage of hard fats. Gluten feeds and linseed meal, on the other hand, produce a soft butter fat.

With the advance of the period of lactation the percentage of hard fat increases. This chemical change, together with the physical change which butter fat undergoes, makes churning difficult in the late period of lactation.

The individuality of the cow also to a great extent influences the character of the butter fat. It is inherent in some cows to produce a soft butter fat, in others to produce a hard butter fat, even in cows of the same breed.

Soluble Fats. The soluble or volatile fats, of which butyrin is the most important, give milk and sweet cream butter their characteristic flavors. Butyrin is found only in butter fat and distinguishes this from all vegetable and other animal fats.

The percentage of soluble fats decreases with the period of lactation, also with the feeding of dry feeds and those rich in protein. Succulent feeds and those rich in carbohydrates, according to experiments made in Holland and elsewhere, increase the percentage of soluble fats. This may partly account for the superiority of the flavor of June butter.

It may be proper, also, to discuss under volatile or soluble fats those abnormal flavors that are imparted to milk, cream, and butter by weeds like garlic and wild onions, and by various feeds such as beet tops, rape, partially spoiled silage, etc. These flavors are undoubtedly due to abnormal volatile fats.

Cows should never be fed strong flavored feeds shortly before milking. When this is done the odors are sure to be transmitted to the milk and the products therefrom. When, however, feeds of this kind are fed shortly after milking no bad effects will be noticed at the next milking.

Albumenoids. These are nitrogenous compounds which give milk its high dietetic value. Casein, albumen, globulin, and nuclein form the albumenoids of milk, the casein and albumen being by far the most important.

Casein. This is a white colloidal substance, possessing neither taste nor smell. It is the most important tissue-forming constituent of milk and forms the basis of an almost endless variety of cheese.

The larger portion of the casein is suspended in milk in an extremely finely divided amorphus condition. It is intimately associated with the insoluble calcium phosphate of milk and possibly held in chemical combination with this. Its study presents many difficulties, which leaves its exact composition still undetermined.

Casein is easily precipitated by means of rennet extract and dilute acids, but the resulting precipitates are not identically the same. It is not coagulated by heat.

Albumen. In composition albumen very closely resembles casein, differing from this only in not containing sulphur. It is soluble and unaffected by rennet, which causes most of it to pass into the whey in the manufacture of cheese. It is coagulated at a temperature of 170° F. It is in their behavior toward heat and rennet that casein and albumen radically differ.

Milk Sugar. This sugar, commonly called lactose, has the same chemical composition as cane sugar, differing from it chiefly in possessing only a faint sweetish taste. It readily changes into lactic acid when acted upon by the lactic acid bacteria. This causes the ordinary phenomenon of milk souring. The maximum amount of acid in milk rarely exceeds .9%, the germs usually being checked or killed before this amount is formed. There is therefore always a large portion of the sugar left in sour milk. All of the milk sugar is in solution.

Ash. Most of the ash of milk exists in solution. It is composed of lime, magnesia, potash, soda, phosphoric acid, chlorine, and iron, the soluble lime being the most important constituent. It is upon this that the action of rennet extract is dependent. For when milk is heated to high temperatures the soluble lime is rendered insoluble and rennet will no longer curdle milk. It seems also that the viscosity of milk and cream is largely due to soluble lime salts. Cream heated to high temperatures loses its viscosity to such an extent that it can not be made to "whip." Treatment with soluble lime restores its original viscosity. The ash is the least variable constituent of milk.

Colostrum Milk. This is the first milk drawn after parturition. It is characterized by its peculiar odor, yellow color, broken down cells, and high content of albumen which gives it its viscous, slimy appearance and causes it to coagulate on application of heat.

According to Eugling the average composition of colostrum milk is as follows:

Water	71.69%
Fat	3.37
Casein	4.83
Albumen	15.85
Sugar	2.48
Ash	1.78

The secretion of colostrum milk is of very short duration. Usually within four or five days after calving it assumes all the properties of normal milk. In some cases, however, it does not become normal till the sixth or even the tenth day, depending largely upon the condition of the animal.

A good criterion in the detection of colostrum milk is its peculiar color, odor, and slimy appearance. The disappearance of these characteristics determines its fitness for butter production.

Milk Secretion. Just how all of the different constituents of milk are secreted is not yet definitely understood. But it is known that the secretion takes place in the udder of the cow, and principally during the process of milking. Further, the entire process of milk elaboration seems to be under the control of the nervous system of the cow. This accounts for the changes in flow and richness of milk whenever cows are subjected to abnormal treatment. It is well known that a change of milkers, the use of rough language, or the abuse of cows with dogs and milk stools, seriously affects the production of milk and butter fat. It is therefore of the greatest practical importance to milk producers to treat cows as gently as possible, especially during the process of milking.

How Secreted. The source from which the milk constituents are elaborated is the blood. It must not be supposed, however, that all the different constituents already exist in the blood in the form in which we find them in milk, for the blood is practically free from fat, casein, and milk sugar. These substances must then be formed in the cells of the udder from material supplied them by the blood. Thus there are in the udder cells that have the power of secreting fat in a manner similar to that by which the gastric juice is secreted in the stomach. Similarly, the formation of lactose is the result of the action of another set of cells whose function is to produce lactose. It is believed that the casein is formed from the albumen through the activity of certain other cells. The water, albumen, and soluble ash probably pass directly from the blood into the milk ducts by the process known as osmosis.

Variations in the Quality of Milk. Milk from different sources may vary considerably in composition, particularly in the percentage of butter fat. Even the milk from the same cow may vary a great deal in composition. The causes of these variations may be assigned to two sets of conditions: I.—Those natural to the cow. II.—Those of an artificial nature.

I. QUALITY OF MILK AS AFFECTED BY NATURAL CONDITIONS.

1. The composition of the milk of all cows undergoes a change with the advance of the period of lactation. During the first five months the composition remains practically the same. After this, however, the milk becomes gradually richer until the cow "dries up." The following figures from Van Slyke illustrate this change:

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

It will be noticed from these figures that the milk actually decreases somewhat in richness during the first three months of the period. But just before the cow dries up, it may test as high as 8%.

2. The quality of milk also differs with different breeds. Yet breed differences are less marked than those of the individual cows of any particular breed.

Some breeds produce rich milk, others relatively poor milk. The following data obtained at the New Jersey Experiment Station illustrates these differences:

Breed.	Total Solids.	Fat.	Milk Sugar.	Proteids.	Ash.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Ayshire........	12.70	3.68	4.84	3.48	.69
Guernsey	14.48	5.02	4.80	3.92	.75
Holstein	12.12	3.51	4.69	3.28	.64
Jersey..........	14.34	4.78	4.85	3.96	.75

3. Extremes in the composition of milk are usually to be ascribed to the individuality or "make up" of the cow. It is inherent in some cows to produce rich milk, in others to produce poor milk. In other words, Nature has made every cow to produce milk of a given richness, which can not be perceptibly changed except by careful selection and breeding for a number of generations.

II. QUALITY OF MILK AS AFFECTED BY ARTIFICIAL CONDITIONS.

1. When cows are only partially milked they yield poorer milk than when milked clean. This is largely explained by the fact that the first drawn milk is always poorer in fat than that drawn last. Fore milk may test as low as .8%, while the strippings sometimes test as high as 14%.

2. Fast milking increases both the quality and the quantity of the milk. It is for this reason that fast milkers are so much preferred to slow ones.

3. The richness of milk is also influenced by the length of time that elapses between the milkings. In general, the shorter the time between the milkings the richer the milk. This, no doubt, in a large measure accounts for the differences we often find in the richness of morning's and night's milk. Sometimes the morning's milk is the richer, at other times the evening's, depending largely upon the time of day the cows are milked. Milk can not, however, be permanently enriched by milking three times in stead of twice a day.

4. Unusual excitement of any kind reduces the quality of milk. The person who abuses cows by dogs, milk stools, or boisterousness, pays dearly for it in a reduction of both the quality and the quantity of milk produced.

5. Starvation also seriously affects both the quality and the quantity of milk. It has been repeatedly shown, in this country and in Europe, that under-feeding to any great extent results in the production of milk poor in fat.

6. Sudden changes of feed may slightly affect the richness of milk, but only temporarily.

So long as cows are fed a full ration, it is not possible to change the richness of milk permanently, no matter what the character of feed composing the ration.

7. Irregularities of feeding and milking, exposure to heat, cold, rain, and flies, tend to reduce both the quantity and the quality of milk produced.

CHAPTER XVIII.

THE BABCOCK TEST.

This is a cheap and simple device for determining the percentage of fat in milk, cream, skim-milk, buttermilk, whey, and cheese. It was invented in 1890 by Dr. S. M. Babcock, of the Wisconsin Agricultural Experiment Station, and ranks among the leading agricultural inventions of modern times. The chief uses of the Babcock test may be mentioned as follows:

1. It has made possible the payment for milk according to its quality.
2. It has enabled butter and cheese makers to detect undue losses in the process of manufacture.
3. It has made possible the grading up of dairy herds by locating the poor cows.
4. It has, in a large measure, done away with the practice of watering and skimming milk.

Principle of the Babcock Test. The separation of the butter fat from milk with the Babcock test is made possible:

1. By the difference between the specific gravity of butter fat and milk serum.
2. By the centrifugal force generated in the tester.
3. By burning the solids not fat with a strong acid.

Sample for a Test. Whatever the sample to be tested, always eighteen grams are used for a test. In testing cream and cheese, the sample is weighed. For testing milk, skim-milk, buttermilk, and whey, weighing requires too much time. Indeed, with these substances weighing is not necessary as sufficiently accurate samples are ob-

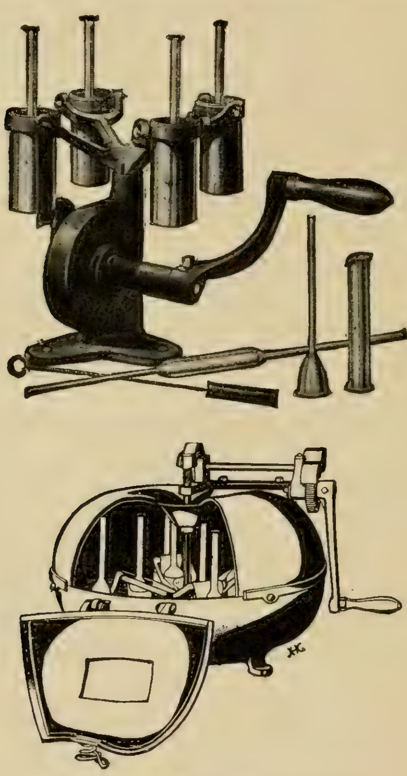


Fig. 29—Two styles of Babcock testers.

tained by measuring which is the method universally employed. In making a Babcock test it is of the greatest importance to secure a uniform sample of the substance to be tested.

Apparatus. This consists essentially of the following parts: A, Babcock tester; B, milk bottle; C, cream bottle; D, skim-milk bottle; E, pipette or milk measure; F, acid measures; G, cream scales; H, mixing cans; I, dividers.

A. Babcock Tester. This machine, shown in Fig. 29, consists of a revolving wheel placed in a horizontal position and provided with swinging pockets for the bottles. This wheel is rotated by means of a worm wheel (lower machine) at the top of the tester. When the tester stops the pockets hang down allowing the bottles to stand up. As the wheel begins rotating the pockets move out causing the bottles to assume a horizontal position. The wheel is enclosed in a cast iron frame provided with a cover.

B. Milk Bottle. This has a neck graduated to ten large divisions, each of which reads one per cent. Each large division is subdivided into five smaller ones, making each subdivision read .2%. The contents of the neck from the zero mark to the 10% mark is equivalent to two cubic centimeters. Since the Babcock test does not give the percentage of fat by volume but by weight, the 10% scale on the neck of the bottle will, therefore, hold 1.8 grams of fat. In other words, if the scale were filled with water it would hold two grams; but fat being only .9 as heavy, 2 cubic centimeters of it would weigh nine-tenths of two grams or 1.8 grams. This is exactly 10% of 18 grams, the weight of the sample used for testing. A milk bottle is shown in Fig. 30.

C. Cream Bottles. These are graduated from 30% to 55%. A 30% bottle is shown in Fig. 31. Since cream usually tests more than 30%, the sample must be divided when the 30% bottles are used.

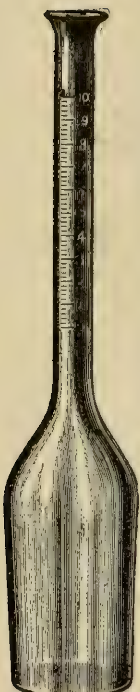


Fig. 30.—Milk bottle.

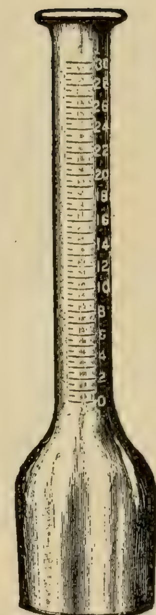


Fig. 31.—Cream bottle.

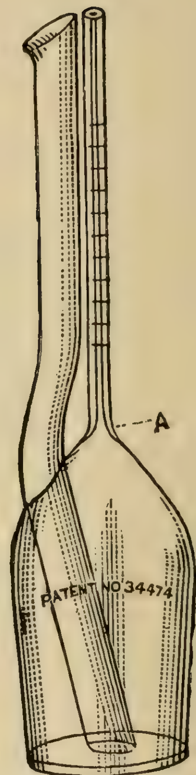


Fig. 32.—Skim-milk bottle.

D. Skim-milk Bottle. This bottle, shown in Fig. 32, is provided with a double neck, a large one to admit the milk, and a smaller graduated neck for fat reading. The entire scale reads one-half per cent. Being divided into ten subdivisions each subdivision reads .05%. The same bottle is also used for testing buttermilk.

Fig. 33.—Pipette.

Fig. 34.—Acid measure.

Fig. 35.—Acid measure.

E. Pipette. This holds 17.6 c.c., as shown in Fig. 33. Since about .1 c.c. of milk will adhere to the inside of the pipette it is expected to deliver only 17.5 c.c., which is equivalent to 18 grams of normal milk.

F. Acid Measures. In making a Babcock test equal quantities, by volume, of acid and milk are used. The acid measure, shown in Fig. 34, holds 17.5 c.c. of acid, the amount needed for one test. The one shown in Fig. 35 is divided into six divisions, each of which holds 17.5 c.c. or one charge of acid. Where many tests are made a graduate of this kind saves time in filling, but should be made to hold twenty-five charges.

H. A cream scales commonly used is illustrated in Fig. 36.

Acid. The acid used in the test is commercial sul-

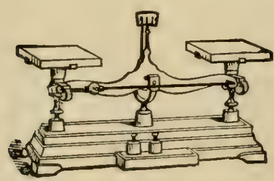


Fig. 36.—Cream scales.

phuric acid having a specific gravity of 1.82 to 1.83. When the specific gravity of the acid falls below 1.82 the milk solids are not properly burned and particles of curd may appear in the fat. On the other hand, an acid with a specific gravity above 1.83 has a tendency to blacken or char the fat.

The sulphuric acid, besides burning the solids not fat, facilitates the separation of the fat by raising the specific gravity of the medium in which it floats.

Sulphuric acid must be kept in glass bottles provided with glass stoppers. Exposure to the air materially weakens it.

Fig. 37.—Showing manner of emptying pipette.

Making a Babcock Test. The different steps are indicated as follows:

1. Thoroughly mix the sample.

2. Immediately after mixing insert the pipette into the milk and suck until the milk has gone above the mark on the pipette, then quickly place the fore finger over the

top and allow the milk to run down to the mark by slowly relieving the pressure of the finger.

3. Empty the milk into the bottle in the manner shown in Fig. 37.

4. Add the acid in the same manner in which the milk was emptied into the bottle.

5. Mix the acid with the milk by giving the bottle a slow rotary motion.

6. Allow mixture to stand a few minutes.

7. Shake or mix again and then place the bottle in the tester.

8. Run tester four minutes at the proper speed.

9. Add moderately hot water until contents come to the neck of the bottle.

10. Whirl one minute.

11. Add moderately hot water until contents of the bottle reach about the 8% mark.

12. Whirl one minute.

13. Read test.

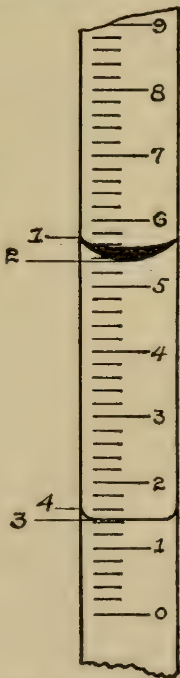


Fig. 38.—Fat column showing meniscuses.

How to Read the Test. At the top of the fat column is usually quite a pronounced meniscus as shown in Fig. 38. A less pronounced one is found at the bottom of the column. The fat should be read from the extremes of the fat column, 1 to 3, not from 2 to 4, when its temperature is about 140° F. Too high a temperature gives too high a reading, because of the expanded condition of the fat, while too low a temperature gives an uncertain reading.

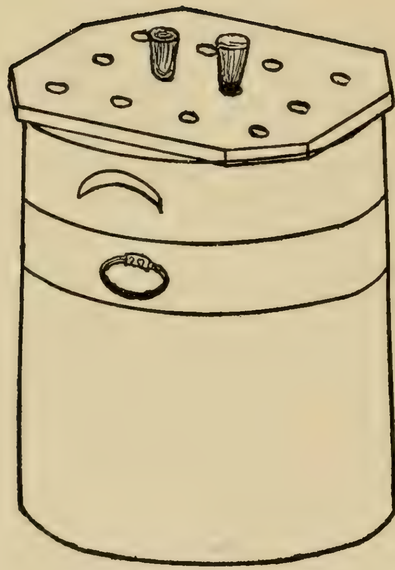


Fig. 39.—Waste acid jar.

Fig. 40.—Milk bottle tester.

Precautions in Making a Test. 1. Be sure you have a fair sample.

2. The temperature of the milk should be about 60 or 70 degrees.

3. Always mix twice after acid has been added.

4. Be sure your tester runs at the right speed.

5. Use nothing but clean, soft water in filling the bottles.

6. Be sure the tester does not jar.

7. Be sure the acid is of the right strength.

8. Mix as soon as acid is added to milk.

9. Do not allow the bottles to become cold before reading the test.

10. Read the test twice to insure a correct reading.

The water added to the test bottles after they have been whirled should be clean and pure. Water containing much lime seriously affects the test. Such water may be used, however, when first treated with a few drops of sulphuric acid.

As stated before skim-milk, buttermilk, and cream are tested in the same way as milk, with the exception that the cream sample is weighed not measured.

Cleaning Test Bottles. As soon as the test is read, the bottle should be emptied into an earthen jar (covered with a perforated board) by shaking it up and down so as to remove the white sediment. (Fig. 39.) It is now rinsed with one-third pipetteful of cleaning solution, which is made by dissolving about an ounce of potassium bichromate in one pint of sulphuric acid. Next run test bottle brush once up and down the neck of the bottle and finally rinse with hot water.

Testing or Calibrating Milk Bottles. Fill the bottle to the zero mark with water, or preferably wood alcohol to which a little coloring matter has been added. Immerse the lower section of the tester, shown in Fig. 40, in the contents of the bottle. If the bottle is correct, the contents will rise to the 5% mark. Next immerse both sections of the tester which will bring the contents to the 10% mark if the bottle is correctly calibrated.

It has been learned that the volume of the graduated part of the neck is 2 c.c. Each section of the tester is made to displace 1 c.c. when immersed in the liquid, hence the two sections will just fill the scale if the latter is correct.

Calculating Speed of Tester. The speed at which a tester must be run is dependent upon the diameter of the wheel carrying the bottles. The larger this wheel the fewer the revolutions it must make per minute to effect a complete separation of the fat.

In the following table by Farrington and Woll the necessary speed per given diameter is calculated:

Diameter of wheel in inches.	*No. of revolutions of wheel per minute.*
10	1,074
12	980
14	909
16	848
18	800
20	759
22	724
24	693

General Pointers. Black fat is caused by

1. Too strong acid.
2. Too much acid.
3. Too high a temperature of the acid or the milk.
4. Not mixing soon enough.
5. Dropping the acid through the milk.

Foam on top of fat is caused by hard water, and can be prevented by adding a few drops of sulphuric acid to the water.

Unclean or cloudy fat is caused by

1. Insufficient mixing.
2. Too low speed of tester.
3. Too low temperature.
4. Too weak acid.

Curd particles in fat are caused by

1. Too weak acid.
2. Not enough acid.
3. Too low temperature.

CHAPTER XIX.

BACTERIA AND MILK FERMENTATIONS.

A thorough knowledge of bacteria and their action forms the basis of success in butter making. Indeed the man who is lacking such knowledge is making butter in the dark; his is chance work. Much attention will therefore be given to the study of these organisms in this work.

I. BACTERIA.

The term bacteria is applied to the smallest of living plants, which can be seen only under the highest powers of the miscroscope. Each bacterium is made up of a single cell. These plants are so small that it would require 30,000 of them laid side by side to measure an inch. Their presence is almost universal, being found in the air, water, and soil; in cold, hot, and temperate climates; and in living and dead as well as inorganic matter.

Bacteria grow with marvelous rapidity. A single bacterium is capable of reproducing itself a million times in twenty-four hours. They reproduce either by a simple division of the mother cell, thus producing two new cells, or by spore formation in which case the contents of the mother cell are formed into a round mass called a spore. These spores have the power of withstanding unfavorable conditions to a remarkable extent, some being able to endure a temperature of 212° F. for several hours.

Most bacteria require for best growth a moist, warm, and nutritious medium such as is furnished by milk, in which an exceedingly varied and active life is possible.

In nature and in many of the arts and industries, bacteria are of the greatest utility, if not indispensable. They play a most important part in the disintegration of vegetable and animal matter, resolving compounds into their elemental constituents in which form they can again be built up and used as plant food. In the art of butter and cheese making bacteria are indispensable. The tobacco, tanning, and a host of other industries cannot flourish without them.

II. MILK FERMENTATIONS.

Definition. In defining fermentation processes, Conn says that, "In general, they are progressive chemical changes taking place under the influence of certain organic substances which are present in very small quantity in the fermenting mass."

With few exceptions, milk fermentations are the result of the growth and multiplication of various classes of bacteria. The souring of milk illustrates a typical fermentation, which is caused by the action of lactic acid bacteria upon the milk sugar breaking it up into lactic acid. Here the chemical change is conversion of sugar into lactic acid.

The most common fermentations of milk are the following:

- Milk Fermentations
  - Normal.....
    - Lactic.
    - Curdling and Digesting.
    - Butyric.
  - Abnormal...
    - Bitter.
    - Slimy or Ropy.
    - Gassy.
    - Toxic.
    - Chromogenic.

NORMAL FERMENTATIONS.

We speak of normal fermentations because milk always contains certain classes of bacteria even when drawn and kept under cleanly conditions. These fermentations will be discussed in the following pages.

I. LACTIC FERMENTATION.

This is the most common and by far the most important fermentation of milk. Indeed it is indispensable in the manufacture of butter of the highest quality. The germ causing this fermentation is called Lactici Acidi. It is non-spore bearing and has its optimum growth temperature between 90° and 98° F. At 40° its growth ceases. Exposed to a temperature of 140° for fifteen minutes it is killed.

The souring of milk and cream, as already mentioned, is due to the action of the lactic acid bacteria upon the milk sugar changing it into lactic acid. Acid is therefore always produced at the expense of milk sugar. But the sugar is never all converted into acid because the production of acid is limited. When the acidity reaches about .9% the lactic acid bacteria are either checked or killed and the production of acid ceases. Owing to the universal presence of these bacteria it is almost impossible to secure milk free from them.

Under cleanly conditions the lactic acid type of bacteria always predominates in milk. When, however, miik is drawn under uncleanly conditions the lactic organisms may be outnumbered by other species of bacteria which give rise to the numerous taints often met with in milk.

Contradictory as it may seem, the lactic acid bacteria are alike friend and foe to the butter maker. Creamery patrons are expected to have milk as free as possible from these germs so that it may arrive at the creamery in a sweet condition. They are therefore expected to thoroughly cool and care for it, not alone to suppress the action of the lactic acid bacteria but also that of the abnormal species that might have gained access to the milk.

While the acid bacteria are objectionable in milk, in cream made into butter they are indispensable. The highly desirable aroma in butter is the result of the growth of these organisms in the process of cream ripening. There are a number of different species of bacteria that have the power of producing lactic acid.

2. CURDLING AND DIGESTING FERMENTATION.

In point of numbers this class of bacteria ranks perhaps next to the lactic acid type. Indeed it is very difficult to obtain milk that does not contain them. It is not often, however, that their presence is noticeable owing to their inability to thrive in an acid medium.

According to bacteriologists most of these bacteria secrete two enzymes, one of which has the power of curdling milk, the other of digesting it. The former has the power of rennet, the latter of trypsin. "As a rule," says Russell, "any organism that possesses the digestive power, first causes a coagulation of the casein in a manner comparable to rennet."

It is only occasionally when the lactic acid organisms are in a great minority, or when for some reason their action has been suppressed, that this class of bacteria manfests itself by curdling milk while sweet. The curd thus formed differs from that produced by lactic acid in being soft and slimy.

Most of the curdling and digesting bacteria are spore bearing and can thus withstand unfavorable conditions better than the lactic acid bacteria. For this reason milk that has been heated sufficiently to kill the lactic acid bacteria, will often undergo the undesirable changes attributable to the digesting and curdling organisms.

3. BUTYRIC FERMENTATION.

It was mentioned that many bacteria have the power of producing lactic acid but that the true lactic acid fermentation is probably caused by a single species. So it is with the butyric acid bacteria. While a number of different organisms are known to produce this acid, Conn is of the opinion that the common butyric fermentation of milk and cream is due to a single species belonging to the anaerobic type.

The butyric acid produced by these organisms is the chief cause of rancid flavors in cream and butter. These bacteria are widely distributed in nature, being particularly abundant in filth. They are almost universally present in milk, from which they are hard to eradicate on account of their resistant spores. It is on account of these spores and their ability to grow in the absence of oxygen that the butyric fermentation is often found in ordinary sterilized milk from which the air has been excluded.

This class of bacteria has great significance in cream ripening and in the keeping quality of butter. In the ripening of cream the desirable flavor develops with the increase of acidity until the latter has reached .6%. When the development of acid goes beyond this, the flavor is no longer of the desirable kind but turns rancid as a result of the development of the butyric fermentation.

The butyric fermentation is rarely noticeable during the early stage of cream ripening and its subsequent development in a highly acid cream is explained by Russell as being "probably due, not so much to the presence of lactic acid, as to the absence of dissolved oxygen, which at this stage has been used up by the lactic acid organisms."

Butter that is apparently good in quality when freshly made, will usually turn rancid when kept at ordinary temperatures a short time. The quickness with which this change comes is dependent largely upon the amount of acid present in cream at the time of churning. Butter made from cream in which the maximum amount of acid consistent with good flavor has been developed, usually possesses poor keeping quality. This seems to indicate that at least part of the rancidity that develops in butter after it is made is due to the butyric acid bacteria, while light and air, doubtless, also contribute much to this end.

ABNORMAL FERMENTATIONS.

No trouble needs to be anticipated from these fermentations so long as cleanliness prevails in the dairy. The bacteria that belong to this class are usually associated with filth, and dairies that become infested with them show a lack of cleanliness in the care and handling of the milk. Since milk is frequently infected with one or another of these abnormal fermentations a brief discussion will be given of the most important.

I. BITTER FERMENTATION.

Bitter milk and cream are quite common and there are several ways in which this bitterness is imparted: it may be due to strippers' milk and to certain classes of feeds and weeds, but most frequently to bacteria. This class of bacteria has not yet been studied very thoroughly but we know a great deal about it in a practical way. In milk and cream in which the action of the lactic acid germs has been suppressed by low temperatures, bitterness due to the development of the bitter fermentation is almost certain to be noticeable. When the temperature is such as to cause a rapid development of the lactic fermentation, the bitter fermentation is rarely, if ever, present. It is quite evident from this that the bitter organisms are capable of growing at much lower temperatures than the lactic and that so long as the latter are rapidly growing the bitter fermentation is held in check.

This teaches us that it is not safe to ripen cream below 60° F. The author has found that cream quickly ripened and then held at a temperature of 45° for twenty-four hours would show no tendency toward bitterness, while the same cream held sweet at 45° for twenty-four hours and then ripened would develop a bitter flavor. This indicates that the lactic acid is unfavorable to the development of the bitter fermentation.

The bitter germs produce spores capable of resisting the boiling temperature. This accounts for the bitter taste that often develops in boiled milk.

2. SLIMY OR ROPY FERMENTATION.

This is not a common fermentation and rarely causes trouble where cleanliness is practiced in the dairy. The bacteria that produce it are usually found in impure water, dust, and dung. These germs are antagonistic to the lactic organisms and for this reason milk infected with them sours with great difficulty.

The action of this class of bacteria is to increase the viscosity of milk, which in mild cases simply assumes a slimy appearance. In extreme cases, however, the milk develops into a ropy consistency, permitting it to be strung out in threads several feet long.

Slimy or ropy milk cannot be creamed and is therefore worthless in the manufacture of butter. Such milk should not be confused with gargety milk which is stringy when drawn from the cow. The bacteria belonging to this class are easily destroyed as they do not form spores.

3. GASSY FERMENTATION.

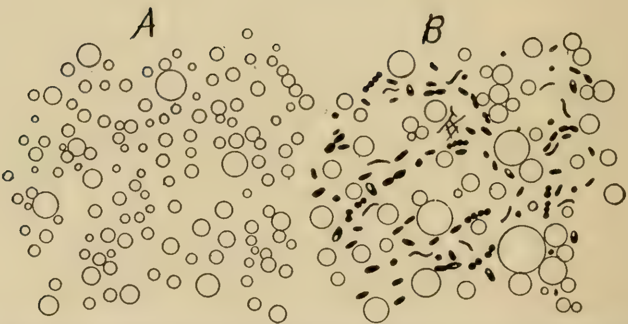
This is an exceedingly troublesome fermentation in cheese making and is also the cause of much poor flavored butter. The gas germs are very abundant during the warm summer months but are scarcely noticeable in winter. Like the bitter germs, they are antagonistic to the lactic acid bacteria and do not grow during the rapid development of the latter. They are found most abundantly in the barn, particularly in dung.

4. TOXIC FERMENTATIONS.

Toxic or poisonous products are occasionally developed in milk as a result of bacterial activity. They are most commonly found in milk that has been kept for some time at low temperature.

5. CHROMOGENIC FERMENTATIONS.

Bacteria belonging to this class have the power of imparting to milk various colors. The most common of these is blue. It is, however, not often met with in dairy practice since the color usually does not appear until the milk is several days old. The specific organism that causes blue milk has been known for more than half a century and is called cyanogenous. Another color that rarely turns up in dairy practice is produced by a germ known as prodigiosis, causing milk to turn red. Other colors are produced such as yellow, green, and black, but these are of very rare occurrence.



Microscopic appearance of pure and impure milk. A, Pure milk ; B, after standing in a wash room for a few hours in a dirty dish, showing, besides the fat globules, many forms of bacteria.—Moore.

CHAPTER XX.

SANITARY MILK PRODUCTION.

Sanitary Milk Defined. Sanitary milk is milk from healthy cows, produced and handled under conditions in which contamination from filth, bad odors, and bacteria, is reduced to a minimum.

Importance of Sanitary Milk. The production of clean milk is one of the most important subjects that confronts the American dairyman at the present time. Further improvement in the quality of butter and cheese must largely be sought in the use of cleaner milk. With the better appreciation by the public of the great nutritive value of milk, there opens an unlimited market for it for consumption in the raw form. Already we find that milk produced under the best sanitary conditions sells for practically double that obtained under ordinary, more or less, slip-shod conditions. So great is the clamor for cleaner milk that any extra efforts expended in producing it are certain to be richly compensated.

The Necessary Conditions for the production of sanitary milk are as follows: (1) Healthy cows; (2) sanitary barn; (3) clean barn yard; (4) clean cows; (5) clean milkers; (6) clean milk vessels; (7) clean, wholesome feed; (8) pure water; (9) clean strainers; (10) dust-free stable air; (11) clean bedding; (12) milking with dry hands; (13) thorough cooling of milk after milking; (14) sanitary milk room.

Healthy Cows. The health of the cow is of prime importance in the production of sanitary milk. All milk from cows affected with contagious diseases should be rigidly excluded from the dairy. Aside from the general unfitness of such milk there is danger of the disease producing organisms getting into the milk. It has been found, for example, that cows whose udders are affected with tuberculosis, yield milk containing these organisms. The prevalence of this disease among cows at present makes it imperative to determine definitely whether or not cows are affected with the disease, by the application of the tuberculin test.

Any feverish condition of the cow tends to impart a feverish odor to the milk, which should therefore not be used. Especially important is it that milk from diseased udders, no matter what the character of the disease, be discarded.

Sanitary Barn. Light, ventilation, and ease of cleaning are essential to a sanitary dairy barn. The disinfectant action of an abundance of sunlight, secured by providing a large number of windows, is of the highest importance.

Of equal importance is a clean, pure atmosphere, secured by a continuous ventilating system. The fact that odors of any description are absorbed by milk with great avidity, sufficiently emphasises the great need of pure air.

To permit of easy cleaning, the barn floors and gutters should be built of concrete. They should be scrubbed daily, and care should be taken to keep the walls and ceiling free from dust and cobwebs. The feed boxes must also be cleaned after each feed.

The stalls should be of the simplest construction, to afford as little chance for lodgement of dust as possible. Furthermore, they should so fit the cows as to cause the latter to stand with their hind feet on the edge of the gutter, a matter of the highest importance in keeping cows clean.

The walls and ceiling should be as smooth as possible. Moreover, they should be frequently disinfected by means of a coat of whitewash. The latter gives the barn a striking sanitary appearance.

Clean Barn Yard. A clean, well drained barn yard is an essential factor in the production of sanitary milk. Where cows are obliged to wade in mire and filth, it is easy to foretell what the quality of the milk will be. To secure a good barn yard it must be covered with gravel or cinders, and should slope away from the barn. If the manure is not taken directly from the stable to the fields, it should be placed where the cows cannot have access to it.

Clean Cows. Where the barn and barn-yard are sanitary, cows may be expected to be reasonably clean. Yet cows that are apparently clean, may still be the means of infecting milk to no small degree. When we consider that every dust particle and every hair that drops into the milk may add hundreds, thousands, or even millions of bacteria to it, we realize the importance of taking every precaution to guard against contamination from this source.

To keep cows as free as possible from loose hair and dust particles they should be carded and brushed regularly once a day. This should be done after milking to avoid dust. Five to ten minutes before the cow is milked her udder and flanks should be gently washed with clean, tepid water, by using a clean sponge or cloth. This will allow sufficient time for any adhering drops of water to drip off, at the same time it will keep the udder and flanks sufficiently moist to prevent dislodgment of dust particles and hairs at milking time. This practically means that the milker must always have one or two cows washed ahead. He should be careful to wash his hands in clean water after each washing.

Under ordinary conditions the cow is the greatest source of milk contamination. The rubbing of the milker against her and the shaking of the udder will dislodge numerous dust particles and hairs unless the foregoing instructions are rigidly followed.

Attention should also be given to the cow's switch, which should be kept scrupulously clean. The usual switching during milking is no small matter in the contamination of milk when the switch is not clean.

Clean Milkers. Clothes which have been worn in the fields are not suitable for milking purposes. Every milker should be provided with a clean, white milking suit, consisting of cap, jacket and trousers. Such clothes can be bought ready made for one dollar; and, if frequently laundered, will materially aid in securing clean milk.

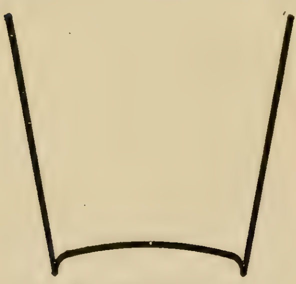


Fig. 42. Unflushed seam.

Fig. 43. Flushed seam.

Milkers should also wash and dry their hands before milking, and, above all, should keep them dry during milking.

Clean Vessels. All utensils used in the handling of milk should be made of good tin, with as few seams as possible. Wherever seams occur, they should be flushed with solder. Unflushed seams are difficult to clean, and, as a rule, afford good breeding places for bacteria. Fig. 42 illustrates the character of the unflushed seam; Fig. 43 shows a flushed seam, which fully illustrates its value.

Fig. 44 illustrates a modern sanitary milk pail. The value of a partially closed pail is evident from the reduced opening, which serves to keep out many of the micro-organisms that otherwise drop into the pail during

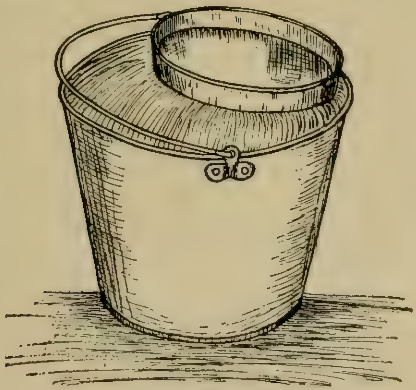


Fig. 44. Sanitary Milk Pail.

milking. While such a pail is somewhat more difficult to clean than the ordinary open pail, it is believed that the reduced contamination during milking far outweighs this disadvantage.

All utensils used in the handling of milk should be as nearly sterile as possible. A very desirable method of cleaning them is as follows:

First, rinse with warm or cold water. Second, scrub with moderately hot water containing some sal soda. The washing should be done with brushes rather than cloth because the bristles enter into any crevices present which the cloth cannot possibly reach. Furthermore, it is very difficult to keep the cloth clean. Third, scald thoroughly with steam or hot water, after rinsing out the water in which the sal soda was used. After scalding, the utensils should be inverted on the shelves without wiping and allowed to remain in this place until ready to use. This will leave the vessels in a practically sterile condition. Fourth, if it is possible to turn the inside of the vessels to the sun, in a place where there is no dust, then it is desirable to expose the utensils during the day to the strong germicidal action of the direct sun's rays.

Clean, Wholesome Feed. Highly fermented and aromated feeds, like sour brewers grains and leeks should be rigidly withheld from dairy cows when anything like good flavored milk is sought. So readily does milk absorb the odors of feeds through the system of the animal, that even good corn silage, when fed just previous to milking, will leave its odor in the milk. When fed after milking, however, no objection whatever can be raised against corn silage because not a trace of its odors are then found in the milk. Aromatic feeds of any kind should always be fed after milking.

Pure Water. Since feeds are known to transmit their odors to the milk through the cow, it is reasonable to expect water to do the same. Cows should, therefore, never be permitted to drink anything but pure, clean-flavored water. The need of pure water is further evident from the fact that it enters so largely into the composition of milk.

Clean Strainers. Since all milk passes through strainers it is of the highest importance to keep them sterile. Wire strainers with fine meshes are the most sanitary. Several thicknesses of cheese cloth will, however, answer the purpose very satisfactorily. Where cloth strainers are used they should be placed in boiling water a few minutes after being cleaned, and should then be spread out to dry in a sunny place as free as possible from dust.

Straining is frequently done under the illusion that so long as it removes all visible dirt the milk has been entirely purified. The real harm, however, that comes from hairs and dust particles dropping into the milk is not so much in the hairs and dust particles themselves as in the thousands and millions of germs which they carry with them into the milk. These germs are so small that no method of straining will remove them. In straining milk, therefore, we simply improve its appearance by removing the coarse, insoluable matter, but leave it entirely unchanged so far as the greater evil, the germ content, is concerned. Not only does straining not change the germ content of the milk in any way, but it also fails to remove any dirt which was dissolved in the milk previous to straining it.

Dust=Free Air. Great precaution should be taken not to create any dust in the stable about milking time, for this is certain to find its way into the milk. Cows should, therefore, never be bedded or receive any dusty feed just before or during milking.

Dry roughage, such as hay and corn fodder, always contains a considerable amount of dust, and when fed before or during milking may so charge the air with dust as to make clean milk an impossibility.

The importance of having the barn air clean should be evident from the fact that the milk must travel through about a foot of air before it reaches the milk pail.

Clean Bedding. It certainly seems nothing less than absurd for a man to sweep and dust and scrub his barn with great care and then immediately go to work and bring into the barn a great mass of the worst kind of dust-laden bedding. Yet such practices are not at all uncommon. Probably one of the filthiest bedding materials in common use in some sections is common leaves, raked up in the woods after they have been lying upon the ground for some weeks. A great deal of dirt always adheres to such leaves.

The stepping around on dirty bedding and lying on it a great share of the day, must inevitably result in a dusty barn air and in unclean cows.

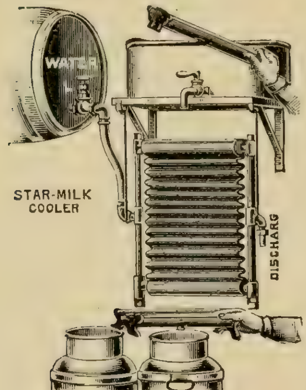


Fig. 45. Milk Cooler.

Milking With Dry Hands. A prolific source of milk contamination is the milking with wet hands. Where the milker wets his hands with milk, some of it is bound to drip into the pail, carrying with it thousands or millions of bacteria, depending upon the degree of cleanliness of the milker's hands and the cow's udder. There is no excuse for the filthy practice of wet milking, since it is just as easy, if not easier, to milk with dry hands.

Thorough Cooling of Milk After Milking. Immediately after milking the milk should be removed to a milk-room or milk-house with a clean, pure atmosphere, where it is aerated and cooled by running it first over an aerator and then over a cooler, or by running it over a combined aerator and cooler of the type shown in Fig. 45.

The barrel here shown is filled with cold water just previous to milking. By opening the valve at the barrel the water flows by gravity into the cooler, entering it at the bottom, where the milk receives the full benefit of the cold just before it leaves the cooler. The warm water discharges at the top. Coolers of this kind will cool

Fig. 46. Showing the effect of temperature upon bacteria growth. a, a single bacterium; b, its progeny in twenty-four hours in milk kept at 50° F.; c, its progeny in twenty-four hours in milk kept at 70° F. (Bul. 26, Storrs, Conn.)

milk to within five degrees of the temperature of the water.

Immediate and thorough cooling checks the growth of the bacteria that have unavoidably gained access to the milk, and thus materially prolongs its keeping quality. The effect of temperature on germ growth is forcibly illustrated in Fig. 46.

Where milk flows in thin sheets over a cooler it not only cools off very rapidly, but also comes into contact with the air sufficiently to make special aeration unnecessary.

Sanitary Milk Room. Since the milk in flowing over the cooler comes in contact with a great deal of air, it is of the highest importance that the air in the milk room be pure and germ-free.

The milk room should have a sunny location and should have a large window space to admit a maximum amount of sunlight. The floor and the first five or six feet of the wall should be constructed of concrete, so as to make possible easy and thorough cleaning. The remaining portion of the wall and the ceiling may be calcimined or receive some other smooth, hard finish.

An important part of a milk room is a separate wash-room. This room should be provided with shelves, some good cleaning substance, as sal soda, good scrub brushes, hot and cold water, and, if possible, steam. The shelves should be placed near windows where the tin-ware is exposed to the disinfectant action of sunlight.

The drainage from the milk room should be the very best, owing to the large quantity of waste and its fermentable nature.

Fore-Milk. Where the purest milk is sought, it is desirable to reject the first stream or two from each teat, as these contain many thousands of bacteria. The reason for this rich development of germs is found in the favorable conditions provided by the milk in the milk-ducts of the teats, to which the bacteria find ready access.

CHAPTER XXI.

FARM BUTTER-MAKING.

CREAMING.

Cause. Creaming is due to the difference in the specific gravity of the fat and the milk serum. The fat being light and insoluble rises, carrying with it some of the other constituents of the milk. The result is a layer of cream at the surface.

Processes of Creaming. The processes by which milk is creamed may be divided into two general classes: (1) That in which milk is placed in shallow pans or long narrow cans and allowed to set for about twenty-four hours, a process known as natural or gravity creaming; (2) that in which gravity is aided by subjecting the milk to centrifugal force, a process known as centrifugal creaming. The centrifugal force has the effect of increasing the force of gravity many thousands of times, thus causing an almost instantaneous creaming. This force is generated in the cream separator.

Shallow-Pan Method. The best results with this method are secured by straining the milk directly after milking into tin pans about twelve inches in diameter and two to four inches deep. It is then allowed to remain undisturbed at room temperature (60° to 65° F.) for twenty-four to thirty-six hours, after which the cream is removed either with a nearly flat, perforated skimmer, or by allowing it to glide over the edge of the pan after it has been carefully loosened along the sides. The average loss of fat in the skim milk by this method is 0.7%.

Deep-Cold-Setting Method. The best results with this method are secured by using a can like the *Cooley* illustrated in Fig. 47. This can is provided with a cover which allows it to be submerged in water. It also has a spout at the bottom by which the skim milk is gently removed, thus preventing the partial mixing of cream and skim milk incident to skimming with a conical dipper.

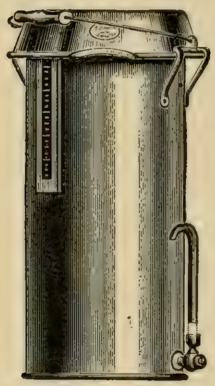


Fig. 47.—Cooley Can.

The milk is put into the cans directly after milking and cooled to as low a temperature as possible. To secure the best results with this method the water should be iced. Where this is done the skim milk will show only about 0.2% fat. It it desirable to allow the milk to set twenty-four hours before skimming, though usually the creaming is quite complete at the end of twelve or fifteen hours.

Dilution or Aquatic Separators. One of the most unsatisfactory methods of creaming is the addition of water to the milk. The creaming by this method is done in variously constructed tin cans, which the manufacturers usually sell under the name of dilution or aquatic separators. Those uninformed about the genuine centrifugal separators are often lead to believe that they are buying *real* separators at a low cost when they are investing five, ten or fifteen dollars in one of these tin cans, which are no more entitled to the term *separator* than are the common shallow pans. The average loss of fat with this system of creaming is about 1½%.

Centrifugal Method (Hand Separator). Dairies having four or more cows should cream their milk by the centrifugal method, the hand separator. The saving of butter fat with this method soon pays for the cost of a separator. Moreover it has the additional advantages over the gravity methods of creaming in providing fresh, sweet skim milk for feeding purposes, and yielding cream of any desired richness.

Efficiency of Creaming With a Separator. Under favorable conditions a separator should not leave more than .05% fat in the skim milk by the Babcock test There are a number of conditions that affect the efficiency of skimming and these must be duly considered in making a separator test. The following are some of these conditions:

A. Speed of bowl.
B. Steadiness of motion.
C. Temperature of milk.
D. Manner of heating milk.
E. Amount of milk skimmed per hour.
F. Acidity of milk.
G. Viscosity of milk.
H. Richness of cream.
I. Stage of lactation. (Stripper's milk.)

A. The greater the speed the more efficient the creaming, other conditions the same. It is important to see that the separator runs at full speed during the separating process.

B. A separator should run as smoothly as a top. The slightest trembling will increase the loss of fat in the skim milk. Trembling of bowl may be caused by any of the following conditions: (1) loose bearings, (2) separator out of plum, (3) dirty oil or dirty bearings, (4) unstable foundation, or (5) unbalanced bowl.

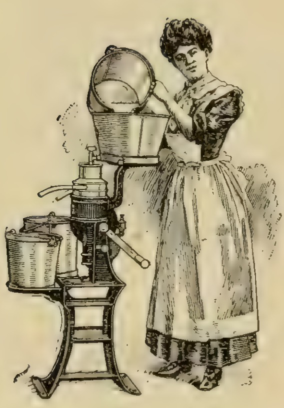


Fig. 48.—DeLaval Cream Separator.

Fig. 49.—Simplex Cream Separator.

C. The best skimming is not possible with any separator when the temperature falls below 60° F. A temperature of 85° F. is the most satisfactory for ordinary skimming. Under some conditions the cleanest skimming is obtained at temperatures above 100° F. The reason milk separates better at the higher temperatures is that the viscosity is reduced.

D. Sudden heating tends to increase the loss of fat in skim milk. The reason for this is that the fat heats more slowly than the milk serum which diminishes the difference between their densities. When, for example,

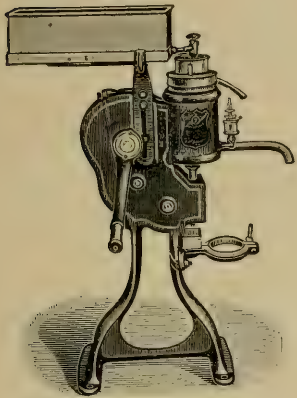


Fig. 50.—U. S. Cre am Separator.

Fig. 51.– Empire Separato.

milk is suddenly heated from near the freezing temperature to 85° F. by applying live steam, the loss of fat in the skim milk may be four times as great as it is under favorable conditions.

E. Unduly crowding a separator increases the loss of fat in the skim milk. On the other hand, a marked underfeeding is apt to lead to the same result.

Fig. 52.—
Sharples Cream Separator.

F. The higher the acidity of milk the poorer the creaming. With sour milk the loss of fat in the skim milk becomes very great.

G. Sometimes large numbers of undesirable (slimy) bacteria find entrance into milk and materially increase its viscosity. This results in very unsatisfactory creaming.

Low temperatures also increase the viscosity of milk which accounts for the poor skimming at these temperatures.

H. Most of the standard makes of separators will do satisfactory work when delivering cream of a richness of 50%. A richer cream is liable to result in a richer skim milk. The reason for this is that in rich cream the skim milk is taken close to the cream line where the skim milk is richest.

I. Owing to the very small size of the fat globules in stripper's milk, such milk is more difficult to cream than that produced in the early period of lactation.

Regulating Richness of Cream. The richness of cream is regulated by means of a cream screw in the separator bowl. When a rich cream is desired the opening in the screw is turned toward the center of the bowl, and for a thin cream it is turned away from the center.

Best Time to Separate Milk. The best results with a separator are obtained by running the milk through the machine immediately after milking.

CREAM RIPENING.

Cream ripening is a process of fermentation in which the lactic acid organisms play the chief role. In every-day language, cream ripening means the souring of the cream. So important is this process that the success or failure of the butter maker is largely determined by his ability to exercise the proper control over it. In common practice the time consumed in the ripening of cream varies from twelve to twenty-four hours.

Object. The ripening of cream has for its prime object the development of flavor and aroma in butter, two qualities usually expressed by the word flavor. In addition to this, cream ripening has several minor purposes, namely: (1) renders cream more easily churnable; (2) obviates difficulties from frothing or foaming in churning; (3) permits a higher churning temperature; (4) increases the keeping quality of butter.

Flavor. This, so far as known at the present time, is the result of the development of the lactic fermentation. If other fermentations aid in the production of this important quality of butter, they must be looked upon as secondary. In practice the degree or intensity of flavor is easily controlled by governing the formation of lactic acid. That is, the flavor develops gradually with the increase in the acidity of the cream. Sweet cream butter, for example, is almost entirely devoid of flavor, while cream with an average richness possesses the maximum amount of good flavor possible when the acidity has reached .6%.

Churnability. Practical experience shows that sour cream is more easily churnable than sweet cream. This is explained by the fact that the development of acid in cream tends to diminish its viscosity. The concussion produced in churning causes the little microscopic fat globules to flow together and coalesce, ultimately forming the small granules of butter visible in the churn. A high viscosity impedes the movement of these globules. It is evident, therefore, that anything that reduces the viscosity of cream, will facilitate the churning.

As a rule, too, the greater the churnability of cream the smaller the loss of fat in the buttermilk.

Frothing. Experience shows that ripened cream is less subject to frothing or foaming than unripened. This is probably due to the reduced viscosity of ripened cream and the consequent greater churnability of same.

Temperature. Sour cream can be churned at higher temperatures than sweet cream with less loss of fat in the buttermilk. This is of great practical importance since it is difficult to get low enough temperatures for the successful churning of sweet cream.

Keeping Quality. It has been found that butter with the best keeping quality is obtained from well ripened cream. It is true, however, that butter made from cream that has been ripened a little too far will possess very poor keeping quality. An acidity of .5% should be placed as the limit when good keeping quality is desired.

CONTROL OF THE RIPENING PROCESS.

We have learned that the highly desirable flavor and aroma of butter are produced by the development of the lactic fermentation. In the following discussion we shall take up the means of controlling this fermentation and treat of the more mechanical side of cream ripening. This will include: (1) the ripening temperature; (2) time in ripening; (3) agitation of cream during ripening.

Ripening Temperature. Since the lactic acid bacteria develop best at a temperature of 90° to 98° F. it would seem desirable to ripen cream at these temperatures. But this is not practicable because of the unfavorable effect of high temperatures on the body of the cream and the butter. Good butter can be produced, however, under a wide range of ripening temperatures. The limits may be placed at 60° and 80°. Temperatures below 60° are too unfavorable for the development of the lactic acid bacteria. Any check upon the growth of these germs increases the chances for the development of other kinds of bacteria. But it may be added that when cream has reached an acidity of .4% or more, the ripening may be finished at a temperature between 55° and 60° with good results. In general practice a temperature between 60° and 70° gives the best results. This means that the main portion of the ripening is done at this temperature. The ripening is always finished at temperatures lower than this.

Time in Ripening. As a rule quick ripening gives better results than slow. The reason for this is evident. Quick ripening means a rapid development of the lactic fermentation and, therefore, a relatively slow development of other fermentations. Practical experience shows us that the growth of the undesirable germs is slow in proportion as that of the lactic is rapid. For instance, when we attempt to ripen cream at 55° F., a temperature unfavorable for the growth of the lactic acid bacteria, a more or less bitter flavor is always the result. This is so because the bitter germs develop better at low temperatures than the lactic acid bacteria.

Stirring Cream. It is very essential in cream ripening to agitate the cream frequently to insure uniform ripening. When cream remains undisturbed for some time the fat rises in the same way that it does in milk, though in a less marked degree. The result is that the upper layers are richer than the lower and will sour less rapidly, since the action of the lactic acid germs is greater in thin than in rich cream.

This uneven ripening leads to a poor bodied cream. Instead of being smooth and glossy, it will appear coarse and curdy when poured from a dipper. The importance of stirring frequently during ripening should therefore not be underestimated.

The Use of Sour Milk (Starter). Cream produced under cleanly conditions ordinarily contains many kinds of bacteria—good, bad, and indifferent—and to insure a large predominance of the lactic acid type in the ripening process, it is necessary to reinforce the bacteria of this type already existing in the cream by adding large quantities of them in a pure form, that is, unmixed with undesirable species. Clean flavored sour milk or skim milk at the point of curdling is practically a pure culture of lactic acid organisms, and the addition of about 10 pounds of such milk to every 100 pounds of cream will result in a better and more uniform quality of butter.

Amount of Acid to Develop. Cream of average richness should have an acidity of from 0.5 to 0.6 per cent. when churned. A rich cream requires less acid than a thin cream.

Sweet and Sour Cream. In small dairies, where only a few churnings are made weekly, care should be taken never to mix sweet and sour cream just before churning. This always results in a heavy loss of fat in the buttermilk on account of the difference in the churnability of sweet and sour cream.

ACID TEST FOR CREAM.

Butter makers do not find it safe to rely upon their noses in determining the ripeness of cream for churning. They use in daily practice tests by which it is possible to determine the actual amount of acid present. The method of using these tests is based upon the simplest form of titration, which consists in *neutralizing* an *acid* with an *alkali* in the presence of an *indicator* which determines when the point of neutrality has been reached.

In the tests for acidity of cream the alkali used is sodium hydroxide. This is made up of a definite strength so that the amount of acid can be calculated from the amount of alkali used.

Farrington's Alkaline Tablet Test. In this test the alkali is used in a dry tablet form in which it is easily handled. Each tablet contains enough alkali to neutralize .034 gram of lactic acid.

Apparatus Used for the Test. This is shown in Fig. 53, and consists of a porcelain cup, one 17.6 c.c. pipette, and a 100 c.c. rubber-stoppered, graduated glass cylinder.

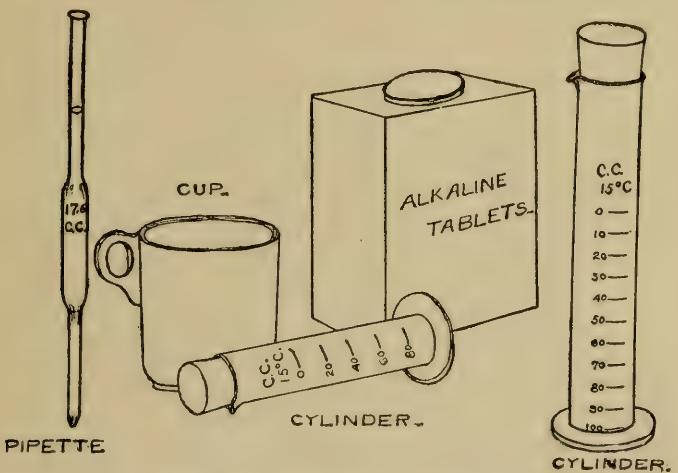


Fig. 53. Farrington Acid Test Apparatus.

Making the Solution. The solution is made in the graduated cylinder by dissolving 5 tablets in enough water to make 97 c.c. solution. When the tablets are dissolved, which takes from six to twelve hours, the solution should be well shaken and is then ready for use. The solution of the tablets may be hastened by placing the graduate in a reclining position, as shown in the cut.

Making the Test. With the pipette add 17.6 c.c. of cream to the cup, then with the same pipette add an equal amount of water. Now slowly add of the tablet solution, rotating the cup after each addition. As soon as a permanent pink color appears, the graduate is read and the number of c.c. solution used will indicate the number of hundredths of one per cent of acid in the cream. Thus, if it required 50 c.c. of the tablet solution to neutralize the cream then the amount of acid would be .50%. From this it will be seen that with the Farrington test no calculation of any kind is necessary.

CHURNING.

Theory. Under the physical properties of butter fat it was mentioned that this fat existed in milk in the form of extremely minute globules, numbering about 100,000,000 per drop of milk. In rich cream this number is increased at least a dozen times owing to the concentration of the fat globules during the separation of the milk.

So long as milk and cream remain undisturbed, the fat remains in this finely divided state without any tendency whatever to flow together. This tendency of the globules to remain separate was formerly ascribed to the supposed presence of a membrane around each globule. Later researches, however, have proven the falsity of this theory and we know now that this condition of the fat is due to the surface tension of the globules and to the dense layer of casein that surrounds them.

Any disturbance great enough to cause the globules to break through this caseous layer and overcome their surface tension will cause them to unite or coalesce, a process which we call *churning*. In the churning of cream this process of coalescing continues until the fat globules have united into masses visible in the churn as butter granules.

CONDITIONS THAT INFLUENCE CHURNING.

There are a number of conditions that have an important bearing upon the process of churning. These may be enumerated as follows:

1. Temperature.
2. Character of butter fat.
3. Acidity of cream.
4. Richness of cream.
5. Amount of cream in churn.
6. Speed of churn.
7. Abnormal fermentations.

1. Temperature. To have the miscroscopic globules unite in churning they must have a certain degree of softness or fluidity, which is greater the higher the temperature. Hence the higher the temperature, within certain limits, the quicker the churning. To secure the best results the temperature must be such as to churn the cream in from thirty to forty-five minutes. This is brought about in different creams at quite different temperatures.

The temperature at which cream must be churned is determined primarily by the character of the butter fat and partly also by the acidity and richness of the cream. Most cream is churned between 55 and 60 degrees Fahr.

Rule for Churning Temperature. A good rule to follow with regard to temperature is this: When the cream enters the churn with a richness of 30 per cent and an acidity of .5 to .6 per cent, the temperature should be such that the cream will churn in from thirty to forty-five minutes. This will insure an exhaustive churning and leave the butter in a condition in which it can be handled without injuring its texture. Moreover, the buttermilk can then be easily removed, so that when a plug is taken with a trier the day after it is churned the brine on it will be perfectly clear.

2. **Character of Butter Fat.** The fat globules in cream from different sources and at different times have the proper fluidity to unite at quite different temperatures. This is so because of the differences in the relative amount of "soft" and "hard" fats of which butter fat is composed. When the hard fats largely predominate the butter fat will, of course, have a high melting point. Such fat may be quite hard at a temperature of 60°, while a butter fat of a low melting point would be comparatively soft at this temperature. For a study of the conditions that influence the hardness of butter fat the reader is referred to the discussion of the "insoluble fats" treated in the chapter on milk.

3. **Acidity of Cream.** This has a marked influence on the churning process. Sour or ripened cream churns with much greater ease than sweet cream because the acid renders it less viscous. The ease with which the fat globules travel in cream becomes greater the less the viscosity. Ripe cream will therefore always churn more quickly than sweet cream. Ripe cream also permits of a higher churning temperature than sweet, which is of great practical importance where it is difficult to secure low churning temperatures.

4. **Richness of Cream.** It may naturally be inferred that the closer the fat globules are together the more quickly they will unite with the same amount of concussion. In rich cream the globules are very close together, which renders it more easily churnable than thin cream.

The former can therefore be churned in the same length of time at a lower temperature than the latter.

The ideal richness is about 30%. A cream much richer than this will stick to the sides of the churn, which reduces the amount of concussion. The addition of water to the churn will overcome this stickiness and cause the butter to come in a reasonable length of time. It is better, however, to avoid an excessive richness when a exhaustive churning is to be expected.

5. Amount of Cream in Churn. The best and quickest churning is secured when the churn is one-third full. With more or less cream than this, the amount of concussion is reduced and the length of time in churning correspondingly increased.

Fig. 54. – Dairy Thermometer.

6. Speed of Churn. The speed of the churn should be such as to produce the greatest possible agitation or concussion of the cream. Too high or too low a speed reduces the amount of concussion. The proper speed for each particular churn must be determined by experiment.

7. Abnormal Fermentations. The slimy or ropy fermentation sometimes causes trouble in churning by rendering the cream excessively viscous. Cream from single herds may become so viscous as to render churning impossible.

Dairy Thermometer. One of the essentials in making good butter is a thermometer like that shown in Fig. 54. It is necessary to watch the temperature of the cream during ripening, and to secure uniform and exhaustive churnings the temperature of the cream must always be definitely known before it enters the churn.

CHURNING OPERATIONS.

Churns. Of the numerous styles of churns upon the market there is none better than the barrel churn. For large dairymen, however, who have 50 or more cows, a combined churn and butter worker is recommended. Such churns, or course, require some form of power to run them, and no large dairy is expected to be without power.

Preparing the Churn. Before adding the cream, the churn should be scalded with hot water and then thoroughly rinsed with cold water. This will "freshen" the churn and fill the pores of the wood with water so that the cream and butter will not stick.

Fig. 55.—Barrel Churn.

Straining Cream. All cream should be carefully strained into the churn. This removes the possibility of white specks in butter which usually consist of curd or dried particles of cream.

Adding the Color. The amount of color to be added depends upon the kind of cream, the season of the year and the market demands.

Jersey or Guernsey cream requires much less color than Holstein because it contains more natural color.

During the summer when the cows are feeding on pastures the amount of color needed may be less than half that required in the winter when the cows are feeding on dry feed.

Different markets demand different shades of color. The butter must therefore be colored to suit the market to which it is shipped.

In the winter time about one ounce of color is required per one hundred pounds of butter. During the summer less than one-half ounce is usually sufficient.

In case the color is not added to the cream (through an oversight) it may be added to the butter at the time of working by thoroughly mixing it with the salt. When the colored salt has been evenly distributed through the butter the color will also be uniform throughout.

Gas in Churn. During the first five minutes of churning the vent of the churn should be opened occasionally to relieve the pressure developed inside. This pressure according to Babcock, "is chiefly due to the air within becoming saturated with moisture and not to gas set free from the cream."

Size of Granules. Butter should be churned until the granules are about half the size of a pea. When larger than this it is more difficult to remove the buttermilk and distribute the salt. When smaller, some of the fine grains are liable to pass out with the buttermilk, and the percentage of water in the butter is reduced. When the granules have reached the right size, cold water may be added to the churn to cause the butter to float better. Salt will answer the same purpose. The churn is now given two or three revolutions and the buttermilk drawn off.

Washing Butter. One washing in which as much water is used as there was cream is usually sufficient.

When butter churns very soft two washings may be advantageous. Too much washing is dangerous, however, as it removes the delicate flavor of the butter.

Too much emphasis cannot be laid upon the importance of using clean, pure water for washing. Experiments have shown that impure water seriously affects the flavor of butter. When the water is not perfectly pure it should be filtered or pasteurized.

Salting. It is needless to say that nothing but the best grades of salt should be used in butter. This means salt readily soluble in water and free from impurities. If there is much foreign matter in salt, it will leave a turbid appearance and a slight sediment when dissolved in a tumbler of clear water.

Object of Salting. Salt adds flavor to butter and materially increases its keeping quality. Very high salting, however, has a tendency to detract from the fine, delicate aroma of butter while at the same time it tends to cover up slight defects in the flavor. As a rule a butter maker will find it to his advantage to be able to salt his butter rather high.

Rate of Salt. The rate at which butter should be salted, other conditions the same, is dependent upon market demands. The butter maker must cater to the markets with regard to the amount of salt to use as he does with regard to color.

The rate of salt used does not necessarily determine the amount contained in butter. For instance it is perfectly possible under certain conditions to get a higher percentage of salt in butter by salting at the rate of one ounce per pound than is possible under other conditions by salting at the rate of one and a half ounces. This means that under some conditions of salting more salt is lost than under others.

The amount of salt retained in butter is dependent upon:

1. Amount of drainage before salting.
2. Fineness of butter granules.
3. Amount of butter in churn.

1. When the butter is salted before the wash water has had time to drain away, any extra amount of water remaining will wash out an extra amount of salt. It is good practice, however, to use a little extra salt and drain less before adding it as the salt will dissolve better under these conditions.

2. Small butter granules require more salt than large ones. The reason for this may be stated as follows: The surface of every butter granule is covered with a thin film of water, and since the total surface of a pound of small granules is greater than that of a pound of larger ones, the amount of water retained on them is greater. Small granules have therefore the same effect as insufficient drainage, namely, washing out more salt.

3. Relatively less salt will stick to the churn in large churnings than in small, consequently less will be lost.

Standard Rate. The average amount of salt used in butter is one ounce per pound.

WORKING BUTTER.

Object. The chief object in working butter is to evenly incorporate the salt. It also assists in expelling any surplus moisture.

How to Work Butter. Where only a small amount of butter is made, the butter may be worked with a ladle in the churn. For larger amounts it is desirable, however, to have a separate worker like that shown in Fig. 56.

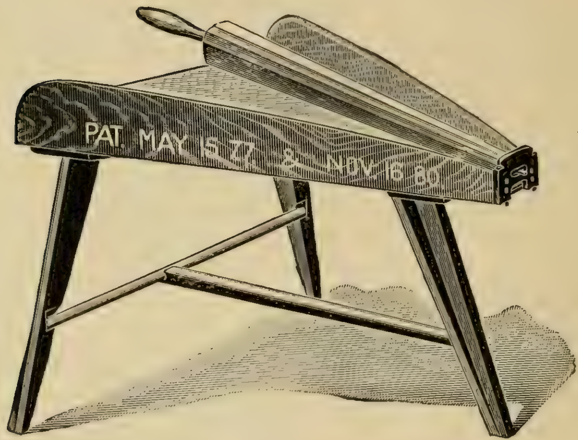


Fig. 56.—Butter worker.

Butter is worked enough when the salt has been evenly distributed. Just when this point has been reached can not always be told from the appearance of the butter immediately after working. But after four or six hours' standing the appearance of white streaks or mottles indicates that the butter has not been sufficiently worked. The rule to follow is to work the butter just enough to prevent the appearance of mottles. To avoid mottles it is best to work butter twice. The first time, it is worked

Fig. 57.—Butter Printer.

just enough to fairly incorporate the salt. It is then allowed to stand six or eight hours, after which white streaks are usually noticeable on cutting the butter with a string. The second working should cease as soon as these streaks or mottles have been removed.

Difficult Churning. The causes of trouble in churning may be enumerated as follows: (1) thin cream, (2) low temperature, (3) sweet cream, (4) high viscosity of cream, (5) churn too full, (6) too high or too low speed of churn, (7) colostrum milk, (8) advanced period of lactation, and (9) abnormally rich cream.

Foaming. This is usually due to churning a thin cream at too low a temperature, or to a high viscosity of the cream. When caused by these conditions foaming can usually be overcome by adding warm water to the churn. Foaming may also be caused by having the churn too full, in which case the cream should be divided and two churnings made instead of one.

Cleaning Churns. After the butter has been removed, the churn should be washed, first with moderately hot water, next with boiling hot water containing a little alkali, and finally with hot water. If the final rinsing is done with cold water the churn dries too slowly, which is apt to give it a musty smell. This daily washing should be supplemented occasionally with a washing with lime water.

Nothing is equal to the cleansing action of well prepared lime water and its frequent use will prevent the peculiar churn odor that is bound to develop in churns not so treated.

The outside of the churn should be thoroughly cleaned with moderately hot water containing a *small* amount of alkali.

Composition of Butter. According to analysis reported by various experiment stations. American butter has the following average composition:

	Per cent.
Water	13
Fat	83
Proteids	1
Salt	3

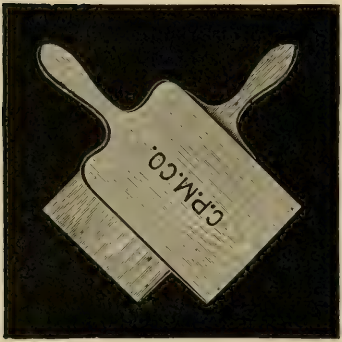


Fig. 58.—Butter Ladles.

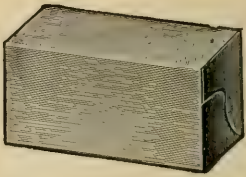


Fig. 59.—Butter Carton for Wrapping One-pound Butter Prints.

CHAPTER XXII.

FARM CHEESEMAKING.

Apparatus and Materials Needed. For dairies from 10 to 75 cows, the following list is recommended: Steam heating cheese vat; boiler; 1¾ inch press screws; cheese hoops; horizontal and perpendicular cheese knives; one gallon dipper; curd scoop; whisk broom; 100 cubic centimeter graduate; acid test; dairy thermometer; rennet extract; cheese color; cheese salt; bandages; press cloths; cheese cloth circles, and a small scales.

Ripening the Milk. Place the night's and morning's milk in the cheese vat and heat to a temperature of 86° F. Next determine the acidity of the milk with the Farrington test described on page 175. (Other tests may be used.) If less than 0.18% acid is found, the milk should be held to develop more acid. If very sweet it is desirable to add one or two pounds of good flavored, sour milk (starter, see p. 173) per 100 pounds. A good starter will not only hasten the ripening but will improve the flavor of the cheese.

Adding Color and Rennet Extract. As soon as the milk shows an acidity of 0.18% to 0.2% add color at the rate of one ounce (30 c. c.) per 1,000 pounds of milk and thoroughly mix. The amount of color to be used depends upon the season of the year, the market demands and the kind of milk. After the color is thoroughly incorporated, add rennet extract (curdling agent) at the rate of about four ounces (120 c. c.) per 1,000 pounds of milk. The rennet extract should be diluted with water to the extent of four or five times its own volume before adding it to the milk. After the rennet extract has been thoroughly stirred in, the milk should be allowed to stand undis-

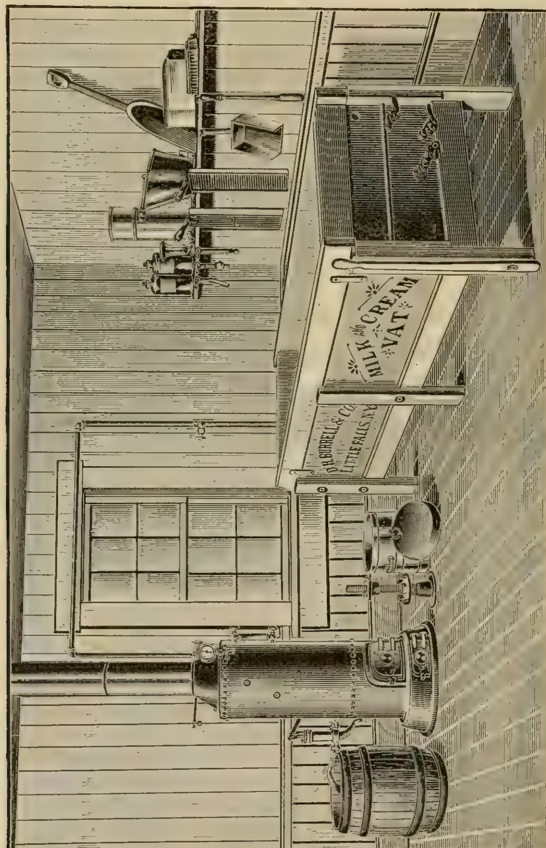


Fig. 60.—Cheesemaking Outfit.

turbed until sufficiently curdled to cut. The temperature at the time of adding the rennet should be 86° to 90° F.

The amount of rennet extract to be used is determined by the quickness with which the cheese is to ripen. If a quick ripening cheese is wanted, add 6 ounces per 1,000 pounds of milk. If a slow ripening cheese is desired, add 3 ounces for 1,000 pounds.

Cheese color and rennet extract are usually placed upon the market in liquid form. They are, however, also procurable in dry, tablet form in which they are preferred for making cheese on a small scale.

Cutting the Curd. To determine when the curd is ready to cut, insert the forefinger, slightly break the curd with the thumb, and move the finger in the direction of the break and parallel to, and half an inch below, the surface. If the whey in the break is clear, the curd is ready to cut; if milky, the curdling has not progressed far enough. The cutting is done as follows: First cut the curd in horizontal layers with the horizontal knife; next cut lengthwise and crosswise, alternately, with the perpendicular knife until the curd cubes are about three-eighths of an inch on a side.

Warming and Stirring the Curd. Immediately after cutting, stir the curd very gently, yet enough to prevent the particles from matting together. Run the palm of the hand along the sides and bottom of the vat to remove any adhering curd. After 10 minutes stirring, gradually apply heat and bring the temperature to 100° F. in about 30 minutes. After this temperature has been reached, the curd may be stirred at intervals of 10 minutes until ready to remove the whey. It is important to keep the temperature as close to 100° F. as possible.

Drawing Off the Whey. When a bunch of curd is pressed between the two hands and on relieving the pressure the particles fall apart readily, the curd is ready for the removal of the whey. When this firmness is reached, the whey should show about 0.17% acid. When the milk is set at the proper ripeness, the degree of firmness and amount of acid indicated above are reached in about two and one-half hours after adding the rennet extract.

Remove the whey through a faucet or by means of a siphon. Place a perforated wooden rack about two inches high at one end of the vat and cover it with a piece of muslin or cheese cloth. Scoop the curd upon the rack and stir. The rack has the advantage of draining the curd quickly and also permits the use of hot water under the curd to assist in keeping the temperature at 98° F., a temperature which should be maintained up to within 10 or 15 minutes of salting.

If a rather moist, open textured cheese is desired, stir 30 minutes after the removal of the whey and salt. In case a firm, close-textured cheese is wanted, the curd must be stirred at frequent intervals for a period of about two hours before salting, so as to allow more acid to develop. A firm cheese is especially desirable during warm weather because of its superior keeping quality.

When the milk is not of uniformly good quality, and when an especially close-textured and uniform cheese is desired, the curd should be allowed to mat upon the racks. This is accomplished as follows: As soon as removed from the whey the curd is stirred a few minutes, spread about six inches deep upon the rack, and then allowed to mat 15 minutes, after which it is cut into strips about 8 by 12 inches and then turned. After another 15 minutes, turn again and pile the strips two layers deep; 15 minutes later turn again and pile three layers deep. Usually after one and a half to two hours matting the curd tears like chicken breast, which indicates that it is ready to cut into little strips the size of a finger. This done, the curd is stirred about 30 minutes and then salted.

Salting. If a fast-curing cheese is desired, salt at the rate of 2¼ pounds of salt per 100 pounds of curd. When a slow-ripening cheese is desired salt at the rate of 2¾ pounds. Use only the best grade of salt, and have the curd at a temperature of about 90° F. at the time of salting.

Molding and Pressing. Twenty to thirty minutes after salting, the curd is ready for the hoops (molds) which are prepared as follows: Place a piece of muslin in the bottom of the hoop and on top of this a cheese cloth circle somewhat less in diameter than the hoop. Now place the bandage on the bandager so that when the latter is in position the bandage will lap slightly over the cheese cloth circle in the bottom of the hoop. Next put in the curd. This done, cover with a piece of muslin and put on the cover (follower). Apply pressure very gradually at the start and do not apply full pressure (about 20 lbs. to the square inch) until after 20 to 30 minutes' pressing. Shortly after full pressure has been applied, remove the follower, the muslin cloth, and bandager. Turn the projecting bandage over onto the cheese. Next place a cloth circle over the top, replace the muslin and bandager, and then apply full pressure for about 12 hours, when the cheese is taken out of the hoop, any folds or irregularities in the bandage are straightened out, the cheese is washed off with hot water, and put back into the hoop inverted. Press about ten hours longer and remove the cheese from the hoop and put it into a suitable place for curing. Leave the cheese cloth circles on the cheese.

Ripening or Curing. After leaving the press the cheese should be placed in a cool, damp room with ample ventilation. Keep the temperature as near 60° F. as possible. The curing or ripening process, which consists of the transformation of insoluble into soluble casein, requires from two to eight months, according to the amount of rennet extract and salt used, amount of moisture in the cheese, and the temperature at which it is ripened. The higher the temperature and moisture, the quicker the cheese will ripen. During the first three weeks the cheese should be turned and rubbed daily, and if any portion of it is not covered with cheese cloth, grease should be applied to prevent cracking. If the curing room is dry, the cheese should be covered with a thin layer of paraffine about a week after it is made, to prevent excessive loss of moisture.

Composition. Cured cheddar cheese has the following average composition: Water, 34% ; fat, 36.5% ; proteids, 26% ; and ash, 3.5%.

CHAPTER XXIII.

MARKETING DAIRY PRODUCTS.

Marketing Butter. Where it is difficult to keep butter cool until it reaches the consumer, there is no better package in which to market it than the common glazed stone jars. These packages are especially to be recommended for local trade. For fancy trade, one-pound prints wrapped in parchment paper are the most popular. These prints are made with a small hand printer (Fig. 57) which should have the manufacturer's monogram cut into it. The imprint of the monogram in the butter will serve as a guarantee of its genuineness. It is also desirable to have some neat lettering on the parchment wrapper, such, for example, as Fancy Dairy Butter, Cold Spring Dairy Butter, Golden Jersey Butter, etc. Prints must be kept cold to preserve their attractive rectangular appearance.

Where butter is made in rather large quantity and shipped some distance without ice, the regular ten or twenty-pound wooden tub is the most satisfactory. These tubs should be scalded in hot water and then soaked in cold water several hours before using. When treated in this way and lined with parchment paper, thoroughly soaked in salt brine, butter will keep remarkably well in these packages. Other packages are found on the market, such as the Gem fibre parchment lined pasteboard boxes, and the Bradley wooden boxes holding from two to ten pounds each.

With the small butter producer the greatest trouble is finding a suitable market for his product. It is customary with most of these producers to sell their butter to the country grocer, who, as a rule, makes little discrimination in the quality of the butter, the good and the poor selling for practically the same price. No producer of good butter can afford to market his butter in the country stores. Those who have made farm butter-making a success have invariably catered to private trade, or have sold their butter to well-known butter dealers. A great deal of butter could be sold in villages, towns, and cities at 25 and 30 cents a pound which would bring only 12 or 15 cents in the country stores. Seek, therefore, private customers who are willing to pay for a good product, and if these are not within easy reach by road, try to reach them by rail. Ten pounds of butter may easily be sent fifty or sixty miles by express for 25 cents. Twenty pounds may be sent for about 30 cents; and it is possible to send fifteen and twenty-pound packages 150 miles for 50 cents. It is certainly a business proposition rather to pay 3 or even 4 cents a pound expressage than to lose 10 or 15 cents a pound by selling it to the country grocer.

Marketing Milk and Cream. Next to cleanliness, a low temperature is of the greatest importance in marketing either milk or cream. The temperature should be reduced to 45° F. or below as soon as possible after milking. This can be accomplished by first running cold water through a cooler like that shown in Fig. 45, or by using a combined uniced water and iced water cooler in which the cooling is accomplished in one operation. It is a matter of economy first to cool milk to as low a temperature as possible with uniced water.

If intended for retail trade, the milk and cream should be bottled immediately after cooling, using bottles like that shown in Fig. 62. If cream is to be shipped in bulk for manufacture into ice cream and other uses, it should be put into insulated shipping cans like that shown in Fig. 61. This can has a heavy layer of felt between the inner, tin surface and the outer, wooden jacket, which makes it possible to maintain a low temperature for a long time. The can is provided with two covers, one of

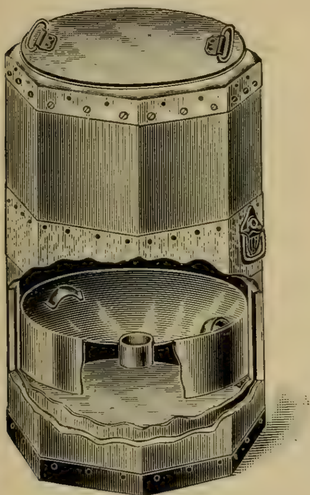


Fig. 61.—Insulated Cream Can.

Fig. 62.—Milk and Cream Bottle.

which can be pushed down to the level of the cream to prevent churning.

The Most Profitable Market. Many milk producers are so situated as to make it possible for them to patronize a creamery or a cheese factory, or to sell milk and cream for retail purposes. To those so situated the question naturally arises, what method of disposal will yield the greatest returns? In general this may be decided from a calculation as follows, using 100 pounds of 4% milk as a basis of calculation:

One hundred pounds of 4% milk will make 4 2-3 pounds of butter, which, at 25 cents per pound, is worth $1.17. The same milk will make two gallons of 25% cream, which, at $1.00 per gallon, is worth $2.00. If sold as milk at 6 cents per quart, the 100 pounds of milk will be worth $2.80 (a quart of milk weighs 2.15 pounds); and if made into cheese at 10 cents per pound the milk will be worth $1.00.

At the prices stated, the returns are greatest when the milk is retailed by the quart, but it should be remembered that this leaves no skim-milk for feeding purposes. The skim-milk also contains nearly all of the fertilizing constituents which are lost to the producer when retailing milk. Moreover in selling milk and cream for retail purposes the extra labor and cost in cooling and handling must be considered. In this connection it may also be stated that skim-milk has practically twice the feeding value of whey.

Standard Weight of a Gallon of Milk and Cream. Milk of average quality weighs 8.6 pounds per gallon. The weight of a gallon of cream varies with its richness. The richer the cream the lighter. Cream testing from 25 to 30% fat has practically the same specific gravity as water and therefore weighs 8.35 pounds, the weight of a standard gallon of water. Cream testing higher will weigh less, and that testing lower will weigh more than 8.35 pounds per gallon.

Standardizing Milk and Cream. This means bringing milk and cream to a definite percentage of butterfat. If the milk and cream are too low in fat, extract skim-milk or add cream until the desired richness is reached. If too rich, add skim-milk or extract cream. It is desirable both from the standpoint of the consumer and the producer to have all milk and cream standardized.

Formulas for Standardizing Milk and Cream. Problem I: The producer contracts to deliver 450 pounds of milk testing 4.0% fat. His milk as it comes from the herd tests 4.3%. How much skim-milk must he add to this to reduce it to 4.0%?

Formula: $X = \left(\frac{A \times B}{C}\right) - A$, in which

X = No. lbs. skim-milk to be added.
A = No. lbs. original milk.
B = test of original milk.
C = test desired.

Substituting we get,

$$X = \left(\frac{450 \times 4.3}{4.0}\right) - 450 = 33.75 \text{ lbs.}$$

Problem II: Suppose that the 450 pounds of milk tested 4.0% and it is desired to raise it to 4.5% by extracting skim-milk; the amount of skim-milk to be extracted is determined from the following formula:

$X = A - \left(\frac{A \times B}{C}\right)$, in which X = No. lbs. of skim-milk to be extracted, and A, B, and C are the same as in the preceding formula.

Substituting we get,

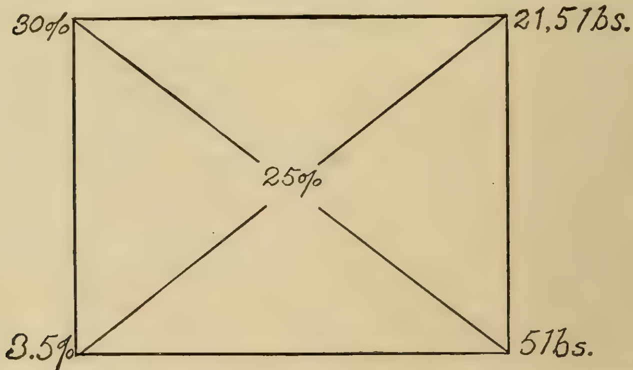
$$X = 450 - \left(\frac{450 \times 4.0}{4.5}\right) = 50 \text{ lbs.}$$

The test of cream can be raised or lowered in the same way, by the use of the preceding two formulas.

When it is desired to standardize milk or cream by using milks or creams of different richness, the following method recommended by R. A. Pearson is the simplest:

Draw a square with two diagonals, as shown below. At the left hand corners place the tests of the milks or creams to be mixed. In the center place the richness desired. At the right hand corners place the differences between the two numbers in line with these corners. The number at the upper right hand corner represents the number of pounds of milk or cream to use with the richness indicated in the upper left hand corner. Likewise the number at the lower right hand corner represents the number of pounds of milk or cream to use, with the richness indicated in the lower left hand corner.

Example: How many pounds each of 30% cream and 3.5% milk required to make 25% cream?



21.5, the difference between 3.5 and 25, is the number of pounds of 30% cream needed; and 5, the difference between 25 and 30, is the number of pounds of 3.5% milk needed.

The Value of Advertising. To secure fancy prices for dairy products, it is necessary in the first place to have products of a superior quality. In addition, the particular merits possessed by the products must be forcibly brought to the attention of the consumers. Here is where advertising counts as in any other business.

If the milk is produced in clean, ventilated, whitewashed stables, and from cows which are clean and regularly tested for tuberculosis, and if, in addition, all this is certified to by a competent inspector, an increase in prices and patronage is certain to follow. The majority of consumers in the city have little conception of the average conditions under which milk is produced, and for this reason the man who is producing milk under the best sanitary conditions will find it highly profitable to place in contrast before his customers vivid pictures of the conditions that yield *average* milk and those that yield *sanitary* milk.

Fig. 63.—Box for Carrying Print Butter.

Fig. 64.—Box for Carrying Print Butter.

Fig. 65.—Jacketed Can for Shipping Cr eam.

Fig. 66.—Milk Can.

CHAPTER XXIV.

MACHINE MILKING.

Recent results secured by experiment stations and numerous large dairymen indicate that the milking machine will be an important factor in future dairying. The testimonials from these sources show that machines milk fully as satisfactorily as average hand milkers; and since one attendant can milk four to six cows at the same time, there is a material saving in labor, besides making labor more agreeable. Moreover cleaner milk is possible with machine milking.

Principle of Operation. Milking by machine is accomplished by suction similar to that produced by a sucking calf. The suction is intermittent and is created by producing a partial vacuum in a system of pipes to which the milking machines are attached during milking.

Fig. 67. Milking Machine in operation.

Apparatus. The necessary apparatus for machine milking consists of a milker, which includes a tin pail, teat cups, etc.; a vacuum pump; some form of power; a vacuum reservoir; two vacuum gauges; a safety valve; and about 150 feet of gas pipes. Each machine milks two cows.

Cost of Apparatus. The following may be considered an approximate estimate of the cost of a milking outfit for about 30 cows: Two milkers, $180; vacuum pump, $50; vacuum reservoir, including two vacuum gauges and a safety valve, $35; a two horse power gasoline engine, $85; and pipes and piping, $50; The cost of pipes depends largely upon the distance of the power from the barn. It is not necessary to have the power in the barn or even near it. (See Chapter on Farm Power.)

Operating Machine. When ready to begin milking start the vacuum pump and place a milker between two cows and open valve on main vacuum pipe. Bend over teat cups and attach one by one to one cow and then proceed to do the same with the other. Similarly attach one or two more milkers, so as to keep four to six cows milking at the same time. A short glass tube at the machine shows when the milking is completed.

The mouthpieces on the teat cups must be of a size to correspond with the size of the teats. They must be neither too small nor too large. It is important, also, that the piping system be kept air tight and free from moisture.

Details concerning the installation and operation of the machines may be had for the asking by writing to the manufacturers.

APPENDIX.

Period of Gestation. This refers to the time which elapses between conception and calving. The average period of gestation of a cow is 283 days.

Frequency of Heat. As a rule non-pregnant cows will come in heat every 21 days. The period of heat lasts from 2 to 3 days.

Metric System of Weights and Measures. This system was devised by the French people and has very extensive application wherever accuracy in weights and measures is desired. Some of its equivalents in ordinary weights and measures are given in the following table:

Ordinary weights and measures.	Equivalents in metric system.
1 ounce (av)	28 35 grams.
1 quart	0 9464 liter.
1 gallon	3.7854 liters.
1 fluid ounce	29.57 cubic centimeters (c.c.)
1 pound (av.)	0.4536 kilogram.
1 grain	64.8 milligrams.
1 inch	2 54 centimeters.
1 foot	0.3048 meter.

ADDRESSES OF DAIRY CATTLE BREEDERS' ASSOCIATIONS.

Breed.	Secretary.	Postoffice.
Jersey	J. J. Hemingway	8 W. 17th st., New York, N. Y.
Guernsey	Wm. H. Caldwell	Peterboro, N. H.
Holstein-Friesian	F. L. Houghton	Brattleboro, Vt.
Ayrshire	C. M. Winslow	Brandon, Vt.

Rations According to Yield of Milk. The Connecticut (Storrs) standard rations for varying yields of milk are shown in the following table:

TABLE—FEEDING STANDARDS.

When giving daily.	Live weight, pounds.	Daily, per 1,000 pounds of live weight.				
		Total dry matter, pounds.	Digestible nutrients, pounds.			Nutritive ratio.
			Protein.	Carbohydrates.	Fat.	
10-20 lbs. milk.	700-950	20 22	2.0	10 12	0.3 0 5	1:6.0
20-25 " "	700-950	21-23	2 3	10-12	0.4 0.6	1:5.3
25-30 " "	700 950	21-23	2.6	10 12	0.4-0.6	1:4.7
30 35 " "	700 950	22-24	2.9	11-13	0.5-0 7	1:4.6
35-40 " "	700 950	22 24	3.2	11-13	0.5-0.7	1:4.2
10-20 " "	950-1100	22-24	2.3	12-14	0.4-0 6	1:6.1
20 25 " "	950-1100	22-25	2.6	12-14	0 5 0.7	1:5.5
25-30 " "	950-1100	23-25	2.9	12-14	0.5 0.7	1:5.0
30-35 " "	950-1100	24 26	3 2	13 15	0 6 0.8	1:4 9
35-40 " "	950-1100	24 26	3.5	13-15	0.6-0.8	1:4.4

Scale of Points for Judging Butter. Butter is judged commercially on the basis of 45 points for flavor, 25 for texture, 15 for color, 10 for salt, and 5 for package, total 100.

Scale of Points for Judging Cheese. Cheese, as a rule, is judged commercially on the basis of 45 points for flavor, 30 for texture, 10 for salt, 10 for color, and 5 for appearance, total 100.

Milk Solids. The solids of milk include everything but the water. If a sample of milk be kept at the boiling temperature until all the water is evaporated, the dry, solid residue that remains constitutes the solids of milk. It is convenient to divide the solids into two classes, one including all the fat, the other all the solids which are not fat. In referring, therefore, to the different solids of milk, we speak of the "fat" and the "solids-not-fat" which, together, constitute the "total solids."

Relationship of Fat and Solids-not-Fat. In normal milk a fairly definite relationship exists between the fat and the solids-not-fat. For example, milk rich in fat is likewise rich in solids-not-fat. On the other hand, milk poor in fat is also poor in solids-not-fat. Hence the justice of paying for milk, delivered to cheese factories, on the butterfat basis. See table on page 133.

Composition of Cream. Cream contains all the constituents found in milk, though not in the same proportion. The fat may vary from 8% to 68%. As the cream grows richer in fat it becomes poorer in solids-not-fat. Richmond reports the following analysis of a thick cream:

	Per cent.
Water	39.37
Fat	56.09
Sugar	2.29
Proteids	1.57
Ash	.38

Capacity of Cylindrical Siloes. The approximate capacity of cylindrical siloes for well-matured corn silage is shown in the following table:

TABLE—CAPACITY OF CYLINDRICAL SILOES, TONS.*

Depth of silo, feet.	Inside diameter of silo, feet.												
	10	12	14	15	16	18	20	21	22	23	24	25	26
20	26	38	51	59	67	85	105	115	127	138	151	163	177
21	28	40	55	63	72	91	112	123	135	148	161	175	189
22	30	43	59	67	77	97	120	132	145	158	172	187	202
23	32	46	62	72	82	103	128	141	154	169	184	199	216
24	34	49	66	76	87	110	135	149	164	179	195	212	229
25	36	52	70	81	90	116	143	158	173	190	206	224	242
26	38	55	74	85	97	123	152	168	184	201	219	237	257
27	40	58	78	90	103	130	160	177	194	212	231	251	271
28	42	61	83	95	108	137	169	186	204	223	243	264	285
29	45	64	88	100	114	144	178	196	215	235	265	278	300
30	47	68	93	105	119	151	187	206	226	247	269	292	315
31	49	70	96	110	125	158	195	215	236	258	282	305	330
32	51	73	101	115	131	166	205	226	248	271	295	320	346

*From Modern Silage Methods.

Pasteurization of Milk. Where no ice is available, the keeping quality of milk may be materially prolonged by a process of heating and cooling known as pasteurization. This process consists in exposing milk to a temperature of about 150 degrees F. for thirty minutes, after which it is immediately cooled to the lowest temperature possible with water. This treatment destroys practically all of the bacteria in milk and thus not only materially increases its keeping quality, but also renders it free from harmful or disease-producing bacteria.

Definition of Technical Terms. A list of technical terms not specially defined in the text is presented below:

ALBUMENOIDS.—Substances rich in albumen, like the white of an egg, which is nearly pure albumen.

ANAEROBIC.—Living without free oxygen.

CENTRIFUGAL FORCE.—That force by which a body moving in a curve tends to fly off from the axis of motion.

CHEMICAL COMPOSITION.—This refers to the elements or substances of which a body is composed.

COLLOIDAL.—Resembling glue or jelly.

CONCUSSION.—The act of shaking or agitating.

CUBIC CENTIMETER (c. c.).—See metric system p. 203.

EMULSION.—A mixture of oil (fat) and water containing sugar or some mucilaginous substance.

ENZYMES.—Unorganized ferments, or ferments that do not possess life.

FIBRIN.—A substance which at ordinary temperatures forms a fine network through milk which impedes the rising of the fat globules.

FOREMILK.—The first few streams of milk drawn from each teat.

GALACTASE.—An unorganized ferment in milk which digests casein.

MAMMARY GLAND.—The organ which secrets milk.

MENISCUS.—A body curved like a first quarter moon.

MILK SERUM.—Milk free from fat. Thus, skim-milk is nearly pure milk serum.

NEUTRAL.—Possessing neither acid nor alkaline properties.

NON-CONDUCTOR.—A material which does not conduct heat or cold, or only so with great difficulty.

OSMOSIS.—The tendency in fluids to diffuse or pass through membranes.

RENNET EXTRACT.—The curdling and digesting principle of calf stomach.

SECRETION.—The act of separating or producing from the blood by the vital economy.

SPECIFIC GRAVITY.—The weight of one body as compared with an equal volume of some other body taken as a standard.

SPORE.—The resting or non-vegetative stage of certain kinds of bacteria.

STERILIZATION.—The process of destroying all germ life by the application of heat near 212° F.

STRIPPERS' MILK.—The milk from cows far advanced in the period of lactation.

STRIPPINGS.—The last few streams of milk drawn from each teat.

SUSPENSION.—The state of being held mechanically in a liquid, like butter fat in milk.

TUBERCULIN.—A sterile glycerine extract of the growth products of the tubercule bacillus.

VACUUM.—Space devoid of air.

VEGETATIVE BACTERIA.—Those bacteria that are in an actively growing condition.

VISCOSITY.—The quality of being sticky; stickiness.

VOLATILE.—The state of wasting away on exposure to the atmosphere. Easily passing into vapor, like ammonia.

WHOLE MILK.—Milk which has neither been watered nor skimmed.

INDEX.