DAIRY FARMING

ECKLES AND WARREN

FARM SERIES

DAIRY FARMING

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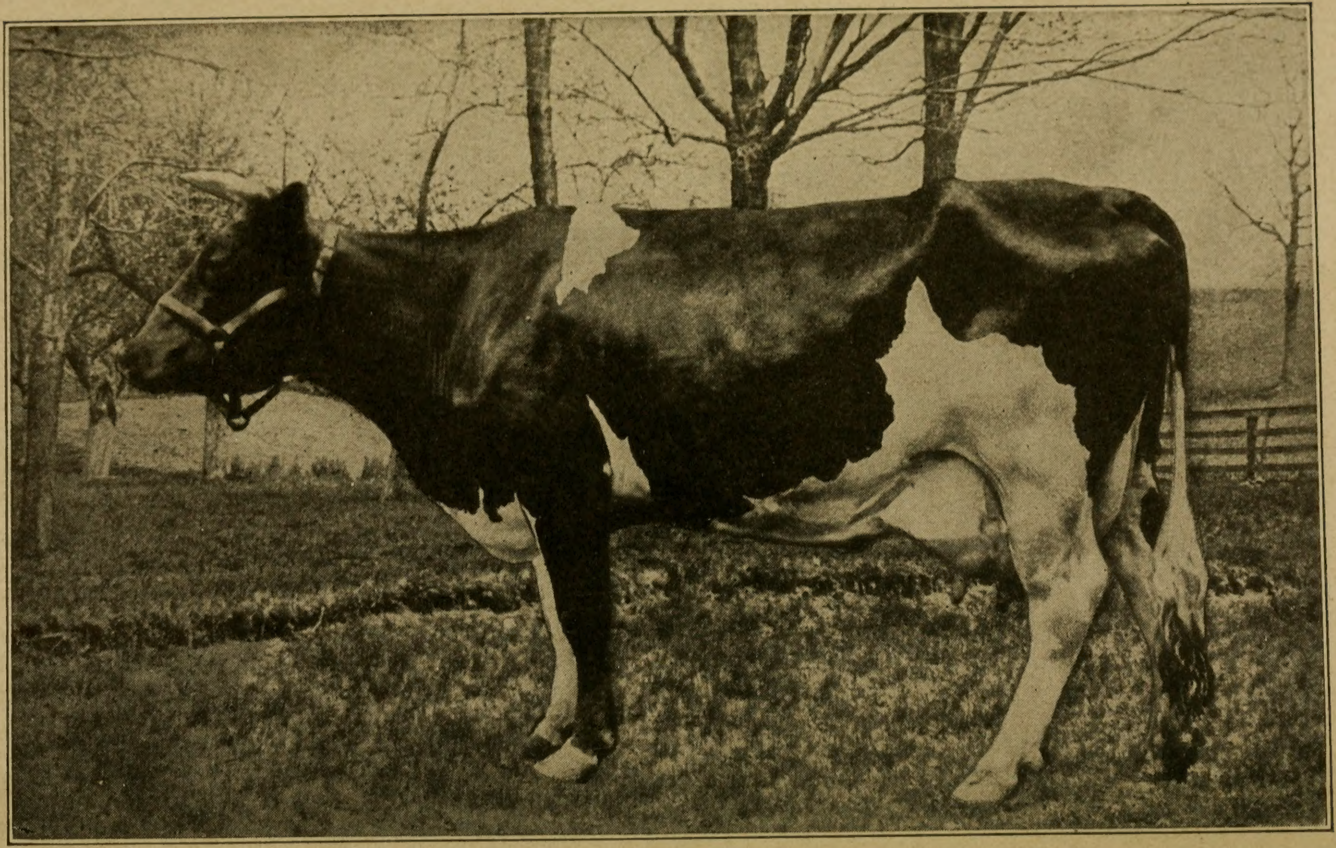

BANOSTINE BELLE DEKOL

A cow that in one year produced 27,404 pounds of milk, containing 1058 pounds of butter-fat.

DAIRY FARMING

BY

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INTRODUCTION

Agriculture now has a recognized place in both high schools and colleges. If this progress in scientific study is to continue, it is necessary that the instruction be kept on an equal educational basis with all other subjects. The courses in agriculture must stand for good, solid work such as is typical of the entire farming industry. There is a need for text-books that give the basic principles of the subject briefly without being superficial. To help in meeting this need a series of books, to be known as the Farm Series, is being prepared. The aim of each book will be to discuss the phases of its subject that are of most importance to the farmer; that is, to answer the farmer's questions, and to make these answers in the form of underlying principles rather than as rules. The positive advice or rules that may work in one region may be absolutely wrong in another region, or at another time in the same region. If one understands the principles involved, he will be better able to change his practice to meet the ever-changing conditions. Statements are often made that a farmer should raise all his cows, that he should produce winter milk, that he should build a silo. Such rules have no educational value and usually have no practical value. The real problem depends on the factors involved in each case. For instance a few of the points that must be considered in deciding whether or not to build a silo are the adaptation of the farm to corn production, the price of hay, the size of the herd, the price of milk, whether winter or summer dairying is followed, the amount of money available. No rule can be made that will include all these points, for many of them may be changed next year.

It is fitting that the first book of the series should deal with what is probably the most important source of income of American farmers, — dairy farming.

As population increases we must of necessity depend more on dairy products and less on beef cattle. The best methods of producing beef are very different from the best methods of producing milk. Many farmers who once kept beef cattle are changing to dairying. For such farmers a study of dairying is of particular importance because it will bring to them information that has been worked out by long experience in dairy regions. Even in the old established dairy regions the changes in prices of land, feed, labor, and dairy products and the increasing importance of manure for growing cash crops, make a study of the principles of dairy farming of prime importance.

The success of the teacher will depend in large measure on the extent to which the conditions in the community are studied. Many suggestive questions are given after each chapter. Much time should be spent in finding answers to these. A number of laboratory exercises should be given on farms in the region. One should not too lightly condemn the practices of the farmers, but should rather try to learn what are the natural and economic conditions that led to the present practices. Many farmers in the community are in all probability farming in a manner that is best for present conditions, but that may not be best a few years from now when conditions change.

This book is adapted for use in schools and colleges that wish to devote some time to the study of dairy farming. Three to five recitations per week and two laboratory periods per week will usually be desirable. At least a part of the laboratory exercises, and preferably all of them, should be given in periods that are two hours long. If this much time cannot be allowed, the laboratory period may be placed at the end of the day so that when farms are visited, it will be possible to take the longer time that is necessary.

It is hoped that the book will also prove useful to farmers who wish a better understanding of the principles involved in the successful operation of a dairy farm.

G. F. WARREN.

ITHACA, N.Y.,
April 1, 1916.

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DAIRY FARMING

CHAPTER 1

IMPORTANCE OF THE DAIRY INDUSTRY

G. F. Warren

1. Milk a Universal Food. Milk is the one universal food of mankind. All civilized peoples use milk from farm animals. The more highly civilized and prosperous the population, the greater is the amount of milk consumed. In regions so far north that cows cannot be kept, reindeer milk is used. In regions like India and the Philippines, which are too hot for our common cattle, the water buffaloes are the dairy animals and beasts of burden. In the deserts the milk of mares and camels serves as food. In regions where the people are very poor, goats and sheep are used as milk animals. In parts of South America llamas are so used. Everywhere civilized man keeps some milk animal.

2. Value of Milk as Food. The value of milk as food is beginning to be better appreciated, but even now its full value is not always realized. Most liquids have very little food value; for this reason, all liquids are sometimes looked upon as luxuries. But average milk contains 12 to 13 per cent of dry matter. This dry matter is readily digestible and contains necessary foods in good proportions.

The edible portion of an average beef animal is only 38 per cent dry matter. The remaining 62 per cent is water.[1]

A quart of milk weighs 2.15 pounds and contains two-thirds as much energy value, and nearly half as much protein as a pound of sirloin steak. It is particularly rich in ash, the bone-forming materials that are so essential for all young animals. It contains about twice as much of these as does beefsteak. A quart of skim-milk has over one-third of the energy value of a pound of sirloin steak. It is richer in ash and has almost half as much protein as the steak, as is shown in Table 1.

TABLE 1. — COMPARISON OF SIRLOIN STEAK WITH MILK, BUTTER, AND CHEESE[2]

	WATER	DRY MATTER	PROTEIN	ASH	ENERGY VALUE
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Calories*
1 pound sirloin steak . .	.54	.46	.165	.009	985
1 quart 4 % milk	1.87	.28	.071	.015	699
1 quart skim-milk . . .	1.95	.20	.073	.015	366
1 pound butter	.11	.89	.010	.030	3605
1 pound cheese (full cream)	.34	.66	.259	.038	1950

As the value of milk as food becomes better known, it is more widely used by persons of all ages. If much that is spent for meat were spent for milk, we could be as well fed at less cost. If much of the money that is spent for tea, coffee, alcohol, and other stimulants, that have little or no food value, were spent for milk, our health and our wealth would both be improved.

3. Butter and Cheese as Food. Butter is often thought of as an expensive food, but it is the most concentrated of

[1] U. S. Dept. Agr.; Office of Experiment Stations, Bulletin (Revised) 28, pp. 27, 28.

[2] U. S. Dept. Agr., Office of Experiment Stations, Bulletin (Revised) 28.

our ordinary foods. As shown in Table 1, a pound of butter will furnish three and two-thirds times as much energy as a pound of sirloin steak. Usually it does not cost twice as much as the steak. It is one of the cheap animal foods, is highly concentrated and easy to digest. Cheese is a cheap source of animal protein. We use over four times as much butter as cheese, but the amount of cheese used is increasing.

4. One Dairy Cow per Family. In the ten years 1900 to 1910 the number of steers and bulls in the United States decreased one-fifth, but the number of dairy cows increased with the population. In 1910 the average number of persons living together as one family was 4.5. Counting the dairy cows on farms and those not on farms, there was one dairy cow for each 4.2 persons, or a little over one cow per family. For sixty years the United States has main-

TABLE 2. — POPULATION AND NUMBER OF DAIRY COWS ON FARMS AND RANGES IN THE UNITED STATES EXCLUSIVE OF OUTLYING POSSESSIONS [1]

YEAR	POPULATION	NUMBER OF DAIRY COWS	NUMBER OF PERSONS PER COW
1850	23,191,876	6,385,094	3.6
1860	31,443,321	8,585,735	3.7
1870	38,558,371	8,935,332	4.3
1880	50,155,783	12,443,120	4.0
1890	62,947,714	16,511,950	3.8
1900	75,994,575	17,135,633	4.4
1910	91,972,266	20,625,432	4.5

[1] Twelfth Census, Vol. V, p. 704. Thirteenth Census, Vol. I, pp. 24, 1285, and Vol. V, p. 341. In addition to the above there were 973,033 dairy cows not on farms in 1900 and 1,170,338 in 1910. Most of these were kept by families in villages, Vol. V, p. 430. The census does not give the number of cows in cities for the earlier years.

tained an average of a little more than one dairy cow per family. Because meat is so expensive we are using less of it, but we are not decreasing the number of dairy cows.

5. Amounts of Dairy Products Used. The number of dairy cows just about keeps pace with population, but there have been changes in the use made of milk. The amount of condensed milk produced increased 165 per cent in the ten years 1899 to 1909.[1] The amount of fresh milk used as food has increased rapidly. In New York City the amount consumed per capita has increased one-third in twenty years.

TABLE 3. — BUTTER AND CHEESE PRODUCED AND CONSUMED IN THE UNITED STATES, AND MILK SHIPPED TO NEW YORK CITY

Year	Butter		Cheese		Milk and Cream Shipped to New York City[4]	
	Produced per Capita[2]	Consumed per Capita[3]	Produced per Capita[2]	Consumed per Capita[3]	Milk per Capita	Condensed Milk and Cream
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Quarts*	*Quarts*
1870	13.3		4.2			
1880	16.1		4.8			
1890	19.1	18.9	4.1	2.9	100	2
1900	19.6	19.4	3.9	3.6	109	5
1910	17.6	17.5	3.5	3.8	133	7

Approximately 288 quarts of milk per person are used per year in the farm family. In cities about 112 quarts per capita[5] are consumed. It is possible that this difference has something to do with the better development of

[1] Thirteenth Census, Vol. X, p. 374.

[2] U. S. Dept. Agr., Bulletin 177, p. 7.

[3] Amount produced plus imports less exports as given in reports of U. S. Dept. Agr.

[4] Data for New York City furnished by The Milk Reporter.

[5] U. S. Dept. Agr., Bulletin 177, pp. 17, 18.

children on farms. But the amount consumed in cities is rapidly increasing.

6. Milk Inspection. In recent years great interest has been taken in improving the milk supply. Physicians and boards of health have been agitating and inspecting. As in most worthy publicity campaigns many statements are made that are not true. The agitation has brought pressure for better milk, but at the same time the extreme statements made have led many persons to use less milk than they otherwise would. The writer believes that for every person who is injured by milk, many persons suffer from the lack of it. We need education for better care of milk on the farm, in the city, and in the home, but we also need education as to the great food value of milk so that more milk will be used. It is unfortunate when one of these interferes with the other.

Dairy inspection has done much good. It will do more good when more wisely performed. In the past it has too often been made by persons who do not understand farming or farmers. The emphasis is often placed on unessential things. An inexperienced youth with an arbitrary score card turned loose among dairy farmers usually does more harm than good. In this way unnecessary antagonism is often aroused. Recent investigations have shown that there is no relationship between the score of a dairy as shown by a score card and the quality of the milk produced.[1] In a later chapter the essentials for the production of wholesome milk are discussed. The vital points are that the milker and the cow both be in good health and that the milk be kept cold and as free from dirt as possible.

7. Dairy Cattle as a Source of Meat. Since there is one dairy cow per family there is approximately one veal calf

[1] New York Agricultural Experiment Station, Bulletin 398.

or cow available for beef each year per family. About seventeen pounds of dressed veal per family is used annually in the United States.[1] Nearly all of this is produced by dairy cows. From the comparative number of dairy cows and other cows, it appears that in addition to veal calves almost half of the beef animals slaughtered are produced by dairy cows. As population becomes more dense, we shall depend more and more on the dairyman for our meat supply. Beef from the beef breeds of animals will become too expensive for any but the wealthy, as it now is in densely populated countries. In the ten years 1900 to 1910 the number of dairy cows increased. Butter production increased 9 per cent and cheese production 7 per cent. But the number of steers and bulls decreased one-fifth.

8. Dairy Cattle in Other Countries. The British Isles have one dairy cow to eleven persons. They import large quantities of cheese and butter. France and the Netherlands have one cow to five persons. Germany has one cow to six persons. Denmark has one cow to two persons. It furnishes large quantities of butter for England. Japan and China show a striking contrast with America and Europe. Their dense population makes any kind of animal food too expensive to be used freely except by the wealthy. Instead of one cow for a family, Japan has one head of cattle for thirty-seven persons. The number of dairy cows is not reported, but this probably means that there is not more than one cow for from seventy to one hundred persons.[2]

As the population in the United States is becoming denser, we are unfortunately forced to use less animal food, but we

[1] Assuming that the calves slaughtered on farms were as heavy as those killed in slaughter houses.

[2] U. S. Dept. Agr., Yearbook, 1912, pp. 666–668. International Institute of Agriculture, Vol. V, No. 10, p. 485.

still use far more than any other nation. For each person we now produce over twenty-five times as much human food from animals as is produced for each person in Japan.[1]

9. The Dairy Cow an Efficient Machine. From a given quantity of feed the dairy cow produces more human food than does any other animal. According to Armsby's standards, the amount of feed required to grow and fatten a 1200-pound steer would, if fed to dairy cows, produce about three times as much human food.

But the dairy cow must be raised, and the growing heifer is no more efficient than the growing beef animal. Both industries require that cows and bulls be kept. Figures showing the returns from the entire beef industry are not available, but results of the entire dairy industry in one county, including the feed for the entire dairy herds and including milk and meat returned for human food, are given in Table 4, as well as the results from an entire poultry industry. As producers of protein, hens are the nearest competitors of dairy cattle, but judged on an energy basis hogs are second to cows. Both hens and hogs consume a higher class of foods so that when compared with cows they are not quite so productive as the figures would suggest.

10. Cows Effective Users of By-products. As population increases, less and less grain is fed to animals because it is all needed as human food. In Europe and other densely populated regions cows are fed less grain than in America. The dairy cow is the most efficient machine for changing grass, hay, straw, cornstalks, and the by-products from mills into human food. The cow will make a larger amount of human food out of these products than will any other

[1] Calculated on the basis of animal units aside from horses. See page 218.

Table 4. — Proportion of Food Eaten by Various Classes of Live Stock that is Returned for Human Use[1]

	Per Cent of Protein Returned		Per Cent of Energy Returned		
	Of Total Food	Of Digestible Protein	Of Total Food	Of Digestible Food	Of Production Value of Food
Cow[2]		41.0			48.9
Cow[3]		31.4			40.6
Dairy herds[4] . .	14.7	22.9	10.0	15.1	33.8
Steer[5]		8.9			17.0
Steer[6]	6.4	11.8	4.7	6.9	14.8
Hen[7]	16.1	20.9	7.1	8.3	14.1
Poultry flock[8]	14.5	18.6	6.4	7.5	12.6
Hog[9]	10.2	13.2	15.1	17.5	29.9

[1] Values as human food from U. S. Dept. Agr., Bulletin (Revised) 28.

[2] 1000-pound cow giving 6000 pounds of 4 per cent milk based on Armsby's feeding standard.

[3] Similar cow raised to 2 years on Armsby's standard, milked 5 years, then sold as lean beef.

[4] Food eaten by 5191 cows, 1078 heifers, 874 calves, 158 bulls, in Delaware County, New York. Pasture assumed to be one-third of the food. Net product 24, 646,000 pounds milk, 100,000 pounds skim-milk, 260 pounds butter, and 559 cows, 235 heifers, 62 bulls, 9 calves for beef. Most of the calves were killed and thrown away at birth.

[5] Steer grown to 1000 pounds in 2 years, then fattened 200 pounds in 100 days by Armsby's standard. Meat counted as fat beef.

[6] All food eaten by a steer that grew to 1588 pounds in 3 years, assumed to be fat beef. Ontario Agricultural College, Report, 1893, p. 122.

[7] Food and product of 1 hen, average of 1803 by the writer.

[8] All feed except grass for an average of 1803 hens and 60 roosters kept one year, 2713 chickens raised. Net product 204,093 eggs above those used for incubation, 1080 fowls and 1404 cockrels and pullets sold for meat, 4395 pounds, records kept by the writer.

[9] Hogs assumed to have eaten the same feed as 1 hen and to have made a gain of 1 pound for 5 pounds of grain.

animal. Cows also make use of the grasses that grow on large areas of land that cannot be profitably tilled.

11. Dairying and Maintenance of Soil Fertility. From most parts of the United States large quantities of stock foods are shipped out for foreign use. In many sections roughage that is good stock food is still destroyed. The introduction of dairying helps to keep a larger part of the fertility on the farm. Many farmers who make dairying a part of their farm business consider the maintenance of soil fertility, and the use of waste products, to be as important as the direct profits from the cows.

Experiments for many years have shown that it is possible to maintain the fertility of the soil by means of chemical fertilizers, but as a matter of fact farmers who use farm manure are most likely to keep up the fertility.

Cows Help to Provide a Full Year's Work. A farm is primarily a place to work. The carpenter who works only half the year is not likely to accumulate much property, nor is the farmer who works only half the year likely to pay for a farm. A limited number of cows on the farm give employment in the morning and evening when field work cannot be done. In the North where cows are most numerous, the days are so short during much of the year that a full day's work cannot be done, unless there are chores to do. Cattle also provide work for stormy days and for cold days in winter. They also provide work that children can do before and after school.

Farm children are particularly fortunate in that they have to help their fathers in the farm work. In the cities laws are passed to prevent child labor, not because all labor is injurious but because of the conditions under which the work is done. Farm children learn much by working with their fathers. Perhaps the most important thing that they learn is to persist in necessary work even when they would rather not. While helping with the chores the children are learning and at the same time helping to increase the family income.

12. Receipts from Dairy Products. Corn is the most valuable product of American farms but most of it is fed on the farm. Dairy products are probably the largest single source of income of American farmers. The dairy products sold from farms in 1909 amounted to nearly $500,000,000. The value of both cotton and wheat sold exceeded this. But if the cattle and calves that are also a product of the dairy were combined with the milk, the receipts from these sales would probably exceed the sales of any other product.

QUESTIONS AND PROBLEMS

1. Get the local retail prices of butter, cheese, milk, skim-milk, and sirloin steak. Make a table showing the amount of protein and energy value that $1 will buy in each product.

2. Define "per capita." Define "dry matter."

3. Find the amount of milk and butter used per person in 10 to 12 families in your region. Average these and compare with the averages given on page 4. Each student may report on one family, or more if there are not 10 students in the class.

4. From the census reports for your state find the population and the number of dairy cows for your county. How many persons are there for one cow? Compare with Table 2. What dairy products are shipped into your county? What products are shipped out of the county?

5. Repeat question 4 for your state.

6. What was the total value of all dairy products sold in your county in 1909? In your state? Which of the dairy products sold are most important?

7. What was the value of dairy products compared with other leading farm products in your state?

8. Why is more cheese used in Europe than in America? Why are we using more cheese than formerly?

9. Of what dairy products does the United States import more than it exports? Of which does it export more than it imports? Which are greater in value, the total imports or exports? To what product is this due? See page 296.

COLLATERAL READING

The Production and Consumption of Dairy Products, U. S. Dept. Agr., Bulletin 177.

The Use of Milk as Food, U. S. Dept. Agr., Farmers' Bulletin 363.

In the lists of collateral reading no attempt is made to give a complete list of books and bulletins. A few of the more important references that are readily available are given. Bulletins of the different state experiment stations are not always available, for this reason they are not often given as collateral reading but are referred to in footnotes. At the beginning of the course the experiment station in your state should be asked for all available bulletins. If after examination it appears that certain ones of the publications are likely to be needed for special study, members of the class should send postal cards requesting them. It is better to have the students do this writing because instruction as to where to get information is a part of the course.

Write to the Bureau of the Census, Washington, D.C., or to your congressman for the census report on agriculture for your state. Also ask for the report on animals and animal products for the United States.

Many important laboratory exercises are given after Chapter 2, page 39, and for following chapters. These exercises should be begun while Chapters 1 and 2 are being studied. Because of the frequent use that is made of the Babcock milk test it is a good plan to begin the laboratory work with Exercise 20, page 196.

CHAPTER 2

BREEDS OF CATTLE

C. H. Eckles

Origin of Breeds

13. Origin of Domesticated Cattle. No cattle are native to America. All those found in both North and South America are descended from cattle brought from Europe and are the descendants of wild cattle that formerly lived in Europe and Asia. It is not known where or by whom cattle were first domesticated as it occurred in prehistoric times. It is generally believed that there were two original forms of wild cattle, the one somewhat smaller than the Jersey, the other probably larger than any cattle that live to-day and in type something like the long-horned cattle formerly raised on the ranges of South America and in Texas.

14. Origin of Breeds. The differences between these two wild types account in part for the differences between breeds of cattle, such for instance as the extreme difference in type between the Jersey and the Holstein, or between the long-horned cattle found in Texas and the Angus or the Shorthorns.

Other factors in the formation of breeds are climate, food, and nature of the surroundings. For example, the cattle of Holland as a result of living for generations in a rich level country have become adapted to these conditions and are not so well suited to rough scanty pastures as the Brown Swiss, or the Ayrshires which have been produced on poor pastures. On the continent of Europe the breeds and sub-breeds are almost innumerable. They have chiefly originated in the manner mentioned. In Great Britain alone ten or twelve distinct breeds have developed. Up to about the middle of the eighteenth century these natural influences were the chief factors in the development of breeds. About that time, largely as the result of the work of Robert Blakewell, a great interest was aroused in England in improving cattle.

The beginning of modern breeds may be traced largely to this great movement. The methods used were careful selection, more liberal feeding, and good management. In some cases, as with the Shorthorns and the Ayrshires, crossbreeding and inbreeding were at first practiced. At the present time most cattle breeders direct their efforts towards further improvement in the breeds already in existence and not towards the establishment of new breeds.

15. Definition of Terms. *Scrub* and *native* are terms used to indicate that an animal does not carry more than a small amount of the blood of an improved breed.

Grade. This term, generally used with some breed name, as Grade-Holstein, means that the animal has one-half or usually more of the blood of the improved breed. When the proportion of improved blood is high, the animal is called a "high grade."

Crossbred indicates that the animal is the offspring of pure-bred parents of distinct breeds.

Pure-bred. This term is properly applied to cattle whose ancestors came from the native home of the breed and conformed to the standards of the breed. Records must be available showing the breeding of these animals and tracing back in all lines to those coming from the original home of the breed. Pure-bred animals are sometimes called thoroughbred, but this term is also used to indicate a particular breed of horses and is usually restricted to that meaning.

Registered. The breeders of each important breed of cattle have an organization for the purpose of keeping records and advancing the interests of the breed. Each of these organizations keeps record books. Any pure-bred animal that has the breed characteristics may be recorded, provided both parents are already on record. A pure-bred animal that is recorded is called a registered animal.

16. Classification of Cattle. The breeds common in America are generally classed as follows:

Dairy Breeds. Holstein, Ayrshire, Jersey, Guernsey, Brown Swiss, Dutch Belted.

Dual Purpose. Shorthorn (Dairy Type), Red Polled, Polled Durham, Devon.

Beef. Shorthorn, Hereford, Aberdeen-Angus, Galloway.

17. Value of Breeds. Animals of a distinct breed that is adapted to the region usually sell for more than animals of mixed or unimproved breeding even if the latter are equally good animals individually. The value of the pure-bred is due to the fact that it is possible to predict with reasonable certainty what characteristics will be inherited by the offspring. Among dairy cattle it is not uncommon to find animals of mixed breeding that rank with pure-breds as producers of dairy products. These animals of mixed breeding, however, cannot be depended upon to reproduce themselves in their offspring. Very high grades are more likely to produce young like themselves. Pure-breds have been bred for generations with certain objects in view, and in time these characteristics become fixed and are transmitted with fair certainty.

The breed should be looked upon as a means of retaining the characteristics that have been developed by the efforts of the breeders in the past. Certain breeds have for generations been selected and developed for the purpose of producing the greatest possible amount of good beef from the least feed. It is reasonable to expect an animal belonging to one of these breeds to excel one whose ancestors have never been selected for any definite purpose. Other breeds have been developed as dairy breeds, or for dual-purpose use, and are the most efficient animals for these purposes.

18. Pedigrees. A pedigree is a record of the ancestry of an animal. Its value lies in the opportunity it affords to study the characteristics of the ancestors. Breed associations[1] have been organized by those interested, primarily for the purpose of keeping authentic records of the ancestry of pure-bred animals. Upon payment of the registration fee an animal that has the required breed characteristics and both of whose parents are recorded, may be recorded and assigned a registration number. By this means it is possible to trace the ancestry of any registered animal as far back as the ancestors that were imported. In ordinary use from three to six generations are recorded on the pedigree as studied by the breeder.

While pedigrees are of great value in making it possible to select breeding animals to better advantage, it is a common mistake to attach too much importance to them. An animal with a pedigree may not be any better than others that are high grades of the same breed. Pedigree alone is

[1] See addresses on p. 289.

no indication of the merit of the animal as an individual since it is merely a record of parentage.

Below is given the pedigree of the Jersey cow, Rosette's Gipsy Maid, including four generations. The name of the sire in each case appears at the top, and that of the dam at the bottom of the bracket.

Rosette's Gipsy Maid 220623	Eminent Rosette 66050	Rosette's Golden Lad 57498	Orlando P. 2535 H. C.
			Rosette's 5th P. 2881 H. C.
		Financial Queen 155098	Reminder P. 2052 H. C.
			Financial Pride P 6060 H. C.
	My Jolly Girl 206038	Guenon's Golden Lad 62168	Guenon Lad P. 2571 H. C.
			Loraine 82951
		Guenon's Mag V 189777	Guenon's Golden Lad 62168
			Maceo's Mag V. 174758

Dairy Breeds

19. Number of Animals Registered. Some idea of the greatly increased interest in pure-bred cattle is shown by the rapid increase during recent years in the number of animals registered by the breed associations. Over five times as many Holsteins were recorded in the last ten years as were recorded in the previous ten years. Three times as many Guernseys, twice as many Ayrshires, and nearly twice as many Jerseys were recorded as in the preceding ten years. Although the totals look large it should be taken into account that the number of registrations for each breed includes all since the herdbook was established. Probably not over one-third of the total registered are now living. In proportion to the total number of dairy cattle in use in the United States the number registered is very small, probably less than one in fifty. Table 5 gives the number of each breed registered, also a comparison of the numbers recorded in the last ten years and in the previous ten years.

TABLE 5. — NUMBERS OF ANIMALS REGISTERED

BREED	BEFORE 1895	1895–1904	1905–1914	TOTAL UP TO 1915	LAST TEN YEARS COMPARED WITH PREVIOUS TEN YEARS
					Per Cent
Jersey . . .	143,519	111,782	197,300	452,601	176
Holstein . .	56,141	49,296	267,374	372,811	542
Guernsey . .	11,029	15,661	52,450	79,140	335
Ayrshire . .	18,306	11,051	26,919	56,276	244

20. Holstein-Friesian. This well-known breed of cattle originated in Holland and is especially well developed in the province of Friesland. It is not native, as the name Holstein would indicate, to the duchy of Holstein, which is a province of North Germany. Some of the first cattle of this breed imported to America were incorrectly called Holstein, and a breed association was organized under this name. Later another was started called the Dutch-Friesian. These two were combined in 1885 under the name Holstein-Friesian, which is the official name of the breed in this country. It is now generally called Holstein in America.

FIG. 1. — Holstein-Friesian cow, champion at the National Dairy Show. An excellent specimen of this breed. Barrel, udder and milk veins especially good.

This breed is probably one of the oldest among those in general use. Holland has been famous for its cattle since the time of the Romans. The best part of Holland is below the level of the ocean, which is kept back by great dikes. The land is level and very fertile and especially adapted to grass. The cattle kept in Holland are given the best care of any cattle in the world. Attention is given to proper feeding, gentle handling of the animals, and to good sanitary conditions. As a result Holland exceeds all other countries in the average yield of milk and butter-fat per cow. Nearly all of the Holsteins in the United States are descended from about 10,000 head which were imported between 1875 and 1885. This breed ranks first in the number of animals now being recorded.

Holsteins are the largest of the dairy breeds, the cows reaching an average weight of 1200 pounds and the bulls 1800 to 2200 pounds as a rule. The color is always black and white in any proportion but never blended. Cows of this breed are gentle and quiet in disposition. The breeding qualities are excellent, as is indicated by the rapid increase in numbers of recorded animals. The calves average 95 pounds at birth, the largest of any breed except the Brown Swiss.

Holsteins produce more milk on the average than any other breed. In percentage of fat they rank the lowest. The figures in Table 6 give the averages of cows in experiment station herds. It is quite certain that these cows, on the average, do not produce any more than well-kept private herds.

On a farm where good conditions of management prevail, a herd should average at least 8000 pounds of milk per year. A high average would be 10,000 pounds per year. The milk or butter from this breed has considerably less yellow color than that of Jerseys, and in fact ranks the lowest in this respect.

TABLE 6. — PRODUCTION OF HOLSTEIN COWS IN EXPERIMENT STATION HERDS.

	AVERAGE	NUMBER OF COWS REPRESENTED
Pounds milk per year	8699	83
Per cent fat	3.45	83
Pounds fat per year	300	83
Per cent total solids	12.29	9

The highest fat records for a year made by this breed up to April 1, 1916, were:

	POUNDS MILK	POUNDS FAT
Duchess Skylark Ormsby	27,762	1205
Finderne Pride Johanna Rue	28,404	1176
Finderne Holingen Fayne	24,612	1116

The highest milk record was made by Tilly Alcartra, who produced 30,452 pounds of milk in a year, but she did not give as much fat as a number of other cows.

In Holland, cattle of this breed are used for beef production as well as for dairy purposes. The calves are especially well adapted for veal as they are large at birth and gain rapidly during the first few weeks. When dry the cows fatten readily, and as is the case with other dairy breeds the gains are made as cheaply and rapidly as with animals of beef breeds. In the great cattle markets the price is always lower for animals of the dairy breeds than for those of beef breeds. There is some basis for this discrimination in the fact that the dairy breeds during fattening deposit larger quantities of fat around the internal organs, and tallow is worth but little as compared with the edible meat. The beef-bred animals deposit more of their fat in the muscular tissue giving the marbled condition so much prized. However, the average meat consumer scarcely discriminates between the beef from a Holstein and that from a beef-bred animal if both be of the same age. It is safe to prophesy that, in the future, dairy cattle will supply a much larger proportion of the beef used in this country, as has long been the case on the continent of Europe.

The strong points of the breed are the high milk yield, the marked vigor of constitution especially of the calves, the good breeding qualities, the quiet disposition, and the value for beef and veal. The weakest point is generally considered to be the low percentage of fat, but owing to the large yield of milk the total production of fat is high.

21. Jersey. The Jersey and the Guernsey breeds are often spoken of as the Channel Island breeds. They take their names from the islands of Jersey and Guernsey, located in the English Channel. Jersey Island is only eleven miles long and nine wide. The climate is mild and even. The cattle are pastured by tethering. The system of agriculture followed is very intensive since the average rent of the land is about $50 per acre. The sale of pure-bred Jersey cattle for export is an important source of income. Since 1789 the laws of the island have prohibited the importation of cattle, so this breed has been kept pure since that time. Much attention is given to the type of the animal as well as to the butter production. This has resulted in the development of a breed of great symmetry and beauty.

At the present time this breed is used to a limited extent in England, and has been taken to all English speaking countries, although by far the greatest number is now in North America. Some were brought to the United States about 1850. From 1868 to 1890 large numbers were imported, and again since 1900 several importations have been made

Fig. 2. — Imported Jersey cow, Lady Viola, many times champion in the show ring. A good representative of the Island type; rather small, extreme dairy type, udder almost perfect, long level rump, very symmetrical outline.

each year. This breed is most numerous in the Eastern and Southern States.

The color may be any shade of yellow except orange — and ranges from light fawn to dark gray or black. The most common color is fawn shading to dark on the lower parts of the body. The tongue, and the switch of the tail are black in the majority of cases. White spots are not uncommon, especially on the lower part of the body. These were at one time strongly objected to, but now receive little attention. The color bears no relation to the value of any particular cow as a dairy animal. Mature Jersey cows usually weigh from 750 to 900 pounds. Those found on Jersey Island and those recently imported are of smaller and more refined type and are known as the Island type in contrast to the larger, coarser type descended from the early importations, known as the American type.

Cows of this breed are more sensitive than many others on account of a highly developed nervous temperament. When handled gently they become very docile, when carelessly handled or abused they are quite the reverse. They seem to thrive better than some other breeds in warm climates. As meat producers they rank very low. The calves are small at birth, weighing 55 pounds on the average and they do not gain rapidly for the first few weeks. For these reasons they are not well adapted for veal.

The published records of Jersey cows owned by the American experiment stations are given in Table 7. On a farm where fairly good conditions are maintained a Jersey herd should be expected to average about 5500 pounds of milk per year containing on the average 5 per cent of fat. A high average milk yield would be 7000 pounds per cow.

Table 7. — Production of Jersey Cows in Herds Belonging to Experiment Stations

	Average	Number of Cows Represented
Pounds milk per year	5508	153
Per cent fat	5.14	154
Pounds fat per year	283	153
Per cent total solids	14.9	29

The highest records for a year up to April 1, 1916, were:

	Pounds Milk	Pounds Fat
Sophie 19th of Hood Farm . . .	17,558	999
Spermfield Owl's Eva	16,457	993
Eminent's Bess	18,783	963

In quantity of milk the Jersey is surpassed by other dairy breeds. In use of food for the economical production of fat the Jersey and her close relative the Guernsey are unsurpassed. The best-known characteristics of this breed are the high percentage of fat and the yellow color of the product. The yellow color adds nothing to the flavor or the food value of milk or cream but makes the article more attractive to the consumer. The Jersey cow is also an unusually persistent milker which contributes to her popularity as a family cow. This breed is best adapted for the production of cream or butter. The weakest points are a lack of vitality in the calves and lack of good breeding qualities in the cow.

22. Guernsey. This breed is a native of the island of the same name, which is the second in size of the Channel Islands. The ancestors of this breed and of the Jersey were undoubtedly the same, and in fact a century ago the two breeds were essentially alike. The conditions under which the two breeds developed are almost identical, but type has been emphasized far less than on Jersey Island. As a result the Guernseys lack the symmetry and uniformity of type characteristic of the Jersey. The Guernsey cow weighs about 1000 pounds on the average, or at least 100 pounds more than the Jersey, and is also coarser boned. In

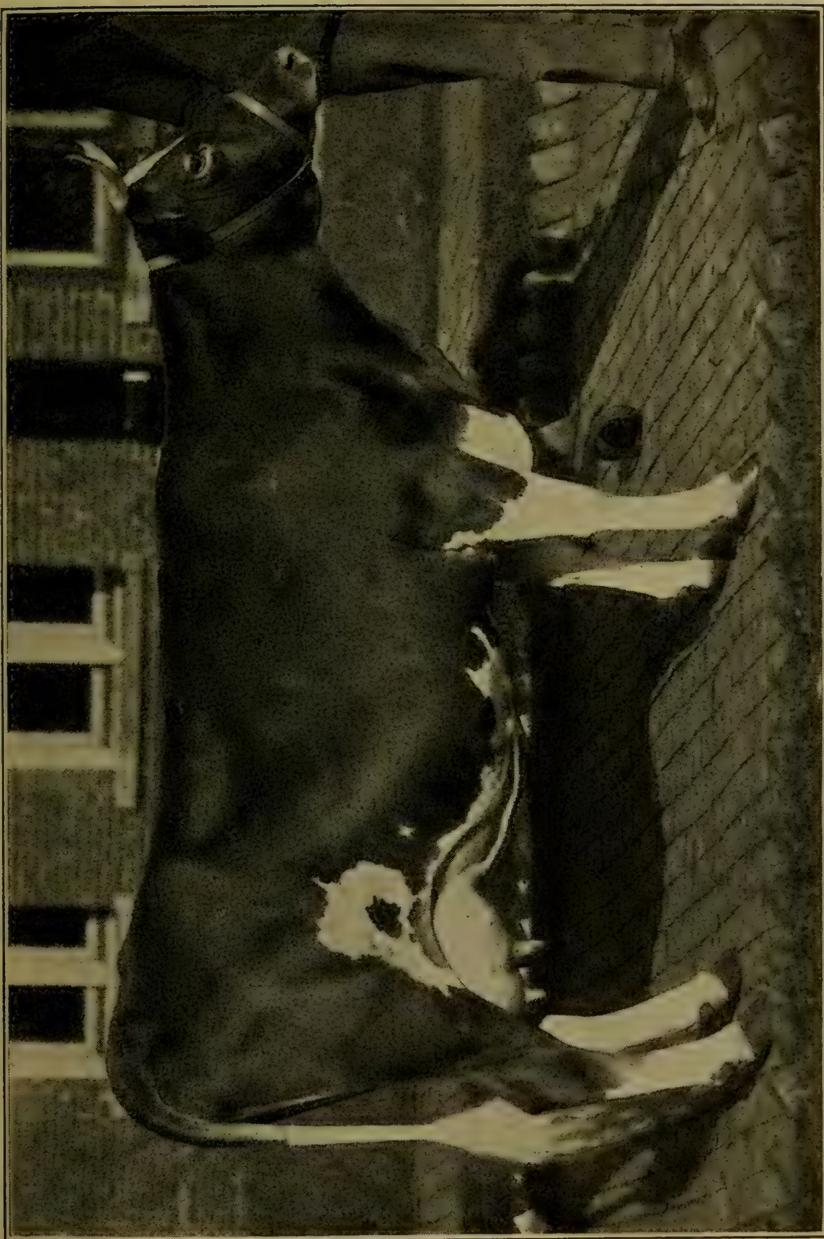

FIG. 3. — A Guernsey cow that has many times been champion in the show ring.

general the colors resemble those of the Jersey, but include some colors not found in that breed. The common colors are reddish yellow, or lemon, or orange-fawn, with white markings. Guernseys are probably a little slower maturing than Jerseys, but are ready to freshen when about 24 months old. Like the Jerseys they have little adaptation for beef.

Table 8. — Production of Guernsey Cows in Experiment Station Herds

	Average	Number of Cows Represented
Pounds milk per year	5509	17
Per cent fat	4.98	21
Pounds fat per year	274	17
Per cent total solids	14.2	6

Records for cows belonging to experiment stations are given in Table 8. A herd should average at least 5500 pounds of milk per year containing 5 per cent of fat. A high average would be 7000 pounds per cow.

The highest records for one year up to April 1, 1916, were:

	Pounds Milk	Pounds Fat
Murne Cowan	24,008	1098
May Rilma	19,673	1073
Spotswood Daisy Pearl	18,603	957

Guernsey milk and butter have a higher color than do the products of any other breed, and for this reason the Guernsey is especially favored where cream is sold in a critical market. The strong and weak points of this breed are practically the same as for the Jersey. They are best adapted for the production of cream and butter. Their milk yield is not sufficient to warrant their use where milk is sold without regard to its fat content.

23. Ayrshire. The home of this breed is the county, or shire, of Ayr in southwest Scotland. This is a rolling, moderately fertile region and is not subject to great extremes of temperature. The origin of the breed is somewhat uncertain, but it dates back to the latter part of the eighteenth century. It is generally believed that the breed was the result of crossing Holland, Durham, and Channel Island animals upon the native stock. It is at present the leading dairy breed in Scotland and in New Zealand, and is common in parts of England.

Ayrshire cattle were brought into Canada at an early date, and were brought to Massachusetts as early as 1837. These importations stopped after twenty or thirty years, and were not resumed until about 1900. Until recent years the Ayrshires in America were the descendants of the early importations. The importations of the past few years have met with the greatest favor, and as a result the best Ayrshires in America are now of the same type as those found in Scotland. At the present time this breed ranks fourth among the dairy breeds in numbers registered in the United States. They are most numerous in the dairy sections of the East and in Wisconsin, Ohio, and Illinois. In portions of Canada they constitute the majority of the cattle in use.

Many of their characteristics are between the Holstein and Jersey. This is true of the size, yield of milk, yield of fat, disposition of animals, size of calves, and breeding qualities. The common color is spotted, red and white, or brown and white in varying proportions. The two colors are distinct and never blend to form a roan as with the Shorthorns.

Fig. 4. — Ayrshire cow, champion, at the National Dairy Show. Note this animal is less angular than the Jersey or Holstein and has the typical Ayrshire udder and horns.

The Ayrshire cows do not show the extreme angular dairy type exhibited by some other breeds. They are smoother over the shoulders and have fuller hind quarters. The udder development is the most perfect found in any breed. Special attention has been paid to this point by the Scotch breeders. The teats are placed uniformly on the udder and are of uniform size. The tendency to short teats has been the cause of much unfavorable criticism, but the care which has been taken within recent years to breed for longer teats has largely removed this objection. In beef production Ayrshires rank high for a dairy breed. The calves weigh 65 to 70 pounds at birth and are strong and vigorous.

TABLE 9. — PRODUCTION OF AYRSHIRE CATTLE IN EXPERIMENT STATION HERDS

	AVERAGE	NUMBER OF COWS REPRESENTED
Pounds milk per year	6533	24
Per cent fat	3.85	24
Pounds fat per year	252	24
Per cent total solids	12.9	17

Results from experiment station herds are given in Table 9. An average yield of about 6000 pounds of milk containing 3.80 per cent fat may be expected from a herd under farm conditions if given reasonably good treatment. The milk does not show much yellow color. The breed is well adapted for the production of market milk since it gives a large amount of milk of average composition.

The best record up to April 1, 1916, is held by Lady of Willowmoor with a production of 956 pounds of fat in one year.

24. Brown Swiss. These cattle are native to the northeastern part of Switzerland where they have been bred as far back as history records. During the winter season the cattle are kept in the valleys and in the summer they are pastured upon the mountain slopes. In America this breed is found in almost every state but as a rule only in isolated herds. The total number is small compared with the leading dairy breeds.

In appearance these animals are plain, substantial, and well proportioned although inclined to be fleshy and often rather coarse in bone. The cows reach a weight of about 1200 pounds. They are called brown, but the color is really more of a mouse color and varies from a silver gray or light brown, to a dark brown or nearly black.

They are noted for their vitality and good breeding qualities. They are quiet and gentle. The calves are the largest of any breed used in America and are easy to raise on account of their strong vitality. As milk producers the cows rank about with the Ayrshires in both yield and richness of milk. A milk yield of from 6000 to 9000 pounds per year is often obtained, and an average of 6500 pounds per cow should be obtained under good conditions. The fat averages a trifle under 4 per cent. Some excellent advanced registry records have been made by this breed. The best record up to April 1, 1916, is held by College Bravura 2d with a production of 19,461 pounds of milk and 798 pounds of fat in one year.

25. Dutch Belted. This breed has practically the same characteristics as the Holstein, except that it has a white band or belt extending around the body. It is used, to a limited extent only, in the Eastern States.

26. Kerry. These cattle are smaller than those of any other breed. They are natives of Ireland. The average weight of the cows is 650 pounds. The color is black with a little white on the udder and underline. Another somewhat larger type of this breed is known as the Dexter Kerry. A few small herds are to be found in the Eastern States. The cows produce a large amount of milk for their size. The milk averages about 4 per cent of fat.

Dual-purpose Breeds

27. Dual-purpose. The term dual-purpose is used to describe those breeds of cattle kept for both milk and beef, in contrast with the more specialized breeds, which are kept primarily for either milk or beef alone. All dairy breeds have some value for beef, and all beef breeds are sometimes used for milk. The real dual-purpose cow stands about midway between the dairy type and the beef type. It must not be expected that a cow of this type will compare as a dairy animal with good individuals of the special dairy breeds in milk production, or that her calves can compete in beef production with those from the special beef breeds. A dual-purpose cow should be expected to produce about 200 pounds of butter-fat per year as against about 300 for an equally good specimen of a special dairy breed, and her calves should make fair beef.

Dual-purpose breeds have been in favor in many sections of the United States especially in the corn belt. The dual-purpose breeds are less economical producers of dairy products than the special dairy breeds and for this reason should not be chosen by the man who is making dairying an important part of his farming operations. If the dual-purpose cow is to be used at all, it should be on the general farm in the corn belt where cream is sold and skim-milk is available for feeding calves and pigs, and where the abundance of roughage makes it desirable to have more animals to consume it than the farmer is prepared to handle in the form of dairy cows.

28. Shorthorn. The Shorthorn is probably the best known and most widely distributed breed of cattle. Its native home is northeast England in the counties of York

FIG. 5. — Doris Clay, a Shorthorn cow of the dairy type with a milk record of 10,270 pounds in one year. A dual-purpose cow but showing more dairy characteristics than is typical.

and Durham. The name Durham, which was formerly applied to this breed to some extent, is explained in this way. As with other breeds it is not possible to tell exactly how the breed was originated. It is probable that the cattle brought from the Continent were crossed with the native English stock. It is certain that Holland cattle were also a factor in the improvement. The first systematic breeding began about 1780. The men best known in the early history of the breed are Charles and Robert Colling, Thomas Bates, Thomas Booth, and, more recently, Amos Cruickshank. In developing this breed most attention was given to early maturity and good beef qualities. At the same time certain breeders, especially Thomas Bates, were equally interested in developing a dual-purpose, or general-purpose, animal in which the dairy qualities and the beef characteristics should be well balanced. As a beef animal the Shorthorn ranks in the first class. Within recent times the beef qualities have been best developed in animals descended from the herd of Cruickshank. At the present time animals of this breed seen in the show ring in America are of the most pronounced beef type, and their popularity is based upon their beef qualities. Certain strains, however, have been developed by breeders who have maintained the milking characteristic of the early type, and as a result at the present time there is a fairly distinct milking type of pure-bred Shorthorns found in large numbers in England and to a limited extent in America. In recent years a number of milk and butter records have been made by cows of this breed that rank with the special dairy breeds.

Herds selected and bred for dual-purpose should average about 5000 pounds of milk per year with a fat content of from 3.8 to 4 per cent. The highest record up to April 1, 1916, is held by Rose of Glenside, 18,075 pounds of milk and 625 pounds of fat in one year.

The dual-purpose type does not have so good a beef conformation as the strains developed for beef. The beef animals of this breed produce more milk than does the Hereford, Angus, or Galloway. The Shorthorn is more widely distributed than any other breed, being widely used in

North and South America, South Africa, and Australia, as well as in its native home.

The colors may be pure red, pure white, red and white, or roan. The color cannot be taken as in any way an indication of the quality of the animal. The mature cows usually weigh about 1400 pounds but may reach 1800 pounds or more. They are larger than the cows of any other breed.

Importations to America began as early as 1790, although in small numbers until between 1830 and 1840 when a large number were brought into Ohio. The American Shorthorn Breeders' Association was established in 1882 and since that time has looked after the interests of the breed. More cattle of this breed have been registered than of any other.

29. **Polled Durham.** Polled Durham cattle are either pure-bred Shorthorns or nearly so. They are of American origin. The "Single Standard" Polled Durhams were originated by crossing native mulley cows with pure-bred Shorthorns. After a certain number of crosses of Shorthorn blood these animals were registered in the Polled Durham herdbook. The "Double Standard" Polled Durhams are so called since they are eligible to registry in the Shorthorn herdbook. They were originated from naturally mulley cows which appeared in pure-bred Shorthorns. At the present time the latter line of breeding has practically superseded the former. They are in every respect the same as Shorthorns except for the polled characteristics. They are found in considerable numbers in the Central States and have met with considerable favor on account of the polled characteristics.

30. **Red Polled.** This breed is classed as dual-purpose and comes nearest at the present time, as a breed, to meeting the

definition of this classification. It is native to the counties of Suffolk and Norfolk in the eastern part of England. It is believed by some who have studied the question that Red Polls are descended from cattle brought to England by the Danes and mixed with the native cattle. Until 1846 the cattle of these two counties were known as independent breeds, but on account of their similarity, at this date they

FIG. 6 — Jean Duluth Beauty, a Red Polled cow, with a record of 20,280 pounds of milk, and 892 pounds of fat in one year. A dual-purpose cow with a remarkable dairy record.

were combined and have since been known as Red Polls. They are used in England as dual-purpose cattle. At the present time the breed is found mostly in the two counties where it originated, to some extent in Australia and New Zealand, and in considerable numbers in America.

They were probably introduced into America during the colonial times, but it was not until after 1870 that animals were brought over the descendants of which have been kept pure. They are most numerous in the Middle States. They yield a medium amount of milk, take on flesh readily, and make a fair grade of beef. As beef animals they do not rank in the first class, nor can the cows compete in milk and fat production with the special dairy breeds. A herd kept under good farm conditions may be expected to average about 5000 pounds of milk per year, containing close to 4 per cent of fat on the average. A number of excellent milk records have been made, though none are comparable with those of the special dairy breeds. The cows usually weigh between 1200 and 1300 pounds, but occasionally more; while the bulls reach a weight of about a ton. In color they are a deep cherry red; white may appear on the switch of the tail, on the udder, and a few white markings are allowed on the belly. White on any other part disqualifies the animal for registration. American herds of this breed vary widely in type. Some breeders have given most attention to beef production. Other breeders have given most attention to dairy qualities. The proper type to maintain is a balance between these two extremes. The best record up to April 1, 1916, of 20,280 pounds of milk and 892 pounds of fat is held by Jean Duluth Beauty.

31. Devon. Devon cattle are commonly classed as dual-purpose. They were bred and developed in Devonshire, England. They are thought to be one of the oldest of the breeds that originated in Great Britain. The Devons are smaller than the distinctive beef breeds, the cows weighing from 1200 to 1300 pounds. The color is a bright red. The animal is blocky and compact with a noticeable refinement in bone. They are fair milk producers, yielding milk rich in fat, comparing favorably in this respect with the Jerseys. The breed is not numerous in the United States but is found to some extent in the Eastern States. Their popularity seems to be decreasing, judging from the number that are exhibited at fairs.

Beef Breeds

32. Hereford. This breed has been developed strictly for beef purposes. The cows are milked to a very limited extent. A few cows in a herd kept primarily for beef may be utilized to supply the family of the owner with milk, or at times may produce enough to make it possible to sell a small amount of dairy products. There are no records of milk production available, although it is known that the milk of this breed ranks rather high in richness and has much the same characteristics as that of the Devons. The Hereford probably ranks lowest in dairy qualities. As is the case with all beef breeds, occasionally a cow is found that is a fair milk producer, but she cannot be depended upon to transmit this characteristic. This breed is a native of Hereford in the south central part of England, where it has been developed for about 150 years. The cows reach a weight of about 1400 pounds and the bulls as high as 2200 pounds. The most distinctive characteristic of the breed is the white face, which is never absent. This is transmitted very strongly to practically all animals having even a small amount of Hereford blood. Herefords are used mostly for grazing on the plains of the West and Southwest.

33. Aberdeen-Angus. This excellent breed of beef cattle ranks about with the Hereford as a producer of milk. The cattle are always black in color and polled. Only rarely is a cow found that would be profitable in a dairy. These exceptional cows cannot be counted upon to reproduce this characteristic in their offspring. They are bred primarily for beef, but are often used in a limited way for supplying milk for the use of the owners. Angus grades may even be found occasionally in mixed herds kept for milk. Practically no records of the amount or richness of milk are available. A limited number of fat tests made by the author indicate that the milk of this breed averages about 4.0 per cent of fat, or about the same as that of the Shorthorns. The Angus breed originated in northern Scotland. In America it is found chiefly in the corn-producing states. It has not been considered the equal of the Hereford on the ranges.

34. Galloway. This breed is a native of southwestern Scotland. The cattle are black in color, always polled, and are especially known for their long, thick hair, seen to the best advantage during the winter season in northern regions. They are found chiefly in the Middle States and on the ranges. They are strictly a beef breed. No records are available regarding the yield of milk or its richness. As is the case with other beef breeds, occasionally a reasonably good milk producer is found.

QUESTIONS AND PROBLEMS

1. Which means more, to say that an animal is pure-bred or to say that it is registered?

2. Fill out a table like the following, including all breeds of cattle.

Breed	Native Home	Horned or Hornless	Dairy, Dual-purpose or Beef	Colors	Usual Weight Pounds

3. Tell how each breed of cattle may be distinguished.

4. From Tables 6, 7, 8, 9, find the percentage of solids not fat for the milk of each breed.

5. How did Shorthorn cattle come to be called Durham?

6. What is meant by Channel Islands?

7. On a map locate the region where each breed originated. Give the leading characteristics of the region as to climate, topography, and food supply for cattle. Which one of the regions is most like the region where you live?

8. Make a list of all the known owners of pure-bred cattle in the school district or region, with the breeds owned and numbers of each breed.

9. Which breed of dairy cattle is most numerous in the region? Which one is increasing most rapidly? Why?

10. Why did so many breeds originate in Europe, and why does the same thing not happen in America?

LABORATORY EXERCISES

1. If different breeds of cattle are available, make comparisons of them, and write a description of the cattle of each breed that were studied. The score cards given on pages 290 to 296 may be of help in studying each breed.

2. Make an outline drawing of the head of a Jersey and of a Holstein cow as seen from the front. If possible measure the length and width and draw to scale. The difference in the shape of the head is supposed to be one indication that these breeds are descended from two distinct forms of wild cattle.

COLLATERAL READING

Breeds of Dairy Cattle, U. S. Dept. Agr., Farmers' Bulletin 106.

Cyclopedia of American Agriculture, L. H. Bailey, Vol. III, pp. 301–302 and 330–382.

Types and Breeds of Farm Animals, C. S. Plumb, pp. 169–332.

Dairy Cattle and Milk Production, C. H. Eckles, pp. 27-106.

CHAPTER 3

SELECTION AND IMPROVEMENT OF DAIRY CATTLE

C. H. Eckles

Selection of a Breed

35. Selection of a Breed. One of the first questions that arises in starting a herd is the choice of a breed. There is a tendency to attach too much importance to this decision. In choosing a breed the following points should be considered.

1. Kind of cattle most common in the locality.
2. Form in which the products are to be marketed.
3. Topography, climate, and food supply.
4. Preference of the breeder.
5. Average production of milk.
6. Average production of butter-fat.
7. Economy of production of milk and fat.
8. Breeding qualities of the cows.
9. Vigor of the calves.
10. Adaptability of the calves for veal, and beef value of discarded cows and bulls.
11. Original cost and probable demand for surplus animals.

Most of the points have been discussed in the previous chapter. The advantages to the farmer of using the same kind of stock as his neighbors, should be given far greater prominence than his own preference or any small points of difference between breeds. The advantages may be enumerated as follows:

1. May save expense in buying males for breeding, and make it possible to make more use of a bull that is found to sire especially valuable animals.

2. It is a great advantage in selling stock, since buyers are attracted by large numbers of the same breed in one locality.

3. May save expense in official testing of registered cows for advanced registration.

4. Makes possible a local breed organization and creates greater interest in good stock and proper management.

If the pastures are steep and rocky, the more active breeds are likely to be most successful. Where pastures are luxuriant and where large quantities or roughage are used, the larger breeds are more at home.

Between similar breeds the preference of the breeder may decide the choice. For example, if location and market would suggest the Jersey or the Guernsey as the most suitable, the choice between the two might be easily determined by preference. If the dairy farmer expects to sell milk for market, wholesale or retail, his choice would hardly fall on the Channel Island breeds, unless the market is the exceptional one that will pay enough more for rich milk to justify its production. For milk production the Holstein, Ayrshire, or Brown Swiss would be the natural choice. On the other hand, if the location is such that cream is to be sold, then the Jersey and Guernsey breeds would come in for strong consideration on account of their well-known economical use of feed for the production of butter-fat. Under these conditions the probable value of skim-milk for pigs and for calf feeding is still another consideration and in some cases is sufficient to cause the choice to fall upon the Holstein on account of the large production of this valuable by-product.

When selling butter-fat, cream or butter, the total quantity of fat and not the percentage of fat is the important point. For cheese making and for market milk, the total solids, and not fat alone are what is wanted.

It is impossible to give data that are entirely satisfactory regarding the relative production of the breeds. The best figures the author has been able to gather are brought together in Table 10. These are yearly records of pure-bred animals as reported by experiment stations in the United States for animals owned by them. It is assumed that the conditions under which these records are made are fairly comparable with and certainly no more favorable than those found in good herds owned by individuals.

Table 10. — Production per Year of Cows Owned by Experiment Stations

Breed	Average Pounds Milk		Average Per Cent Fat for Year		Average Pounds Fat
	Number Cows	Pounds Milk	Number Cows	Per Cent Fat	
Holsteins	83	8699	83	3.45	300
Jerseys	153	5508	154	5.14	283
Shorthorns	37	6017	40	3.63	218
Red Polls	9	5906	9	4.03	238
Guernseys	17	5509	21	4.98	274
Ayrshires	24	6533	24	3.85	252

Individual Selection

36. Selection of Individual Cows. The success of a dairy farmer depends more upon the selection of the individuals within the breed than it does upon the choice of a breed.

The efforts of the breeder are constantly directed towards the development of the dairy breeds to the point where the characteristic of high milk production will be uniformly inherited. Even our poorest dairy cows give much more milk than was given under natural conditions. Although much progress has been made we must always expect many cows to fall below our standards because these standards are so far above nature. A certain number of the dairy cows with good parents will have inferior dairy qualities. No method of growing the heifer or of feeding the mature cow can make a naturally inferior cow into a good one. The cow must first of all have the tendency to use her feed for making milk. High production of milk results from selecting such a cow and then providing the proper amount and kind of feed. A cow of high dairy qualities will do little if any better than one of inferior quality unless given sufficient and suitable feed.

There is little evidence to support the common idea that an inferior cow is the result of wrong methods of raising as a calf. Recent experiments indicate that while the size of the animal and possibly the vigor may be influenced by the feeding when young, the tendency to produce milk is not much affected by the methods followed in raising the animal.[1] It should be clearly understood that this does not mean that it makes no difference how a calf is raised. It means that the efficiency of the cow as a milk producer is chiefly a matter of inheritance. Her yield of milk is the result of this inheritance plus the method of feeding and management.

If a cow shows one year that she has inherited a tendency toward milk production, she can be expected to produce

[1] Missouri Agricultural Experiment Station, Bulletin 135.

well for her entire lifetime. A cow that is a small producer by inheritance remains so year after year. The average yearly records in Table 11, selected from many kept by the writer for a number of cows for a term of years, indicate this fact. Some variation occurs, but Table 11 shows that

TABLE 11. — YIELD OF BUTTER-FAT OF DIFFERENT INDIVIDUALS BY YEARS IN POUNDS

BREED	FIRST YEAR	SECOND YEAR	THIRD YEAR	FOURTH YEAR	FIFTH YEAR	SIXTH YEAR	SEVENTH YEAR
Jersey	296	416	468	499	580		
Jersey	44	115	169	159			
Jersey	336	452	545	425	440		
Jersey	62	171	123				
Holstein	282	323	330	450	380	373	390
Holstein	151	167	210				

the good cows were good producers year after year, while the inferior ones remained poor just as regularly. Occasionally a cow has a poor year because she is out of condition, but normally the results will be uniform when the feed and care are the same.

37. Extent of Variation of Individuals. An abundance of data has been gathered within recent years to make it plain that the variation of individuals as milk producers is the greatest single factor in the success of the dairy. The Connecticut Experiment Station found the five most profitable in their herd were fed a year at a cost of $56.54 each, while the five poorest consumed feed worth $52.02. The best five averaged 304 pounds of fat for the year, and the poorest five 189 pounds. One group lacked $4.09 per cow of paying for their feed. The other group gave $26.91 per cow above the cost of feed. For $4.52 in additional feed

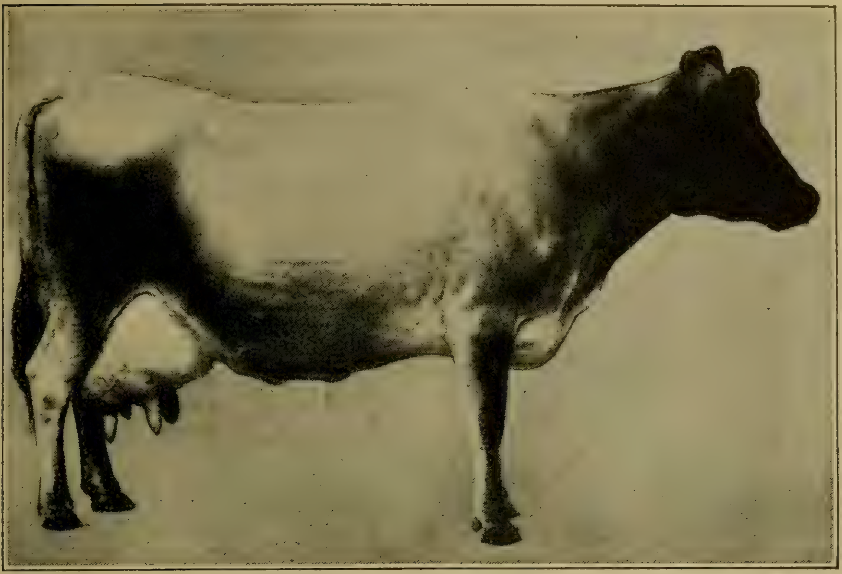

FIG. 7. — An example of wide variation in production. These cows are registered Jerseys and half sisters. The one above averaged 418 pounds of fat for the first three years in milk. With the same treatment the one below averaged 109 pounds of fat for the same three years. The variation in the production was due to inherited characteristics.

the animals in the better group produced 115 pounds more fat each.[1] Reports from the Southern States for 719 cows, covering in each case a full year, show that for each $1.00 invested in feed the best 10 cows gave returns of $2.20, while the poorest 10 cows barely returned the value of the feed. The best 30 cows produced three and a half times as much as the poorest animals.[2]

In the University of Missouri herd one pure-bred Jersey averaged 480 pounds of fat per year for three years, while her half sister averaged 114 pounds for the same period. A test of 18 Illinois herds, including 226 cows, showed the best herd to average 389 pounds of fat and the poorest 142.[3]

38. The High-producing Cows More Economical Producers. A striking fact brought out by all such figures is that the high producers will give a greater return from the same amount of feed. It costs from $10 to $15 more per year to feed the cow that produces 350 pounds of fat than it costs to feed the cow that yields 200 pounds. It is a common mistake to assume that it costs no more to feed a cow producing 10,000 pounds of milk per year than it does to feed one yielding 5000 pounds of milk of the same quality. The larger producer must use more feed, but not double that used by the smaller. The former will use about 25 per cent more feed than the latter, while the production of milk is 100 per cent more. In many herds that have not been carefully culled, a greater total profit might be realized by retaining one-half to two-thirds of the herd and disposing of the inferior cows, but a still better return may come from replacing the poor cows by good ones.

[1] Connecticut Agricultural Experiment Station, Bulletin 29.
[2] U. S. Dept. Agr., Bureau of Animal Industry, 25th Annual Report, p. 67.
[3] Illinois Agricultural Experiment Station, Circular 102.

SELECTION BY TYPE

39. How Individual Selection is Made. There are in general two methods of selecting dairy cows. The first is by type or conformation, and the second is by records of production. There is undoubtedly a certain conformation that generally goes with high milk production. This conformation is generally distinct enough to enable experienced judges to select very good from very inferior cows. As a rule it is fairly easy to select cows that will yield 300 to 350 pounds of fat per year from those that will give half that amount. It is not possible, however, to judge by this means alone which one will produce 300 and which one 500 pounds per year. Often even experienced judges will make decided errors in selecting animals by this method, especially if the cow is not in the most favorable condition to be judged. Since records are available for very few cows offered for sale, it is necessary for most cattle buyers to depend largely upon type.

If it were possible to select all cows when giving their largest yield of milk, judging by type would be reasonably accurate. Under practical conditions this is not possible, and cows have to be selected that vary from dry to the highest milk flow. The appearance of a dry cow gives little indication of her merits.

40. The Dairy Type. The three striking points in the conformation of a highly developed dairy cow are:

1. The spare angular form, carrying no surplus flesh but showing evidence of liberal feeding in her vigorous condition.

2. The extraordinary size and development of the udder and milk veins.

FIG. 8. — These pure-bred Jerseys illustrate a wide range in type and also the relation of type to production. The cow above shows good type. A large barrel with plenty of depth from hips to the udder, well-developed udder and milk veins. She produced 592 pounds of fat in a year.

The animal below, although perfectly healthy, is very shallow in body, has a small barrel, and an extremely small udder; she produced 122 pounds of fat in a year.

3. The marked development of the barrel in proportion to the size of the animal.

A high-class dairy cow rarely carries much flesh when in full flow of milk. At the same time her alert vigorous ap-

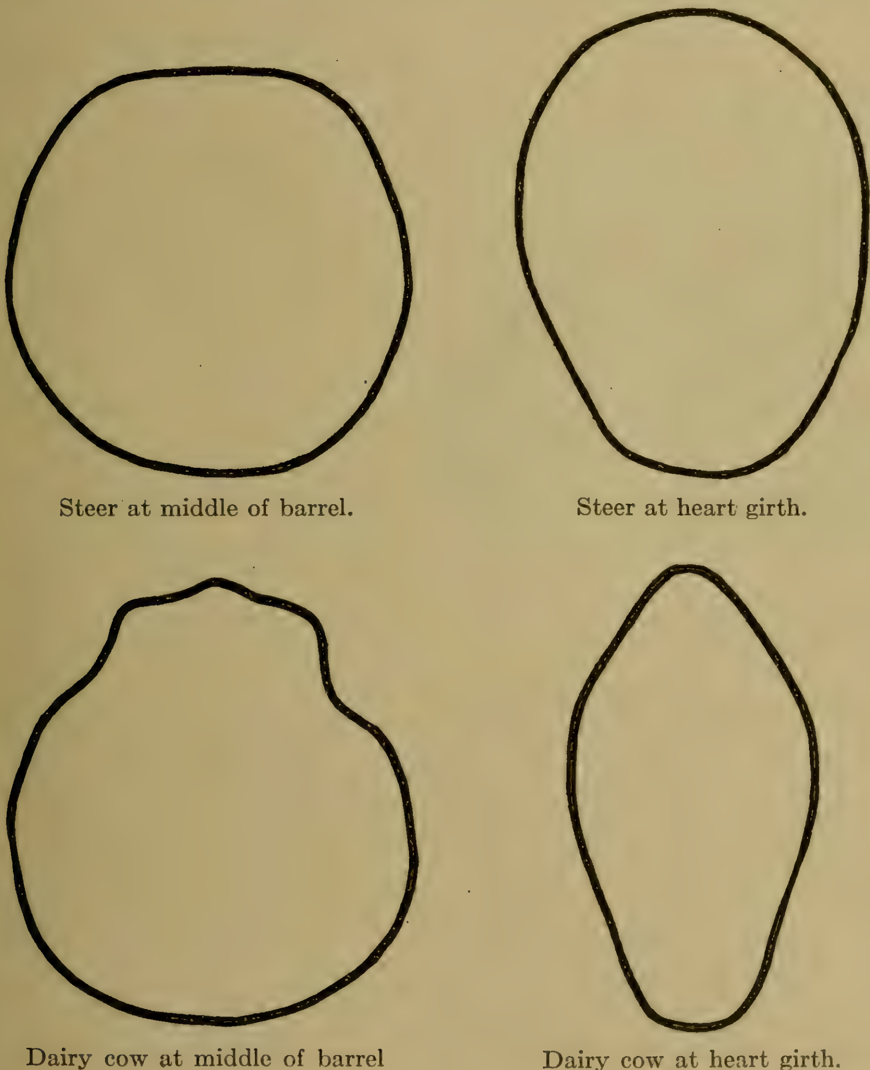

Fig. 9. — Cross section of a fat steer compared with that of a high-class dairy cow. Notice the large abdomen, bony back, and sharp withers of the cow. The skeleton of the steer is more fully covered with flesh.

pearance, her soft pliable skin and soft hair show that she is not thin on account of a lack of feed. An animal thin in flesh on account of insufficient feed has a stupid appearance and shows a lack of vigor, while the hair generally is rough and stands on end. In either case the paunch may be large or small, depending on the bulkiness of the feed consumed.

So characteristic is the angular appearance of the dairy cow that an animal that does not show this form when in full flow of milk should not be selected. When the cow is near the end of the lactation period, or is dry, she should carry more flesh, and it is a mistake to be too quick to condemn a cow at this stage for being too beefy.

FIG. 10. — A well-formed udder. Note the length of attachment to the body, and the well-developed forequarters.

The well-developed beef animal on the other hand is square and blocky. The general shape, leaving the legs and head out of consideration, is rectangular. The back is broad and level, the thighs full and straight.

This difference in the shape of the body of a high-class dairy cow and of a fat steer ready for market is shown by the cross sections in Fig. 9. These were obtained by a device that made it possible to get the exact outlines.

41. The Udder. A well-developed udder is the most important characteristic to be considered in selecting a cow for milk production. Since this gland has the function of secreting the milk, its size and development are of the greatest importance in judging the milk-producing ability of the cow. It is not alone size, but active secreting cells that count. For this reason a meaty hard udder that remains nearly as large after milking as before is of little value. The udder should have a long attachment to the body, extending well up in the rear and well forward in front. The quarters should be even in size without deep indentations between, and the teats should be of proper size for convenient milking and evenly placed. When the cow is dry, it is impossible to judge accurately of the development of the udder. However, a large amount of loose skin showing an abundance of room for expansion when the udder is filled may be taken as an indication that the udder will develop in a satisfactory manner. Little can be judged regarding the future size and shape of the udder in the calf or heifer until the time for calving approaches.

FIG. 11. — A well-formed udder. Figs. 10 and 11 are both high-producing cows.

42. The Milk Veins and Milk Wells. Large milk veins are one of the indications of high milk production that should be given careful attention. The blood after passing through the udder and supplying the cells with material for secreting milk starts back towards the heart through the milk veins. The name, of course, is a misnomer since they carry blood, not milk. One of these opens on either side near the front of the udder and passes forward just beneath the skin. These veins crook back and forth and sometimes separate into two or more divisions and finally pass upward through the wall of the abdomen into the body cavity. The portions of the veins from the udder to the openings through which they pass into the abdomen are spoken of as the milk veins. The openings are known as the milk wells. The milk veins are one of the most reliable indications of dairy quality, since a large milk production calls for a large flow

FIG. 12. — Udder of an inferior cow. This udder is large and well shaped but meaty, and is nearly as large after milking as before.

FIG. 13. — A very pendulous udder, objectionable because it interferes with the cow when walking, and because it easily becomes soiled.

of blood to the udder, and large milk veins indicate such a circulation.

43. The Barrel. The term barrel is applied in general to that portion of a cow's body between the hind and fore legs. The dairy cow to be a heavy producer must consume enormous quantities of feed. To do this requires large organs of digestion. A high-producing cow has wide-sprung ribs and a deep abdomen, giving great capacity for the digestive tract and other vital organs.

An animal lacking in barrel cannot use sufficient feed to make her a large producer. The age of the animal has some influence upon the size of the barrel. The apparent capacity is also influenced to some extent by the ration fed. Bulky feeds, such as hay and silage, when fed in large quantities give this effect. In considering the barrel development of a cow the depth as viewed from the side should be observed, then the width as viewed from behind. Some animals show

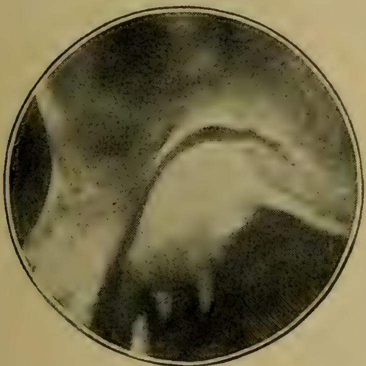

Fig. 14. — A typical weak fore udder, a very common defect.

Fig. 15. — Udder showing poor development behind, and short attachment to the body.

great depth but on account of being narrow really have a small capacity. In short a dairy cow should show great vigor, great capacity to use food, and should have a strong development of the milk-secreting organs, indicating that she is likely to use the food for milk production.

44. The Score Card. The score cards adopted by the various breed associations are shown on pages 290 to 296. These are designed to set forth the desirable characteristics of the breed and may be studied as a means of becoming familiar with breed types. The preceding discussion of the dairy type is general and applies to all breeds. It is based wholly upon the indications of milk production and does not take into account the many smaller points that go to make up a conformation that is symmetrical and pleasing to the eye. The breed associations in preparing their score cards, in

FIG. 16. — Defective udders. The one on the left is that of a pure-bred dairy cow that produced only 10 pounds of milk daily. This udder is extremely small, ill-shaped, weak in the forequarters, and the teats are too short. The one on the right has very small capacity with almost no development in the forequarters.

certain cases, apparently emphasize points in which the breed is likely to be deficient. An example of this is the large number of points given to the fore udder in the Jersey score card. Before using the score card the student should

FIG. 17. — A well-developed milk vein. On this cow the milk vein is over one inch in diameter and extends forward nearly to the front legs, entering the body through three milk wells on each side. The veins on the udder are also very prominent.

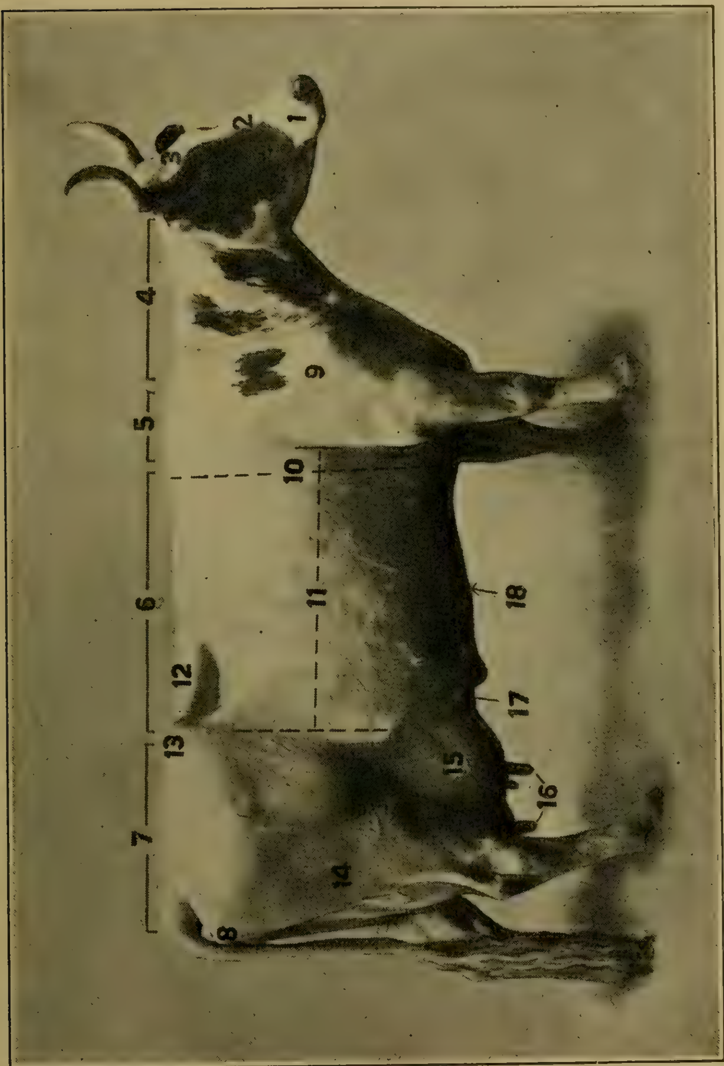

Fig. 18. — Points of a cow:

1. Muzzle	4. Neck	7. Rump	10. Heart Girth	13. Hips	16. Teats
2. Face	5. Withers	8. Pinbones	11. Barrel	14. Thigh	17. Milk Veins
3. Forehead	6. Back	9. Shoulders	12. Loin	15. Udder	18. Milk Wells

be familiar with the points of the animal as illustrated in Fig. 18. The use of the score card is an advantage to the beginner as a means of impressing the points to be taken into account and their relative importance. It helps to make the examination systematic and prevents one from forgetting points that should be observed. The value of the score card decreases as experience is gained. Judging in the show ring is done entirely by comparison.

The score card given on page 77 is in use by the Department of Dairy Husbandry, University of Missouri, and is an attempt to give the points that are important in teaching the selection of dairy cows for milk production. It gives comparatively little attention to the smaller details of conformation or to breed type.

Selection by Performance Records

45. Selection by Records. While it is often necessary to select cows by appearances when buying, it is not necessary to follow this plan after the animals are in the herd. A more business-like plan is to keep a record of production for each individual in order that the unprofitable animals may be known and rejected. The records to be kept will depend to some extent upon the use made of the milk. If it is sold by quantity regardless of quality, then the total production is the important fact. If the price of milk is based upon the butter-fat, both the quantity and the quality need to be known.

46. Overrating the Importance of Rich Milk. A common mistake in judging cows by records is attaching too much importance to the percentage of fat. The cow that produces the richest milk does not necessarily give the largest amount of fat, nor does it follow that she is the most economical producer. It is the total amount of fat that counts where fat is the basis of market value. Figures selected from accurate records kept by the author show the relation between the yield of milk, the percentage of fat, and the total fat yield.

TABLE 12. — RICH MILK *vs.* HIGH FAT PRODUCTION FOR THE YEAR

Breed	Yield Milk	Average Per Cent Fat	Total Fat Yield
	Pounds		*Pounds*
Jersey	2,796	6.29	176
Jersey	3,188	5.31	169
Jersey	13,895	4.90	681
Jersey	2,849	4.42	126
Holstein	18,405	3.36	618
Holstein	6,387	3.26	208
Holstein	26,861	2.76	741

These figures show that the highest percentage of fat is often accompanied by a low total yield. On the other hand a low percentage of fat may go with either a high or a low milk yield. The figures given, which are some of the extremes taken from the records of a large herd, also indicated clearly that the amount of milk varies much more than the percentage of fat. For this reason it is far more important to know how much milk a cow gives than to know its richness. If all the animals in a herd belong to the same breed, it is about three times as important to know the quantity as it is to have records of the richness, even where milk is sold by the fat content. For this reason the keeping of individual records of cows should always begin with the use of the scales. The cow owner should keep the records by weight and not by measure, and become accustomed to thinking of milk yields in terms of weights.

Three things should be known in order that the relative profits of each animal may be calculated. These are the amount of milk, the percentage of fat, and the cost of feed consumed. When comparing individual animals these factors rank in importance in the order given. While cows should be fed according to their production, it is not generally practical to keep an individual feed record of each. The best plan on the farm is to know the cost of feeding the entire herd and the total income above feed, and then make such calculations as may seem necessary to determine whether certain low-producing cows should be kept.

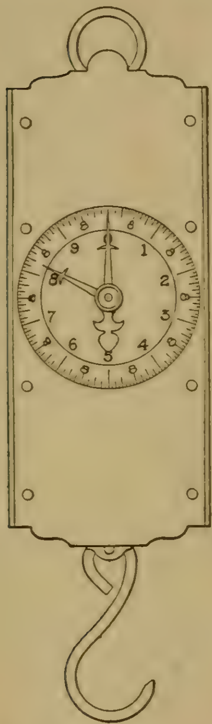

FIG. 19. — A good scale for weighing milk. The second pointer is set to read zero when the empty pail is attached.

47. Complete Milk Records. The most satisfactory plan of keeping records is to weigh the milk of each cow daily. This does not require much extra time when proper arrangements are made. The experience of every one who has tried it is that no time spent on the farm pays better. A spring balance, graduated to pounds and tenths, should be provided and placed at a point convenient for the milkers with the milk sheet close at hand. The advantages of daily weighing may be summed up as follows:

1. It makes it possible to reject the unprofitable cows.

2. Makes possible economic feeding. Individual cows should be fed in proportion to the amount of milk they produce.

3. Enables the herdsman to detect sickness. Often the first indication that a cow is out of condition is seen on the milk sheet.

4. Makes it possible to judge of the work of different milkers.

5. Creates interest among the milkers that results in better work on their part.

When milk records are kept in this form it is recommended that a sample covering two or three days be taken for a Babcock test. This sample is tested for fat, and the result considered the average for the month.

Some dairymen weigh the milk on the first and fifteenth of each month or at other stated intervals. From these weights the yearly production may be estimated fairly accurately, but the other advantages of daily weighing are enough to make daily weighing preferable. In large herds there is no way for the manager to keep close track of the business except by daily weighing.

48. Taking Samples for Testing. Where many cows are in milk, the most convenient way of taking a sample is with a sampling tube. If a tube is not at hand, a satisfactory sample may be prepared by taking equal quantities of milk from each milking with a very small dipper or spoon, and placing them in a jar. The milk should be well stirred before the sample is taken. Pint glass jars with tightly fitting covers are used to hold the samples. One is provided for each cow and is marked with her name or number. Except in very cold weather some preservative is used to keep the milk from souring before it is tested. For this purpose formalin, which may be purchased at any drug store, is best. Ten drops is sufficient to keep a sample for several days. The sample when complete is tested with the Babcock test.

MILK RECORD FOR THE MONTH ENDING ________________ 181

	NAME AND NUMBER OF ANIMAL																		
1 A.M																			
P.M																			
2 A.M																			
P.M																			
3 A.M																			
P.M																			
4 A.M																			
P.M																			
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P.M																			
30 A.M																			
P.M																			
31 A.M																			
P.M																			
TOTAL FOR MONTH																			
PER CENT. FAT																			

FIG. 20. — Form for daily milk record sheet.

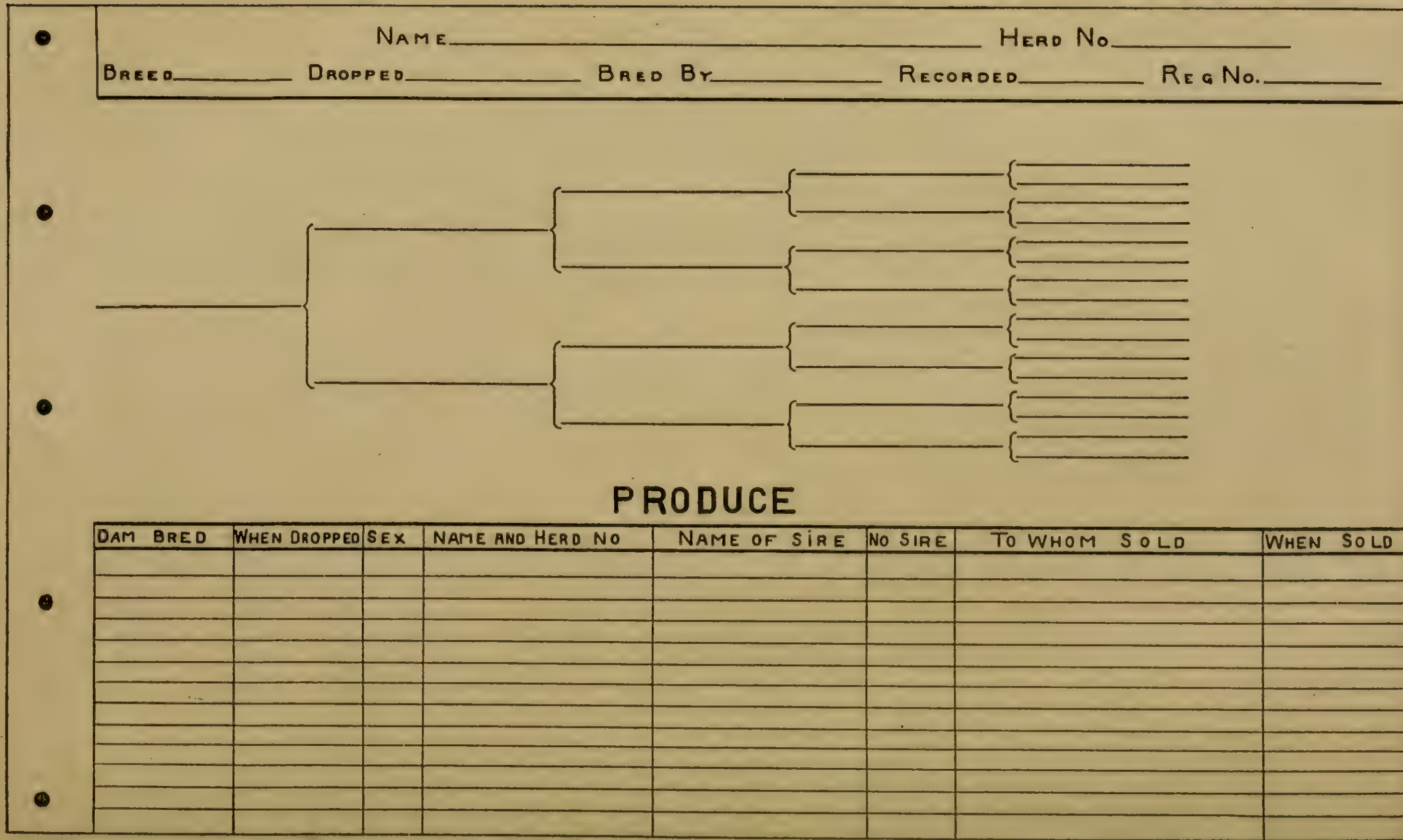
The reading gives the butter-fat per 100 pounds of milk. When butter is made, some curd, salt, and considerable water remain with the fat to make up normal marketable butter. The amount of butter generally exceeds the fat by about one-sixth and may be estimated if desired by adding this amount to the fat.

49. Averaging Tests. A common mistake results from averaging tests. A direct average of the tests made for a certain cow each month during the year will not be a fair average test of the total amount of milk produced during the year by this animal. This results from the fact that the amount of milk represented by each test is not the same. To find the true average test for the year the total fat yield for the period covered by the tests must be divided by the total yield of milk. The same method must be used in getting the average test for the herd.

50. Permanent Records. Many who begin keeping records do not make much of a success on account of not having a suitable form for a permanent record. Fig. 22 is a form that has been used with good satisfaction by the author for a number of years.

Using a blank book, a page may be ruled for each cow. Space sufficient for several years may be provided in this way in a concise form. In pure-bred herds the pedigree and records of offspring may be put on the page opposite the milk records.

51. Cow-testing Associations. Keeping records, especially of a large herd, involves considerable attention to details. To provide for this, coöperative cow-testing associations have been established in many places. This plan originated in Denmark in 1895, and the number of associations has since increased with great rapidity. At present



Dam Bred	When Dropped	Sex	Name and Herd No	Name of Sire	No Sire	To Whom Sold	When Sold

Fig. 21. — Form for herd record, designed especially for pure-bred herds. Can be printed in loose leaf style with the form shown in Fig. 22 on the reverse side of the leaf, or a blank book may be ruled for the purpose, placing the forms on opposite pages.

NAME ______ HERD NO. ______ REGISTRY NO. ______

—— SUMMARY OF MILK AND BUTTER PRODUCTION ——

For Month of	19 and 19			19 and 19			19 and 19			19 and 19			19 and 19			19 and 19			19 and 19			19 and 19		
	Lb's. Milk	% Fat	Lb's Fat	Lb's. Milk	% Fat	Lb's. Fat	Lb's. Milk	% Fat	Lb's. Fat	Lb's. Milk	% Fat	Lb's. Fat	Lb's Milk	% Fat	Lb's. Fat	Lb's. Milk	% Fat	Lbs. Fat	Lb's Milk	% Fat	Lb's. Fat	Lb's Milk	% Fat	Lb's Fat
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June																								
July																								
August																								
September																								
October																								
November																								
December																								
Yield for Period																								
No. Days in Milk																								
Record 365 Days																								

FIG. 22. — Each lactation period should be placed in a column by itself. If the first monthly record is for May, it should be placed in the line opposite that month at the first place this month appears in the column.

over 400 associations are in operation in that country and probably an equal number in other countries of Europe.

These associations are formed by groups of farmers owning from 500 to 1000 cows. A man is employed who goes from farm to farm spending a day at each. He weighs the milk from each cow and tests it for fat content. He calculates the yield of each cow for the month, the cost of feed, and income above feed cost. He also advises the farmer as far as possible regarding methods of feeding and other details. The cost is usually from $1 to $1.50 per cow each year. In a few cases in the United States the man who does the testing also keeps a full set of cost accounts for the farm.

52. Advanced Registry. One of the important factors in the improvement of dairy cattle is the system of advanced registration as conducted by the associations representing the different dairy breeds. The ordinary registration of animals insures the purity of their breeding, but does not indicate their individual merits. Advanced registration gives an accurate record of the production. Cows must be registered in the herdbook before the tests are made. If the production reaches or exceeds a certain standard, they are registered again in another series. This is called advanced registration. The weighing of the milk and the testing for fat are done by representatives of the experiment station in the state where the cow is owned. This insures an accurate record made by a disinterested person.

Many changes in the rules and requirements have been made for the various breeds since the system was begun in 1890. At present the standards set by the different breeds are not uniform, and occasional changes are made, so it is necessary for a breeder of pure-bred cattle to become familiar with the rules and practices governing his breed at the time.

In general it may be said, that while formerly most of the tests made covered seven days only, now all the tests except for Holsteins cover a full year. Where the year test is made, the owner weighs the milk each milking and the experiment station man weighs and tests it for fat two days each month. The average percentage of fat for the two days is taken as the average for the month. The Holstein breeders still use the seven-day plan most extensively, although many year tests are also made.

Where a seven-day test is made, a two-year-old cow must produce 8 pounds of fat for advanced registration. The amount required increases with the age of the cow. A five-year-old must produce 12 pounds or more of fat to be entered. The minimum for a year varies from 214 to 250 pounds of fat with the several breeds for two-year-olds, and for mature cows varies from 322 to 360 pounds.

The great value of the advanced registration system is the possibility it affords of putting the selection of breeding animals upon a sound basis. In selecting a male for breeding purposes, the pedigrees of its ancestors form about the only basis for judgment as to the probable character of its offspring. If the records show the production of each cow in the pedigree, it becomes possible to judge the value of the animal fairly accurately. Advanced registration is unquestionably the strongest factor now in operation for the rapid improvement of dairy cattle. The great mass of dairy cattle are not, and need not be, registered animals, and hence are not eligible to advanced registration. However, the system is equally valuable for grades, since improvement is transmitted to grade herds by the pure-bred sires. The addresses of the different breed associations are given on page 289. Further information can be obtained from them.

The following list includes the cows having fat records of 950 pounds or more in a year up to April 1, 1916:

Name of Cow	Breed	Milk in 1 Year	Fat in 1 Year	State in which Owned
Duchess Skylark Ormsby	Holstein	27,762	1205	Minn.
Finderne Pride Johanna Rue	Holstein	28,404	1176	N. J.
Finderne Holingen Fayne	Holstein	24,613	1116	N. J.
Murne Cowan	Guernsey	24,008	1098	Ohio
Ona Button DeKol	Holstein	26,761	1076	
May Rilma	Guernsey	19,673	1073	Penn.
Banostine Belle DeKol	Holstein	27,404	1058	Ohio
Pontiac Clothilde DeKol 2d	Holstein	25,318	1017	N. Y.
Sophia 19th of Hood Farm	Jersey	17,558	999	Mass.
High-Lawn Hartog De-Kol	Holstein	25,592	998	Ohio
Colantha 4th's Johanna	Holstein	27,432	998	Wis.
Spermfield Owl's Eva	Jersey	16,457	993	Mass.
Lothian Maggie DeKol	Holstein	27,968	991	Ohio
Maple Crest Pontiac Flora Hartog	Holstein	25,106	986	Ohio
Milanhurst America De-Kol	Holstein	26,433	985	N. Y.
Crown Pontiac Josey	Holstein	28,752	982	N. Y.
Maple Crest Pontiac Spotted Annie	Holstein	21,393	981	Ohio
Pearl Longfield DeKol	Holstein	28,050	972	Wis.
Caroline Paul Parthenea	Holstein	25,073	967	Wis.
Eminent's Bess	Jersey	18,783	963	Mich.
Daisy Grace DeKol	Holstein	21,718	963	Ohio
Finderne Mutual Fayne	Holstein	22,150	961	N. J.
Spotswood Daisy Pearl	Guernsey	18,603	957	Ohio
Lily of Willowmoor	Ayrshire	22,596	956	Wash.
Jacoba Irene	Jersey	17,253	953	Ill.
Tilly Alcartra	Holstein	30,451	951	Cal.

53. Relation of Age of Cow to Yield and Richness of Milk. Under ordinary farm conditions the dairy cow freshens the first time at from 24 to 30 months of age. On an

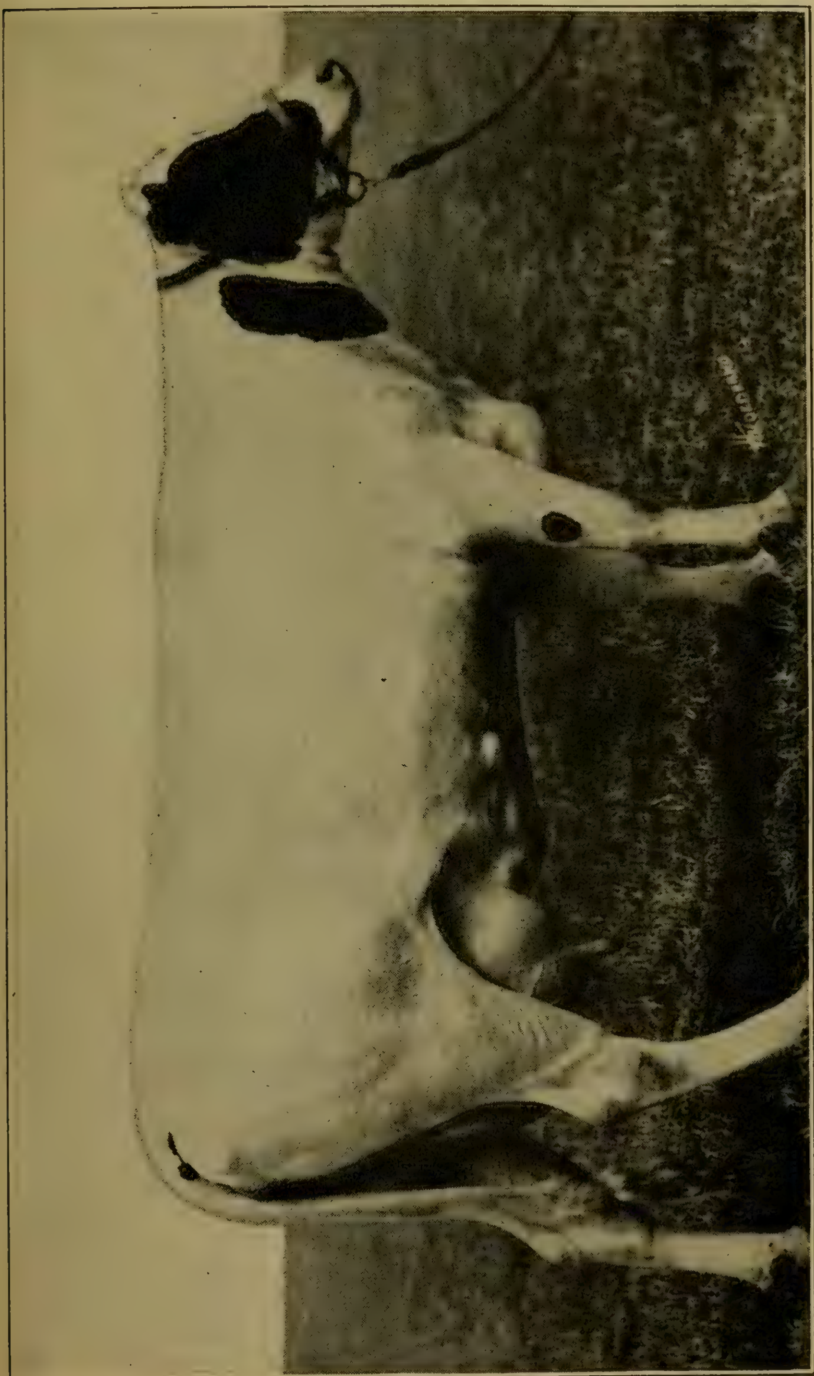

FIG. 23. — Finderne Holingen Fayne, a pure-bred Holstein-Friesian with a record of 24,613 pounds of milk and 1116 pounds of fat in one year. When made it was the highest record ever made by a three-year-old cow.

average the production of milk for the lactation period increases each year until the cow is about five years old, after which the production remains fairly constant until the animal reaches at least 11 or 12 years.

On the average a well-grown two-year-old may be expected to produce 70 per cent, a three-year-old 80 per cent, and a four-year-old 90 per cent of the milk and fat that she will pro-

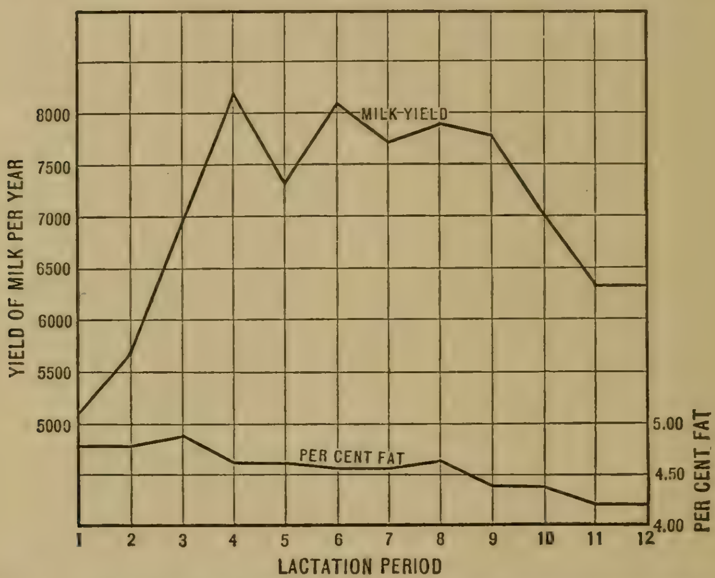

FIG. 24. — Influence of age on yield of milk and percentage of fat, averages for six Jersey cows for twelve years.

duce when mature. The highest production for a year may come anywhere between the 4th and 11th year. Two-year-olds that are not well grown may not give over half as much as when mature. If a cow continues to breed, her milk flow usually shows little decline until she is 12 years old and sometimes even older. Probably the majority of dairy cattle are rejected from the herd on account of failure to breed, or from udder troubles before the effect of advancing years can be observed to have had any effect upon the milk production.

The richness of milk is less affected by age than is the quantity. The average fat content remains practically constant from year to year except that after the cow is eight or nine years old the percentage of fat always declines slowly and gradually with advancing years. A Jersey cow, for example, that averages 5.0 per cent fat when in her prime will decline to about 4.5 per cent when 12 to 15 years of age. The following gives the average percentages of fat by lactation periods for four Jerseys the records of which are complete for 9 years.

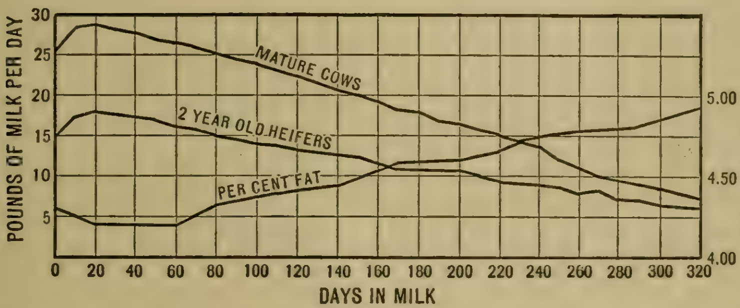

FIG. 25. — Influence of the advance in lactation period upon the milk yield and fat content, averages for ten mature cows and ten two-year-old heifers.

Lactation period	1	2	3	4	5	6	7	8	9
Per cent fat	4.89	4.82	4.96	4.64	4.62	4.62	4.57	4.49	4.39

Selection of a Bull

54. The Selection of the Bull. The successful development of a dairy herd depends more upon the selection of the bull than on any other one thing, unless it be the proper culling out of inferior cows. One-half the inheritance of each young animal in the herd comes from the bull, and for this reason his influence on the herd is far greater than is that of one cow who will have at most only a few daughters. This is the basis of the old but true saying, "the bull is half the herd."

The main opportunity for improvement in a native or mediocre herd is by using a good sire. For example, one

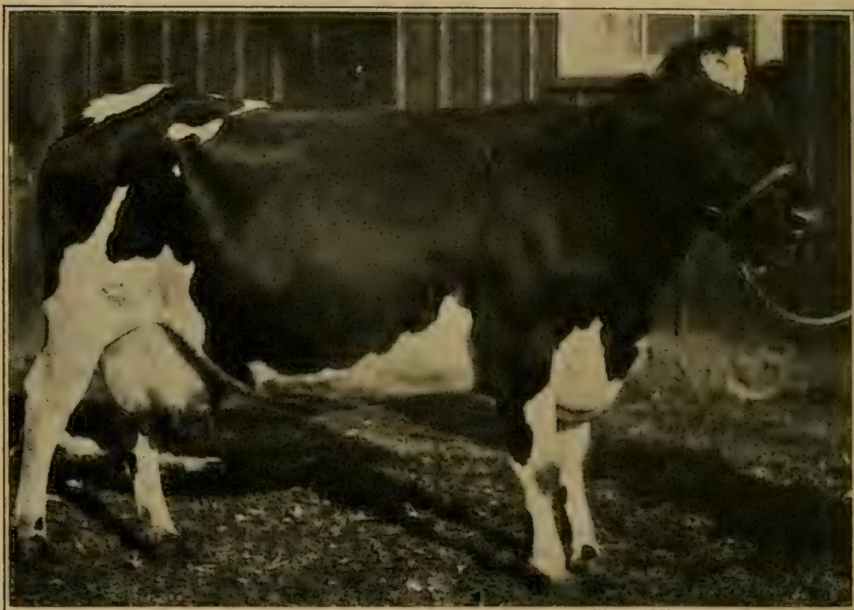

FIG. 26. — An excellent three-quarters-bred cow, showing what a pure-bred sire can do in two generations. The grandmother of this cow was a rather poor milker. She herself produced in nine years, beginning when she was two years old, 96,800 pounds of milk and 3814 pounds of butter.[1]

bull might be the sire of 20 daughters in a herd in one year. If the dams be capable of producing only 200 pounds of fat yearly, and if the sire represents a breed or strain the cows of which are capable of producing 350 pounds of fat per year, it is evident that, if the daughters averaged only half way between, there would be an increase of 75 pounds per cow

[1] The Cornell Reading-courses, Vol. III, No. 54, p. 53.

annually. It is not at all uncommon to find even greater differences than this in actual practice.

The first cross of improved blood makes the offspring one-half, the second, three-fourths, the third, seven-eighths of the same blood as the improved breed. The continued use of pure-bred sires of the same breed for 10 to 15 years will change a scrub herd until it will have essentially the same characteristics as the improved breed. The careful breeder gives a great deal of thought to the selection of the sire for his herd. The more skilled the breeder, the greater the care taken in this respect. Almost any pure-bred bull will improve a scrub herd, but only the bull of the best inheritance will increase or even maintain the standard of a highly developed herd.

55. Difference in Transmission of Dairy Qualities by Different Bulls. There is a wide variation in the way different bulls transmit dairy qualities. This fact is illustrated by the data in Table 13, compiled by the author from the records of the Jersey herd owned by the University of Missouri. This herd is descended from three cows. Complete milk and butter-fat records for 21 years make these comparisons possible. The comparisons are made in each case between the production of the daughters of the various sires used and the dam of these daughters. The figure 4381, for example, given as the milk production of the daughters of Missouri Rioter is an average of the production of each daughter which is found in turn by taking the average of all the lactation periods of the particular animal. If in any case the daughter had only three or fewer lactation periods, the comparison is between those and the corresponding periods for the dam.

TABLE 13. — INFLUENCE OF THE SIRE SHOWN BY A COMPARISON OF THE RECORDS OF DAUGHTERS WITH DAMS

	Averages for all Lactation Periods	
	Dams	Daughters
Missouri Rioter		
Milk Yield	5380	4381
Per cent fat	4.35	4.93
Yield of fat	234	216
Hugorotus		
Milk yield	4969	4576
Per cent fat	4.66	5.35
Yield of fat	231	245
Lorne of Meridale		
Milk yield	4559	6050
Per cent fat	4.85	4.81
Yield of fat	221	291
Missouri Rioter 3rd		
Milk yield	4775	8005
Per cent fat	4.98	4.80
Yield of fat	238	384
Minette's Pedro		
Milk yield	5321	5376
Per cent fat	5.03	5.04
Yield of fat	268	271
Daisy's Prince of St. Lambert		
Milk yield	5362	3932
Per cent fat	5.07	5.03
Yield of fat	269	198
Brown Bessie's Registrar		
Milk yield	6069	4607
Per cent fat	4.94	4.97
Yield of fat	300	229
Fairy's Lad		
Milk yield	6219	6169
Per cent fat	4.80	5.24
Yield of fat	299	323

Many interesting comparisons may be made of the comparative values of these bulls. For example, the daughters of Lorne of Meridale averaged 1491 pounds of milk more per year for their entire lifetime than did their dams. Eleven out of thirteen were superior to their dams. If thirty daughters of this bull had been milked in one herd, their production would have exceeded that of their dams by 44,730 pounds per year. At $1.50 per 100 pounds the income would be $671 per year more for the thirty daughters than for their mothers. If the animals were daughters of Missouri Rioter, they would have produced 999 pounds each less than their dams or a total of 29,970 pounds less milk than their mothers in a year. At $1.50 per 100 pounds this would be a decrease of $450. It would then make a difference of $1121 per year whether these thirty cows be daughters of Missouri Rioter or Lorne of Meridale. If we make the comparison directly from the average yield of the daughters, the difference would be 50,070 pounds of milk per year worth $751 at $1.50 per 100 pounds. If the greatest extremes be taken for comparison, as Missouri Rioter 3d and Missouri Rioter, the difference is far greater.

56. Methods of Selecting a Bull. There are two ways of selecting a bull:

1. On the basis of his pedigree and appearance.
2. From the records of his daughters.

The pedigree is the most reliable means of judging the probable value of a young bull. The system of advanced registration now in use makes it possible to obtain reliable information concerning the dairy qualities of most of the registered animals. In selecting a young bull one should have these records before him. The points to be considered are especially the records of the cows that are the close ancestors of the bull. It should also be observed to what extent the bulls have sired high-producing cows. A well-bred bull should have a large number of these records in his pedigree.

Many persons overvalue an animal that carries a small fraction of the blood of one noted animal. A pedigree that shows moderately good parents and grandparents is better than one that has one or two unusually good ancestors and the rest mediocre. A noted animal farther back than grandparents has no very great significance if the nearer relatives are not good.

It is doubtful if the conformation or appearance of the bull in any way indicates his value as a sire of superior milking cows. On the other hand it is possible to judge from his conformation to some extent as to the probable type of his daughters. The only really safe plan for the owner of a highly developed herd is to select a bull having daughters in milk so that he may know the characteristics that the bull transmits to his offspring. This, of course, can only be done in a few cases but is always advisable when possible. Care must be taken not to introduce disease by obtaining a bull from a diseased herd.

57. Cross-breeding. Crossing means the mixing of the blood of two distinct breeds. It is a practice that is common among American farmers. The object sought is to combine the most desirable characteristics of the two breeds. The practice has nothing to recommend it. Breeds have been developed and are kept pure in order that certain characteristics may be transmitted regularly to the offspring. When two distinct breeds are crossed the chain of inheritance is broken and all possible combinations of the characteristics of the two breeds appear. For example, a farmer having

Jersey cattle may become dissatisfied with the milk yield and cross them with Holsteins, expecting to combine the Jersey quality of rich milk with the Holstein characteristic of a large milk yield. Some animals may show this combination, while just as many may inherit a low yield from the Jersey parent and a low percentage of fat from the Holstein. The proper course is first to select the breed that best meets the requirements, and then to continue along this line unless it is found after sufficient trial that a serious error has been made.

QUESTIONS AND PROBLEMS

1. Calculate the average percentage of fat for the year for two cows making the following records by months:

	Cow 1		Cow 2	
	Pounds Milk	Per Cent Fat	Pounds Milk	Per Cent Fat
January . . .	631	3.4	140	4.5
February . .	600	3.3	0	0
March . . .	450	3.8	1040	4.0
April	440	3.5	1800	3.3
May	390	4.0	1850	3.0
June	280	4.0	1720	3.2
July	140	4.3	1500	3.0
August . . .	0	0	1450	3.0
September . .	950	4.0	1480	3.2
October . . .	1280	3.2	1200	3.4
November . .	1356	3.4	1000	3.8
December . .	1280	3.7	600	4.0

2. Compare the multiplicity of breeds in one neighborhood in this country with conditions in Europe.

3. What advantages are there in having one breed only in a community?

4. Are there any breeders' organizations in your county or state?

5. Are there any cow-testing associations in your county or state? If so, obtain any published results that are available.

What differences in production are found for different cows in the same herd?

6. Define lactation period.

7. Do you know any farmer in the region who weighs the milk from each cow?

8. Distinguish between rich milk and high yield of butter-fat.

9. How is milk sold in this region, by pound, quart, or on butter-fat basis?

10. What is the object of having distinct breeds and keeping them pure?

11. What is the distinction between a grade and a cross-bred animal?

12. Who in this county owns any advanced registry cows?

13. If a Jersey heifer calved at two years of age and in a year produced 3000 pounds of milk, testing 5 per cent fat, how much milk can she be expected to produce when mature? What will her yearly production of butter-fat probably be? Compare with the average for experiment station herds. Is she a good heifer?

14. Considering the proportion of fat to remain the same when the heifer becomes a cow, complete the following table. Consider the average butter-fat production of the experiment station herds of the breed as 100 per cent when filling the last column. Which ones are good animals?

Breed	Age at Freshening	Production in Following Year			Probable Fat Production per Year when Mature	Comparison with Experiment Station Herds
		Milk	Per Cent Fat	Total Fat		
Holstein	$2\frac{1}{2}$	7022	3.7			
Holstein	3	7506	3.8			
Holstein	7	8321	3.4			
Jersey	3	3472	4.9			
Jersey	6	5743	5.1			
Guernsey	$3\frac{1}{2}$	4113	5.2			
Guernsey	5	4223	4.8			
Shorthorn	$3\frac{1}{2}$	5342	4.0			

15. From the figures given on page 17 does there seem to be any danger of over-production of pure-bred cattle in the near future?

Score Card for Dairy Cows

Scale of Points	Per Cent	Cow's Number 1	2	3	4
INDICATING EFFICIENCY OF MILK SECRETING SYSTEM					
Udder — large, evenly quartered, well held up, not meaty, attachments long, teats squarely placed, and of convenient size	30				
Milk Veins — capacious, entering large wells	10				
	40				
INDICATING CAPACITY					
Muzzle — wide	1				
Jaw — wide in angle, strong	1				
Barrel — deep, wide, long, well held up, with ribs broad, long, far apart, slanting, well sprung	23				
	25				
INDICATING CONSTITUTIONAL STRENGTH AND VIGOR					
Nostril — large, expanded	1				
Eye — prominent, bright, intelligent .	1				
Chest — wide, deep	4				
Skeleton — developed for strength, of good quality: roomy, long, and level at pelvis	5				
Skin — loose and mellow showing good circulation and secretion	2				
Carriage — energetic, prompt, alert . .	2				
	15				
INDICATING DAIRY TEMPERAMENT Body wedge shape. General appearance angular and lean, yet clean-cut and neat in every part	10				
BREED TYPE Points characteristic of the particular breed, such as size, color, temperament, ruggedness of build, etc.	10				
SCORE					

Fill out the following, showing which cow you would place first, second, etc., and compare with the score as given above. If milk records are available also, compare with these.

	First	Second	Third	Fourth
Placing				
Score				

LABORATORY EXERCISES

3. The Parts of a Cow. Go to a dairy barn or otherwise arrange to have a cow to study. Without the textbook let each student point out each of the parts of a dairy cow as shown in Fig. 18.

4. Make out a Pedigree. If herdbooks of any breed are available, or if they can be borrowed from a breeder in the region, make a pedigree. If advanced registry books are available, fill in the A. R. O. data. If different students take different animals, the pedigrees may be compared to see which animal shows the best breeding. If any farmer in the region has advanced registry animals, pedigrees of these may be worked out, and the same animals may be used for judging, so that comparisons may be made on the basis of both breeding and individuality.

5. Judging Dairy Cattle. Go to a dairy barn or otherwise arrange to have cows to study. Using a score card like the one on page 77, make comparisons of two or more animals.

Give the reasons for ranking the animals in the order given. Begin the reasons with the most important difference between the animals compared and give all the leading differences. Make the answers terse and concise.

6. Weighing Milk. If any farmer in the region desires to coöperate with the school, take the class to his farm and get the method of weighing started as directed on page 58. Test the milk, and complete the records monthly. Feed records may also be taken by a member of the class weekly or monthly. A still better exercise for students who are living on farms is to have them keep the milk records.

COLLATERAL READING

Cyclopedia of American Agriculture, L. H. Bailey, Vol. III, pp. 26–43, 51, 303–306, 308.

The Dairy Herd, Its Foundation and Management, U. S. Dept. Agr., Farmers' Bulletin 55.

Dairy Cattle and Milk Production, C. H. Eckles, pp. 17-26; 116-174.

CHAPTER 4

MANAGEMENT OF DAIRY CATTLE

C. H. Eckles

58. Decline of Milk Production in Summer. Milk production of the average herd falls off rapidly in the latter part of the summer. It is not uncommon for the amount of milk sold by a farmer in August to be no more than half that marketed during June. At the season when this rapid decline of milk occurs the animals are greatly annoyed by flies. The flies are often looked upon as the main cause of this decline. There are good reasons for believing that the effect of the fly is overestimated. Where soiling or grain feeding is practiced, the decline at this season is little more than the normal one for the stage of lactation represented by the cows. The main cause for the decreased production at this time of the year is undoubtedly the failure of the cows to eat a sufficient amount of feed. This lack of feed may come from poor pasture due to dry weather, or it may result from the fact that the cows do not graze sufficiently because of the hot weather and the annoyance of flies. The cow is sensitive to excessive heat, and this is probably in most cases a stronger factor than the flies. The main precaution to be observed is to make certain that the animals have plenty of feed easily accessible.

59. Protection from Flies. Cattle in this country are troubled most by two kinds of flies, known as the stable fly and the horn fly. The stable fly resembles the house fly except that its mouth parts enable it to bite while the house fly cannot. The horn fly is a native of Europe and was introduced into this country about 1886. It is recognized from its habit of feeding with wings spread, and it usually travels in swarms. It is also seen at times gathered around the base of the horn.

Many of the flies that annoy cattle are hatched in manure. The first precaution to be observed, in any attempt to reduce the number, is to avoid an accumulation of manure where it will remain moist, especially near the barn. Horse manure is preferred by these pests, but they breed in any, even that dropped in the fields by the animals. No practical method has been devised that will do more than reduce the number of flies very slightly. Large fly traps in the barn have been used with some success. Screens on the barn are generally found worse than useless since the flies accompany the animals into the barn and then remain in the barn if the windows are screened.

Milk rooms should always be protected by screens, on account of the serious danger of flies carrying germs of human diseases into the milk.

In recent years a great many preparations designed to repel flies have been placed on the market. These fly repellents consist chiefly of some coal tar products with the addition of fish oil, resin, or pine tar. Results at three experiment stations go to show that there is little value in using these preparations. If they are applied daily, it is possible to keep the flies away fairly well, but it is questionable whether the animal does not suffer more from having the pores of its skin closed up with the oily substance than it does from the insect. There is no appreciable increase in the milk flow when these substances are used.

60. Dehorning. There are many reasons for dehorning the animals in the ordinary business herd. Horns are responsible for frequent injuries and serve no useful purpose. Dehorned cattle may be housed in much smaller space and are fed and watered together with much more convenience. As a matter of safety it is well to dehorn bulls. There is no reason for believing that any bad effects follow. It is not advisable to dehorn animals that are to be used for exhibition purposes. While animals without horns are occasionally found in the show ring, they are at a disadvantage.

Calves may be dehorned successfully by using caustic potash (potassium hydrate) when they are a few days old. The hair is clipped away from the small buttons which later develop into horns. The caustic potash is moistened and rubbed on the spot until the skin bleeds slightly, or is just ready to bleed. Care should be taken not to use too much. If sufficient potash has been applied, a dent will be left in the skull after a few days and no horns will ever develop. Persons who have had considerable experience sometimes use this method on calves that are nearly a month old, but it is best done during the first week, after that more skill is required. A few cases have been reported where so much water was used that it ran down into the eyes and put them out. One man used so much potash that holes were eaten through the skull and the calves killed. Such accidents are inexcusable. In using potassium hydrate wrap paper around the end of the stick to prevent injuring the fingers.

After an animal is at least one year of age, it may be dehorned by using the saw or special dehorning clippers. Dehorning with the saw or clippers should be done in cool weather in the spring or autumn.

61. Marking Calves. In raising pure-bred cattle it is important that some system of marking be adopted which will make it possible to identify the individuals. This is more important with dairy cattle than with beef breeds, since the calves are taken away from the mothers soon after birth. A number of systems of markings are in use. One plan is to insert tags in the ears. There are many forms of these. They are numbered, and if desired the name of the owner is included. The general objection to this system is the possibility that the tags may be torn out. Another plan is to place a numbered brass tag on a strap about the neck. This is removed when the animal is larger and well known to the owner.

The tattoo system is also used with success. This consists in printing letters or numbers in the skin of the ear with India ink. The instruments are so made that a combination of letters or figures may be used. These tattoo marks when properly applied are permanent and do not disfigure the animal. They cannot be seen at a distance, but make it possible to positively identify the animal. This system is the most satisfactory with breeds having light-colored skin.

The system followed by the writer is to place a strap bearing a number on a brass tag around the neck of the calf before it is taken from its mother. This strap is left on until the animal is nearly mature. The tattoo mark is then put on the ear.

The color markings of Holsteins, as shown on the diagram of the application for registry or on the pedigree, enable one to identify these animals. But ear tags or other marking systems are also desirable when large numbers are kept.

62. Shelter. The housing of the dairy cow naturally depends upon climatic conditions. She should not be exposed to severe cold weather. Cold rains and snowstorms are especially to be avoided. The most favorable temperature has not yet been experimentally determined, but observation teaches that a barn temperature around 40 or 50° F. is as favorable as any. In cold climates the cow should remain in the barn during the cold season except for a few hours during the middle of the day while the weather is mild. On stormy days or during extreme cold she had better be kept inside constantly. Many barns in such regions are kept too warm. In warm climates it is not necessary to house the animal so closely as this. An abundance of fresh air is as necessary for the health of the cow as for any other animal. This should be supplied by proper ventilation and not through the walls of an improperly constructed barn, or by leaving the cow outdoors exposed to severe weather. Excessively warm weather is far more injurious to the cow than moderately cold. There is no practical means of making the animal comfortable when it is too hot. For this reason hot weather and warm climates are not favorable for high milk production, especially if accompanied by a high humidity.

FIG. 27. — Teaching a calf to lead: good training for both parties.

63. Milking the Heifer. If the young cow is properly managed before she has her first calf, there is little difficulty in teaching her to be milked. Calves should be accustomed to being tied when small, and if this is done there will be no trouble from tying at any later time. Before freshening, the heifer should be tied for a month or more in the stall where she is to stand when in milk. A careful man should handle her and take care not to excite her. It is especially necessary to use patience and care when she is first milked.

64. Methods of Milking. There is a great difference in the efficiency of milkers. One man may get 20 per cent more milk than another from the same cow. A careless milker may dry up a cow within a few months while a good milker may keep up the milk flow for the entire year. Men who care for cows should always move among them quietly and not startle them by sudden movements or loud talking. The cow cannot control the secretion of milk by her will but it may be affected by excitement. Anything unusual, such as the presence of a dog or a stranger at milking time, will cause some cows to give less milk. Changing milkers is likely to result in a loss of milk for a few milkings, but if the new milker be equally proficient the cow will soon return to the usual amount. However, the milkers should be changed as little as possible. The milking should be done quickly and quietly. If the cow is accustomed to eating grain while being milked, she will not do well without having it every time. She can easily become accustomed to being milked either before or after eating, but always should be treated in the same manner. Care should be taken to get all the strippings, since while the first milk drawn may contain as low as 1 per cent of fat, the last contains from 6 to 9 per cent. The teats should always be dry when milked. Wetting the teats is all too common but it is a filthy practice. A small amount of vaseline rubbed on the hands serves the same purpose as wetting the teats and is not at all objectionable.

65. Hard-milking Cows. Some cows cause considerable annoyance because they milk unusually hard. This condition, which is caused by a strong muscle (sphincter muscle) that closes the opening of the teat, can be remedied by proper treatment. Instruments are made by means of which it is possible to overcome the difficulty with no danger to the animal. In most cases the use of teat plugs alone is sufficient. These plugs, which are made of rubber or lead, are placed in the teat duct and allowed to remain there until the next milking. This is continued until the muscle is somewhat relaxed and the opening remains larger. In severe cases a cutting instrument known as the teat slitter (bistoury) is used. This operation should be performed by a veterinarian or one having experience in the use of such instruments. In using teat plugs, milk tubes, or any instruments which are inserted in the duct of the udder, great care must be taken to sterilize the instruments thoroughly before using them, for if germs gain access they may cause serious trouble. A two per cent solution of carbolic acid or a weak solution of creolin is suitable for disinfecting instruments. It can also be done by boiling them in water just before using. The teats should be thoroughly cleaned before inserting any instrument.

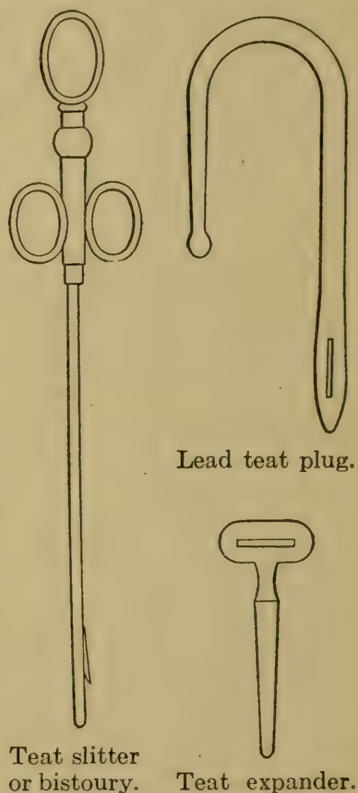

FIG. 28. — Instruments used in treating hard-milking cows.

66. Effect of Interval between Milkings. If the cow be milked twice a day at twelve hour intervals, there is usually no marked difference between the night and morning milk. If the periods are unequal, the larger amount of milk and the poorer quality follow the longer period. Heavy-producing cows and all that are being handled to obtain the largest record should be milked three times a day. Few cows can produce over 60 pounds of milk with two milkings, and when 75 to 80 pounds per day is reached, the production will seldom go higher unless the cow is milked four times each twenty-four hours. Heavy-producing cows may profitably be milked three times a day. With cows of ordinary capacity the increased yield is not sufficient to pay for the extra labor. A cow that will produce 60 pounds per day with two milkings as a rule will increase to at least 70 if milked a third time. The richness of the milk of heavy milkers is increased somewhat when they are milked more than twice per day. If many cows in the herd are giving over 50 pounds when milked twice a day, it will pay to try milking three times.

67. Milking Machines. A satisfactory milking machine has long been one of the greatest needs of the dairy farmer. While it can hardly be said that the milking machine is out of the experimental stage, still it seems sufficiently well developed to be considered a commercial success at the present time. It is thoroughly demonstrated that by its use a skilled operator can do as good work as the average milker. It is still a question whether the amount of milk obtained during the lactation period by a milking machine is equal to that obtained by a good milker. It is quite certain that the cow is not injured by the use of the milking machine.

Provided the machine is properly cleaned and used, the sanitary condition of the milk is better than under ordinary conditions, but with careless handling of the machine the milk may be in worse sanitary condition than that produced by hand milking. So far the milking machine seems adapted only to herds of 30 cows or more. One milker with a suitable outfit can milk from 25 to 30 cows per hour. The indications are that the use of the milking machine will be widely extended in the near future. As a result many more large dairy herds will be kept. The labor problem is at present the main factor in the way of maintaining large herds. The proper management of a machine requires considerable mechanical ability.

68. Cows with Leaky Teats. Some cows lose a portion of the milk by leakage from the teats before milking. No practical remedy has been devised. If conditions warrant the trouble, the cow may be milked three times a day or the teat opening may be closed after the milking by applying collodion.

69. Bloody Milk. Bloody milk is much more common than is generally supposed. Traces of blood are often found in the separator bowl after milk has been separated although its presence was not suspected. It is not an indication of disease or any unhealthy condition of the cow. It is caused by the rupture of a small blood vessel, which allows the blood to escape into the milk ducts. Sometimes certain cows have this trouble for several months but more often it appears only once or twice. It cannot be prevented or stopped by any specific treatment. One should see that the cow is not being injured in the udder by being stepped on by cows in adjoining stalls or by any other cause. As a rule the cow recovers in a short time with no special treatment.

70. Chapped Teats. Chapped teats may occur in cold weather. The application of vaseline for a few times at the first appearance of the trouble will usually check and cure it. For severe cases the teats should be thoroughly washed and softened with warm water, after which glycerite of tannin may be applied.

71. Warts on Teats. These are often troublesome but usually disappear of themselves. They may be treated by applying vaseline or olive oil. If large, they may be cut off with a pair of sharp scissors and the spot touched with a stick of caustic potash.

72. Bitter Milk. This trouble is most often found where one or two cows are kept to provide a family milk supply. The trouble is confined mostly to cows that have been in milk seven months or more. It rarely occurs when the animal is receiving green feed. The milk has a peculiar taste, described by some as salty but more often as bitter. The taste is present in the fresh milk but it seems to become more noticeable as the milk stands. The cream from milk of this kind churns with difficulty and sometimes will not churn at all.

The cause of this trouble and a remedy for it cannot be given with certainty. It most frequently occurs when the animal is overfed with grain. The only treatment that offers promise of removing the trouble is to reduce the grain feed to the amount actually needed by the animal, or preferably less, for a while and to give two or three doses of 1 to $1\frac{1}{4}$ pounds of Epsom salts at intervals of from three to four days.

73. Kicking Cows. The habit of kicking is due usually to wrong management. Cows kick at first from either fear or pain. If not properly handled, they may develop the habit. Striking a cow that kicks makes her worse. In case the cow's teats are sore, use vaseline, or in severe cases, use a milking tube, until the injury can be healed. If the cow is afraid handle her gently. In some cases gentle measures will not work. Some old cows that have got into the habit cannot be cured. Such animals should be tied during milking. This is best done by using a rather heavy strap with a buckle and a loop. The strap is put around one leg above the hock and the end drawn through the loop. The strap is then put around the other leg and buckled so the two legs are held close together. The cow soon learns to stand quietly as long as the strap is in place.

74. Self-sucking Cows. This habit is not very common but it is difficult to break up when once it is acquired. Occasionally one cow will suck another one. If an ordinary cow contracts the habit, the best plan is to dispose of her. A fairly effective treatment seems to be to put a bull ring in the cow's nose and hang a second ring from the first. The second ring can generally be taken off after a time.

75. How Long Should a Cow be Dry? Practically all experienced dairymen agree that cows should be dry for a period before freshening. A cow will produce more milk if allowed six weeks to recuperate, than she will if milked continuously. Heavy milk production is a severe tax upon an animal. A cow that has not been dry for a short time will start at a considerably lower level of milk production than will one that has had a chance to rest. Under ordinary conditions six weeks is sufficient, but if a cow is in a thin condition it is better to make the period longer.

76. Drying up a Cow. The most common method of drying a cow is to lengthen the interval between milkings, by at first omitting one milking each day. After a few days the milk is drawn only once in two days until the secretion is stopped. There is less danger of injuring a cow in drying her up than is generally thought. The secretion of milk near the end of the lactation period depends largely upon the stimulation of the nerves in milking and therefore stops readily if this stimulation be removed. If a cow is producing as little as 10 pounds per day, milking can be stopped at any time with no possible injury. The udder will fill slightly for the first few days, after which the secreted milk is absorbed and no injury follows. If this plan is followed, it is best not to draw any milk after once stopping. If the animal is producing much more than 10 or 12 pounds per day, her feed should at first be reduced for a few days and the character of the ration changed to one low in protein, such as timothy hay, with little or no grain. As soon as the production of milk begins to drop decidedly it is safe to stop abruptly. The author has followed this plan for a number of years with high-producing cows without the slightest injury in any case.

77. Milking the Cow before Calving. It is the practice of some to milk the heavy milkers several times before the birth of the calf, thinking the udder may be injured. As a rule this is not a good practice. It increases the danger of trouble at the time of freshening and does not relieve the congested condition of the udder to any great extent. It is only advisable with the heaviest milkers when they are suffering greatly from the distention of the udder.

78. Care of Cow after Calving. The vitality of the cow is low after calving and she should be treated carefully. She should be protected from cold winds and severe weather. Her drinking water is best warmed for a day or two if the weather is cold. The ration for the first few days should be light and not very abundant. A bran mash, made by moistening bran with warm water, is well adapted as a grain ration for the first day. If the udder is swollen and congested, the grain ration should be increased very slowly until this condition disappears. As a rule at least two weeks are required to get the cow on a full ration. No alarm need be felt if the udder remains hard and somewhat congested for a few days provided milk can be drawn from each quarter.

The cow should be watched closely for the first 48 hours for symptoms of milk fever. This is most likely to occur with the heaviest producers and never with heifers at their first freshening. Every manager of high-producing cows should become familiar with the symptoms of milk fever and have the apparatus on hand to treat it promptly.

79. Management of Young Stock. The cheapest way to raise young stock and the way that produces the most vigorous animals, is to allow them to run loose in open sheds and tie them up only while they eat their grain feed. Some farmers also follow this system with milking cows with good results. The system is best adapted to regions that have an abundance of straw as large amounts of bedding are required.

80. Care and Management of the Bull. The bull calf should be fed in the same manner as a heifer of the same age. He should always be well fed during the entire period of growth as an undersized animal is not desirable. As a winter ration clover, alfalfa, or other legume hay is best adapted to his needs, while for grain a mixture of corn with oats, bran, or oilmeal is excellent. The same ration that is fed to cows in milk may be used. There is no advantage in having the young bull fat, but he should be kept at least in moderate flesh. When the roughage is of good quality the mature bull requires little or no grain to keep him in moderate flesh.

The bull should not be allowed to run loose with the herd. He should be kept in a paddock where plenty of exercise is possible. A ring should be put in his nose at the age of about one year. A bull should be handled carefully and firmly at all times. Teasing should never be allowed. He does not appreciate petting or unnecessary handling, and is best let alone except when it is necessary to handle him. He should be handled in a firm manner and made to respect his keeper but should never be abused. The bull of a dairy breed is more likely to be vicious than one of a beef breed since the former are much more active and nervous. It should always be taken for granted that the bull is dangerous and that he cannot safely be trusted. The animal should be thoroughly trained for tying and leading when a calf. He may then be tied or led at any time later even if handled only at long intervals.

The main mistake made in handling aged bulls is in housing them too closely without exercise. Plenty of exercise is the most important factor in preserving the vitality of a breeding animal. For any but the most severe climates the best housing for the bull during all seasons of the year is a shed protected from the cold winds but open on one side. Some exposure to the weather especially during the cooler part of the year helps to keep him in good physical condition. Where it is necessary that the bull be kept in show condition all the time, as for example in high-class breeding establishments where buyers are present frequently, the bull is generally kept in a box stall where he may be groomed and where he is protected from the weather. Under these conditions some provision must be made to exercise him regularly or he is likely to become infertile. The ties, fences, and gates should always be strong and kept in good repair so that the animal may not have a chance to learn his enormous strength.

QUESTIONS AND PROBLEMS

1. At what time of the year do most cows in your region freshen? From this fact and from Fig. 25, about how much less milk should be given in August than in June? From the creamery or other buyer of milk find the total amount of milk received in April, May, June, July, and August. How does this compare with the natural drop?

2. What proportion of the cattle in your region are dehorned? How is dehorning done?

3. What systems of marking cattle are used in your region?

4. Why do dairy cattle require warmer barns than beef cattle?

5. Are any advanced registry records made by breeders in this region? How many times a day do they milk?

6. How long are most of the cows dry in the best dairy herds of your region?

LABORATORY EXERCISES

7. Removing the Horns from a Calf. Following the direction on page 81 remove the horns from a calf less than three weeks old.

8. Milking Contest. A milking contest may be held. Farmers should act as judges. Some of the points to consider should be: The effect of the manner of handling the cow on her composure; how clean the milk is kept; how completely the milk is removed from the udder; and how fast the work is done.

COLLATERAL READING

Stable Fly, U. S. Dept. Agr., Farmers' Bulletin 540.
Dehorning Cattle, U. S. Dept. Agr., Farmers' Bulletin 350.

CHAPTER 5

FEEDING DAIRY CATTLE

C. H. Eckles

Composition of Feeds and Feeding Standards

81. The Uses of Feed. A dairy cow uses feed for the following purposes:

1. For maintaining the body.
2. To supply the material for milk.
3. For development of the fetus.
4. For growth in case the animal is immature.
5. To produce gain in weight.

Three general classes of food material are required.

1. Protein or nitrogenous material.
2. Carbohydrates and fat.
3. Ash or mineral matter.

The main problem of feeding is to supply the proper amount of the food material of the three classes in the least expensive form. It is evident that the first step is to know what the animal requires for food and how to prepare a ration that will meet this demand.

82. Chemical Analysis of Feeds. When a chemist makes an analysis of any foodstuff, clover hay for example, he determines the amounts of water, protein, ash, crude fiber, nitrogen-free extract, and fat that the substance contains. All feedstuffs contain these same constituents, but in widely varying quantities.

83. **Water.** All feeds, even those apparently dry, like corn or hay, contain a portion of water varying from 10 to 15 per cent. Roots, such as beets and turnips, contain about 90 per cent of water. The water in the feed eaten serves the same purpose as ordinary water consumed by the animals.

84. **Ash.** This is the mineral part of the plant substance remaining after the material is burned. It makes up the greater part of the bone, and is a necessary part of milk and of lean meat. The ash elements that are most likely to be deficient are common salt, phosphorus, and calcium.

85. **Protein.** All protein compounds contain nitrogen. They serve the purpose of building up tissue in the body, such as muscle and skin, and constitute the curd of milk. Lean meat and the white of an egg are familiar examples of nearly pure protein. All feeds contain more or less protein. Among hays, clover, alfalfa, cowpea, and soybean contain the largest amounts. Among the common concentrates linseed meal, cottonseed meal, and wheat bran contain relatively large quantities. A certain amount of protein is indispensable in a ration, as nothing else can be substituted for it by the animal.

86. **Crude Fiber.** This is the woody part of the plant, which is the least digestible. The amount of this constituent increases with the age of the plant, and is large in feeds like hays and corn stover, and small in concentrates like corn and linseed meal.

87. **Nitrogen-free Extract.** This term includes the sugars, starches, and other carbohydrates that are much like crude fiber in composition, but are much more digestible.

88. **Fat or Ether Extract.** That part of the foodstuff that will dissolve in ether is called ether extract. It consists mostly of fats, and is usually so called although it

includes sufficient other products to make it somewhat inaccurate to call it fat.

The crude fiber, nitrogen-free extract, and fat all serve much the same purposes in the body. They supply heat to keep the body warm, and material to be built into fat and to be burned or oxidized in the body to furnish energy.

89. Digestibility. An animal is not able to digest all of the substances in any foodstuff. The proportion of the protein, for example, that may be used depends largely upon the nature of the feed. The grains are more thoroughly digested than the hays. The amounts of each of the substances that can be digested from any feed are determined by what are called digestion trials. The chemist makes such a trial by analyzing the food consumed during a certain period, and at the same time collecting all the dung excreted and analyzing that to find out how much passes through the alimentary canal. The difference between the amount consumed and the amount voided is called digestible. Such tests have been made of all common feeding stuffs, so the practical feeder has data at hand regarding both the composition of feeds and their digestibility to serve as a guide in preparing suitable rations.

90. Production Values. The values of different feeds are not always in proportion to the digestible nutrients. If a food is hard to digest, some of the energy derived from it is required to make up the loss due to the hard work of digestion. Corn and other grains are easily digested, and for this reason, energy from grains is worth more to the animal than is the same amount of energy from timothy hay or other coarse feeds. Timothy hay if burned gives off as much heat or energy as does corn meal, but, in one experiment, Armsby found the animal digested only 44 per cent of the timothy, while

77 per cent of the corn meal was digestible. On account of the energy required for digestion still less was available for use in storing up fat, or for producing milk. On the basis of digestibility 168 pounds of timothy was equal to 100 pounds of corn, but for production purposes, that is, for storing fat, producing milk, or making growth, 269 pounds of timothy was necessary to equal 100 pounds of corn. Table 14 gives a comparison of the amounts of energy available from corn and from timothy hay.

TABLE 14. — ENERGY VALUES PER 100 POUNDS OF CORN MEAL AND TIMOTHY HAY, EACH CONTAINING FIFTEEN PER CENT WATER

	CORN MEAL	TIMOTHY HAY
	Therms	*Therms*
Heat value when burned	171	176
Heat value of material digested	131	78
Production value	70	26

It is not safe to compare roughage with grain on the basis of digestible nutrients, but such a comparison between different classes of hay is fairly reliable, and grains may be compared with grains on the basis of digestible nutrients. The best way thus far found for comparing different feeds is on the basis of the energy values for production. The feeding standards given on pages 298 to 304 are based on digestible material. Armsby's standards given in this chapter are based on production values.

91. Feeding Standards. The many analyses that have been made enable us to know how much of each of the several constituents is contained in all common feeds on the average. It is also known that the cow needs all of these

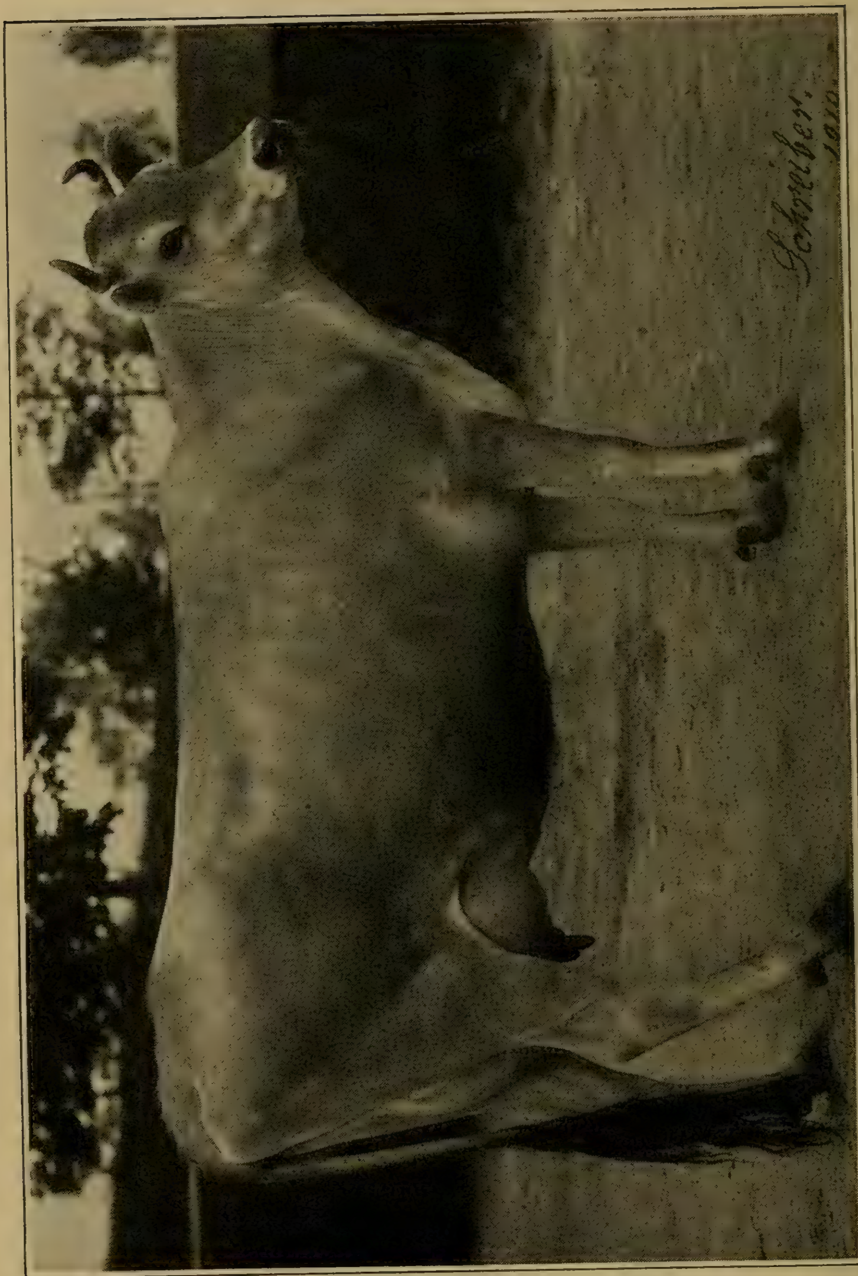

FIG. 29. — Sophie 19th of Hood Farm, who has a record of 17,558 pounds of milk, 999 pounds of fat in a year.

constituents. The next question is, how much of each constituent is needed to supply what the cow must have to enable her to produce a good flow of milk. This problem has been worked on for many years by able investigators, and a fairly accurate knowledge of the subject has resulted. A statement of the food requirements of the animal is known as a feeding standard.

The first feeding standard to come into use in a practical way was one prepared by Wolff, an eminent German investigator. A later revision by Lehmann, known as the Wolff-Lehmann standard, has been widely used. A standard prepared in this country by Hæcker has also met with much favor. The most recent feeding standard to come into use was prepared by Dr. Armsby of the Pennsylvania Experiment Station and is based upon his own extensive investigations and those of Kellner in Germany. He bases this standard upon the amount of digestible protein, and the production value, or energy value, of the feed. He uses the term "therm" to represent the energy or heat value required to raise 1000 kilograms of water one degree centigrade (1000 calories).

He first estimates the protein and energy required for maintaining the animal, and to this adds the amount of each necessary to supply what is needed for the milk. The maintenance requirements for cattle are given as follows:

Live Weight	Digestible Protein Required	Energy Value Required
Pounds	*Pounds*	*Therms*
500	.30	3.80
750	.40	4.95
1000	.50	6.00
1250	.60	7.00
1500	.65	7.90

The maintenance requirement naturally increases with the size of the animal, but not in direct proportion.

As a result of his investigations, Armsby suggested .05 pounds of digestible protein and .3 therms energy value for each pound of milk. This was based upon average milk containing 4 per cent of fat. The author[1] has recently proposed the following modification of Armsby's standard to adapt it to the feeding of cows not producing average milk:

Per Cent Fat	Digestible Protein Required per Pound Milk	Energy Required per Pound Milk
	Pounds	*Therms*
3.00	.050	.26
3.50	.052	.28
4.00	.055	.30
4.50	.058	.33
5.00	.062	.36
5.50	.066	.40
6.00	.070	.45
6.50	.075	.50

Where it is not practicable to take the richness of the milk of each cow into account the following may be used and the requirement based upon breed average:

Breed	Digestible Protein per Pound Milk	Energy per Pound Milk
	Pounds	*Therms*
Holstein	.05	.26–.28
Shorthorn, Ayrshire, Brown Swiss	.055	.28–.30
Jersey, Guernsey	.066	.40–.45

92. Calculating a Ration. Let it be assumed that the cow to be fed weighs 1150 pounds and produces daily 30

[1] Missouri Agricultural Experiment Station, Research Bulletin 7.

pounds of milk testing 4.5 per cent fat. According to the preceding table the maintenance requirement would be as follows:

Digestible protein . . . . .56 pounds
Energy . . . . 6.60 therms

For the production of 30 pounds of 4.50 per cent milk there would be needed:

Digestible protein (30 × .058) . . . . . . 1.74 pounds
Energy (30 × .33) . . . . . . 9.90 therms

The total requirements then are as follows:

	Digestible Protein	Energy Value
For maintenance	.56	6.60
For milk production . . .	1.74	9.90
Total	2.30 pounds	16.50 therms

The problem is to find a ration that contains this amount of digestible protein and has this energy value. Other problems also enter into the question, such as bulk and the comparative cost of the several feeds available. In calculating a ration we always begin with the roughage, since on most farms considerable roughage is on hand that should be used to the best advantage, and, as already pointed out, the cow is adapted for consuming coarse feeds and must have a certain bulk in her ration at all times. We will assume that on the farm where the foregoing ration is to be fed, corn silage, clover hay, and corn are on hand, and wheat bran and cottonseed meal may be purchased if necessary to provide the proper ration.

TABLE 15. — DRY MATTER, DIGESTIBLE PROTEIN, AND ENERGY VALUES PER 100 POUNDS[1]

FEEDING STUFF	TOTAL DRY MATTER	DIGESTIBLE PROTEIN	ENERGY VALUE
	Pounds	*Pounds*	*Therms*
Green fodder and silage:			
Alfalfa	28.2	2.50	12.45
Clover — crimson	19.1	2.19	11.30
Clover — red	29.2	2.21	16.17
Corn fodder — green	20.7	.41	12.44
Corn silage[2]	25.6	.88	16.56
Hungarian grass	28.9	1.33	14.76
Rape	14.3	2.16	11.43
Rye	23.4	1.44	11.63
Timothy	38.4	1.04	19.08
Hay and dry coarse fodders:			
Alfalfa hay	91.6	6.93	34.41
Clover hay — red	84.7	5.41	34.74
Corn forage — field cured	57.8	2.13	30.53
Corn stover	59.5	1.80	26.53
Cowpea hay	89.3	8.57	42.76
Hungarian hay	92.3	3.00	44.03
Oat hay	84.0	2.59	36.97
Soybean hay	88.7	7.68	38.65
Timothy hay	86.8	2.05	33.56
Straws:			
Oat straw	90.8	1.09	21.21
Rye straw	92.9	.63	20.87
Wheat straw	90.4	.37	16.56
Roots and tubers:			
Carrots	11.4	.37	7.82
Mangels	9.1	.14	4.62
Potatoes	21.1	.45	18.05
Rutabagas	11.4	.88	8.00
Turnips	9.4	.22	5.74
Grains:			
Barley	89.1	8.37	80.75
Corn	89.1	6.79	88.84
Corn-and-cob meal	84.9	4.53	72.05
Oats	89.0	8.36	66.27
Pea meal	89.5	16.77	71.75

[1] U. S. Dept. Agr., Farmers' Bulletin 346.

[2] Owing to an error, the original publication gave the protein of corn silage as 1.21, but .88 is correct.

TABLE 15. — DRY MATTER, DIGESTIBLE PROTEIN, AND ENERGY VALUES PER 100 POUNDS (*Continued*)

FEEDING STUFF	TOTAL DRY MATTER	DIGESTIBLE PROTEIN	ENERGY VALUES
	Pounds	*Pounds*	*Therms*
Grains (*Continued*):			
Rye	88.4	8.12	81.72
Wheat	89.5	8.90	82.63
By-products:			
Brewers' grain — dried	92.0	19.04	60.01
Brewers' grain — wet	24.3	3.81	14.82
Buckwheat middlings	88.2	23.34	75.92
Cottonseed meal	91.8	35.15	84.20
Distillers' grains — dried			
Principally corn	93.0	21.93	79.23
Principally rye	93.2	10.38	60.93
Gluten feed — dry	91.9	19.95	79.32
Gluten meal — Buffalo	91.8	21.56	88.80
Gluten meal — Chicago	90.5	33.09	78.49
Linseed meal — old process	90.8	27.54	78.92
Linseed meal — new process	90.1	29.26	74.67
Malt sprouts	89.8	12.36	46.33
Rye bran	88.2	11.35	56.65
Sugar beet pulp — fresh	10.1	.63	7.77
Sugar beet pulp — dried	93.6	6.80	60.10
Wheat bran	88.1	10.21	48.23
Wheat middlings	84.0	12.79	77.65

A good ration of roughage would be corn silage 35 pounds and clover hay 10 pounds.

Using the data given in Table 15, the following calculations are made:

	DIGESTIBLE PROTEIN	ENERGY VALUE
	Pounds	*Therms*
35 lb. silage	(.35 × .88) .31	(.35 × 16.56) 5.80
10 lb. clover hay	(.10 × 5.41) .54	(.10 × 34.74) 3.47
Total	.85	9.27

This leaves 1.45 pounds of protein and 7.23 therms of energy to be supplied by the grain. If corn is grown on the farm, we will use it as far as possible in making up the grain ration. The amounts to be used can only be found by trial. We will start with the following: corn 6 pounds, bran 3 pounds, cottonseed meal 1.5 pounds.

	Digestible Protein	Energy Value
	Pounds	*Therms*
35 pounds corn silage	.31	5.80
10 pounds clover hay	.54	3.47
6 pounds corn	.41	5.33
3 pounds bran	.31	1.45
1.5 pounds cottonseed meal	.53	1.26
Total in ration	2.10	17.31
Required	2.30	16.50

This ration gives more energy than is necessary and is deficient in protein. Since cottonseed meal is the highest in protein we will omit 1 pound of corn and increase the cottonseed meal to 2 pounds. We then have:

	Digestible Protein	Energy
	Pounds	*Therms*
35 pounds corn silage	.31	5.80
10 pounds clover hay	.54	3.47
5 pounds corn	.34	4.44
3 pounds bran	.31	1.45
2 cottonseed meal	.70	1.68
Total in ration	2.20	16.84
Required	2.30	16.50

This ration approaches the standard closely enough for practical purposes. It is not essential to have an exact agreement with the standard, since the composition of the feed varies to some extent and the individual requirements of the animals are also subject to some variations.

93. The Cost of the Ration. In the foregoing, no attention has been given to the relative cost of the feeds used in making up the ration. This question is one of great importance, and must always be taken into account. In preparing the ration the cost should be calculated at the same time, and trial made of various combinations that offer to reduce the cost.

A careful study of the figures in Table 15 will be of great assistance in the selection of the most economical ration. If the ration at hand is short in protein, and the purchase of some concentrate to supply this deficiency is contemplated, a study should be made of the amount of digestible protein in various feedstuffs, together with the price. A good plan is to calculate the cost per pound of digestible protein to ascertain in what feed it can be purchased most economically. For example, if cottonseed meal costs $32 per ton, one pound of digestible protein would cost 4.6 cents, if the value outside the protein be ignored. With bran at $20 per ton a pound of digestible protein would cost 9.8 cents, and with oats at 50 cents per bushel, or $31.25 per ton, it would be worth 18.7 cents. Under these conditions it is readily seen which feedstuff would be the cheapest source of protein for the ration deficient in that constituent.

If the question is that of providing the cheapest ration as a whole and not merely supplying a lack of protein, it is equally important to study the energy value of the several feeds as carefully as is done with the protein. It is readily seen, for example, that while bran has an energy value of 48.23 therms per 100 pounds, corn has a value of 88.84. If corn and bran are the same price per pound, corn is by far the cheaper feed. With bran at $20 per ton, a therm of energy costs 2.07 cents, while in corn at $26 per ton the same energy costs only 1.46 cents. When planning the ration to be purchased, or even the crop to be grown in some cases, it is well to make such calculations as suggested and determine which are the cheapest feedstuffs under the existing conditions.

Discussion of Common Feedstuffs

No particular feed or combination of feeds is essential for the most economical production of milk. The first consideration is to grow the most suitable crops on the farm in order that the amount purchased may be as small as possible without reducing the efficiency of the ration. In the brief discussion which follows, only the most common feedstuffs are considered.

94. Timothy Hay. The value of this hay as a feed for dairy cows is often greatly overestimated. It is unpalatable except when cut early and therefore will not be consumed in sufficient quantities. The most serious objection is the low protein content.

95. Corn Stover. This is the name applied to dried corn stalks from which the ears have been removed. It may be utilized to a small extent. It has the same characteristics and objections as timothy hay, and cannot be depended upon for more than a part of the roughage.

96. Hay from Legumes. Hay of this class is especially valuable for the dairy cow. It includes the common clovers, alfalfa, the cowpea, soybean, field pea, and other less common legumes, such as vetch and crimson clover. Forage from this class of plants when properly cured is highly palatable, and contains a relatively large amount of protein.

For this reason a legume hay should by all means be grown by the dairy farmer. The ash content is also large, which is of importance, especially when fed with corn products that are low in ash.

97. Silage. It is very important that a succulent food be supplied to the cow at all times. In feeding corn silage it should be kept in mind that this of itself is not a complete ration for the cow in milk, since it is relatively high in carbohydrates and low in protein. It is usually not advisable to feed over about 35 pounds to a small cow and 40 to 45 to a large one. It is not advisable to feed it as the only roughage. Some hay should be given. For this purpose the legumes are best adapted, on account of their high protein and ash content.

98. Corn. Over the greater part of America, corn is the cheapest grain. In the corn belt this valuable grain is often fed to excess. On the other hand, some dairymen do not feed any of it, on account of the erroneous idea that it is not suited for milk production. Corn may be fed in reasonable quantities to any class of animals on the farm. It is especially palatable for the cow in milk. However, it should not be the only grain feed. Corn is low in protein and ash content. If combined with corn stover, corn silage or timothy hay for roughage, the protein content is entirely too low for a dairy ration. Corn silage and ground corn combined with clover or alfalfa hay and bran, however, makes a good ration for general feeding.

99. Wheat Bran. Next to corn, wheat bran is the most important cow feed of this country. Its great value as a food for growing animals and cows in milk comes from the high ash and protein content. Its light, loose character also makes it a valuable addition to a heavy ration in the way of lightening up the mass so that it is easier for the digestive juices to act upon it. This is of special importance in connection with such feeds as cottonseed meal, that have a tendency to form a pasty mass in the stomach.

Wheat middlings, or shorts, is a valuable feed for the cow, but it is more like corn meal in composition and properties than like bran. As a rule it is better to make use of bran rather than shorts for the cow in milk.

100. Oats and Oat Products. Oats is an excellent feed for cows and growing animals when the cost is not prohibitive. Woll found oats to be about 10 per cent more valuable per pound than bran as feed for cows. In general, it may be said that oats are themselves an excellent feed. But if the balance of the ration is deficient in protein, oats do not contain enough protein to make up the shortage. The valuable by-products of oats are mainly from oatmeal mills, and consist of oat shorts and finely divided parts of the grain. Besides these, a much larger quantity of hulls must be disposed of by these mills. Hulls are mostly crude fiber and are about like oat straw in feeding value. The by-products of the oatmeal mills are therefore valuable, to the extent that they contain the parts of the grains. Oat hulls are used largely to form a portion of various mixed feeds.

101. Cottonseed Meal. This by-product is left after the oil is extracted from cottonseed. It contains a higher amount of protein than any other common feed. For this reason it is especially valuable for balancing rations deficient in protein, for instance those in which corn and corn products form a large proportion. It should not be fed to excess. As a rule from two to four pounds per day is the maximum. However, in the South, where it is abundant, it is fed in much larger quantities with good results.

102. Linseed Meal. This valuable feed is the residue after linseed oil is extracted from flaxseed. It ranks next to cottonseed meal in protein, and on the market usually sells for a little more. It seems to exert a very favorable effect upon animals of all kinds. Like cottonseed meal, it is especially valuable as a means of supplying the protein usually lacking in the farm-grown ration.

103. Gluten Feed. This is a by-product from starch and glucose factories. It consists of the corn grain after the starch is extracted. In protein content it ranks about midway between bran and oil meal, and is a palatable and valuable feed.

104. Beet Pulp and Molasses. Formerly beet pulp was fed to cattle in the neighborhood of beet-sugar factories, but now much of it is dried. The feeding value of dried beet pulp is a little less per pound than corn, which it resembles in the relative amount of protein and carbohydrates present. It swells greatly when moistened and cannot be pressed into a compact mass. For this reason it is easily digested and is valuable to lighten up a grain ration that otherwise would form a mass in the stomach not easily penetrated by the digestive juices.

Low-grade molasses is another by-product of cane and beet-sugar factories. It is often sold in combination with other feeds, such as beet pulp and alfalfa hay, and sometimes with nearly worthless materials such as peanut hulls, weed seeds, cocoa waste, or peat moss. Molasses serves a useful purpose in making unpalatable feeds more readily consumed. Unfortunately it is too often used to disguise material of little or no feeding value.

105. Brewers' Grains. Fresh brewers' grains are fed in large quantities where they may be hauled directly from the brewery. Considerable objection has been raised by city health authorities to the use of this feed. If fed in moderate amounts under proper sanitary conditions, it is not objectionable. However, the use of it is so often abused that officials in some localities have found it easier to prohibit the use than to regulate it. The objection comes from feeding these grains exclusively, from allowing decomposition to begin before feeding, and from the very objectionable sanitary conditions that exist if special care is not taken to keep the feed boxes, feeding troughs, and, in fact, the entire stable, clean. This feed should not be used in excess of twenty pounds per day, and should be supplemented with hay and some other grain, such as corn.

The greater part of the brewers' grains now produced are dried, and in this form may be transported long distances. This feed is rich in protein. Four or five pounds may be used in the ration to advantage. At present the larger part of this by-product finds a market in Europe.

106. Mixed Feeds. No small proportion of the grain supplied the dairy cows of the United States is in the form of mixed feeds. As a class, mixed feed is to be looked upon with suspicion. Where the unmixed grains and by-products may be bought on the market, it is always safer to purchase them and to make such mixtures as may be best to supplement the available farm feeds. The main purpose of the manufacturers or dealers in putting feed mixtures on the market is to dispose of material of inferior quality or of some by-product of little or no value. One of the most common ingredients of mixed feeds is oat hulls, from oatmeal factories. In many cases the hulls are ground fine to escape detection, and the claim is made that ground oats is a part of the mixture. A careful examination will usually disclose the fact that oat hulls have been added. Ground corncobs and corn bran are occasionally mixed with wheat bran. A cottonseed feed that is a mixture of cottonseed hulls and cottonseed meal is found on the market. The only object in making such a mixture is to sell cottonseed hulls at a good price. Alfalfa hay of doubtful quality is mixed with sugar refuse, and by liberal advertising sold at a price above its real value.

Nearly all states where large quantities of feed are purchased by the farmers now have laws regarding the sale of feeding stuffs. These laws, however, do not take the place of intelligence on the part of feed users. Such a law generally requires the proper branding of each sack and labeling to indicate the chemical composition. It should be remembered that the label gives the total amount of protein and other constituents, and not the amount of each that is digestible, which is decidedly lower. Feed buyers should patronize only reliable dealers, and buy feeds that are labeled and guaranteed. There are no mixtures better than the buyer can make himself, and there is no special feed or mixture having any remarkable properties not possessed by familiar feeds. The buyer of mill feeds should make a point of keeping in touch with the experiment station of his state, and if the feed control is vested in some other body or official, with them as well, and make use of the information they will be able to furnish regarding the feeds on the market.

107. Condimental Stock Foods. Numerous articles variously known as "stock food" and "condition powders" are common on the market and are fed to a considerable extent by farmers who are not well informed regarding the feeding of live stock. They are guaranteed to make stock grow faster, cows to give more and richer milk, and some are recommended as cures for nearly all diseases of domestic animals. The best of these substances generally have for their base common feedstuffs, such as linseed meal or wheat middlings, while others contain low-grade mill refuse or even ground bark or clay. To the base is added various other substances, such as common salt, charcoal, sulphate of iron, gentian, pepper, and Epsom salts, and often tumeric or iron oxide for coloring. Some may have a small value as a tonic, but if such treatment is desirable, the necessary drugs should be purchased at a drug store, and may be had for a small part of the sum asked for the same in the form of stock food.

Many experiment stations have made feeding tests which have shown that no value was derived from the use of the several brands of commercial stock foods. Money expended for this class of articles will give far greater returns if used for the purchase of ordinary feed.

Feeding Young Stock and Dry Cows

108. Calf Raising. The careful dairyman sees in the best heifers the possibility of cows that will not only replace the discarded members of the herd but help to raise the average production. The question is often asked as to whether it pays to raise the calf. The answer is that only under exceptional conditions can the farmer afford not to raise the well-bred heifer calves. Some farmers near large cities where feed is high in price find it more profitable to buy all their cows, but as a general practice in most farming sections, the best heifers should be raised.

The dairy-bred calf is almost always raised by hand. A discussion of the subject is naturally divided into two parts on account of the two common conditions:

1. Calf raising where skim-milk is on hand.
2. Raising the calf where whole milk is sold.

109. Raising the Calf on Skim-milk. It is well known that calves may be raised on skim-milk practically as well as when fed whole milk. A skim-milk calf is not quite so fat during the first few weeks but grows equally as well as the one receiving the unseparated milk and develops into an equally good animal. Skim-milk differs from whole milk only in the much smaller amount of butter-fat that it contains.

FIG. 30. — A thrifty Holstein heifer six months old, raised on skim-milk after the first two weeks with very little grain. It was fed 200 pounds of whole milk, and 2610 pounds of skim-milk.

The calf may be taken from the cow at birth or allowed to nurse two or three days. It should be given its mother's

FIG. 31. — The same animal shown in Fig. 30 when four years old, a good type of cow and a good producer.

milk for the first few days, later mixed milk is as good. Care must be taken not to overfeed at any time. For the first two weeks ten to twelve pounds per day is all that the largest calf will require. A small one needs even less. It may be fed in two feeds, but three feeds are better for the first two or three weeks. Each animal should be fed by itself so that it is certain to get the proper amount of milk. As the calf gets older the amount of milk may be increased somewhat, but it is not necessary to feed over 16 pounds a day at any time. A large calf can take up to 20 pounds without injury. The milk must always be fed fresh and sweet. Milk that has been standing some time, even if it does not taste sour, is not in the best condition for feeding. The milk should have a temperature of 90° F. or higher while the calf is young, but later it becomes less sensitive to a slight change in temperature. After about two weeks the feeder may begin to replace the whole milk with skim-milk. This should be done gradually, about a week being given to the change. The amount fed should not be greater because skim-milk is given in place of whole milk.

Fig. 32. — A Holstein heifer calf six months old, raised on whole milk. Total milk consumed 2960 pounds.

By the time the calf is a month old it will begin to eat grain. The grain is best fed dry after the milk is drunk. Corn meal, linseed meal, oatmeal, or a mixture of all, serves almost equally well for this purpose. Where corn is grown in abundance, corn meal is most commonly used as it alone

FIG. 33. — The same animal shown in Fig. 32, when six years old, a good milk producer but no better than the one raised on skim-milk.

has been found equal to any other grain or any combination for this purpose. The total amount of feed required for a calf raised on skim-milk up to the age of six months is shown by the following, which is the average amount fed to seven calves.

Whole milk	360 pounds
Skim-milk	2804 pounds
Hay	270 pounds
Grain	113 pounds
Average weight of calves at birth	66 pounds
Average weight at 180 days	303 pounds
Average daily gain	1.3 pounds

The skim-milk calf should have hay placed within reach as soon as it is old enough to eat it, or when it is about one month old. The calf does equally well for the first three or four months with hay or with pasture grass for roughage.

Another exceedingly important point is the necessity for cleanliness of the pails and troughs used for calf feeding. A good rule is to have the calf pails as clean as the milk pails. The barn or stalls must also be clean and light. Dark, damp, or dirty stalls often result in serious sickness. The best part of the barn should be used for the calf pens. The raising of the calf on skim-milk may be summarized as follows:

1. Take the calf from its mother not later than the third day.

2. Feed mother's milk for two weeks, then change gradually to skim-milk.

3. Especially avoid overfeeding. Keep the calf a little hungry, and make sure that each calf receives its proper amount.

4. Feed the skim-milk warm and fresh every time.

5. Feed dry grain, preferably corn meal, as soon as the calf will take it.

6. Keep the utensils and stalls clean at all times.

110. Raising Calves when Whole Milk is Sold. The main difficulty in calf raising where whole milk is sold on the market is the matter of expense.

To raise a calf on whole milk means that the milk consumed may be greater in value than the calf raised. If the calf is fed whole milk as freely as skim-milk is given, it would consume 2000 to 2500 pounds before it is weaned. At $1.50 per hundredweight, the feed up to six months would represent a value of $30 to $38. It is evident that this sum can be expended with profit only on very valuable calves.

As a result of this situation the practice of not raising even the best heifer calves is too common. This policy stands in the way of improvement of the herd. The Illinois Experiment Station found the average profit per cow to be $20.53 more each year in those herds in which a pure-bred bull was kept and calves raised.

111. The Use of Milk Substitutes. Several calf meals advertised as milk substitutes are on the market. These are sold under a trade name and the composition is not given. In general they are a mixture of linseed meal, oatmeal, wheat middlings, and corn meal. In some cases bean meal, ground flaxseed, or skim-milk powder is included. The Cornell University Experiment Station[1] obtained good results by the use of a commercial calf meal composed of oatmeal, wheat meal, flaxseed, and dried skim-milk. The calves received in addition a grain mixture consisting of corn, oats, and wheat bran, three parts each. The calves were fed whole milk alone for the first week after which the calf meal was gradually introduced. The feeding of milk was gradually reduced until at the end of about one month the calves were receiving only the calf meal, grain mixture, and hay. Most of the calves were able to grow fairly well on this ration, and they developed into good cows. The average quantities of feed used up to five months of age were:

Whole milk	226 pounds
Calf meal	220 pounds
Grain	109 pounds
Hay	329 pounds
Average gain per day	1.1 pounds
Total cost of feed	$14.69

[1] Cornell University Agricultural Experiment Station, Bulletins 269 and 304.

Excellent results were also obtained by the same station by the use of dried skim-milk powder. The quantities of feed required for each calf up to five months with this ration were:

Whole milk	185 pounds
Milk powder	230 pounds
Hay	370 pounds
Grain	114 pounds
Gain per day	1.25 pounds
Total cost of feed	$11.75

The Illinois Experiment Station conducted an experiment to determine the minimum amount of milk necessary to raise a calf. Milk feeding was continued to the age of from 42 to 56 days. Whole milk was fed the first three weeks followed by skim-milk up to the age of eight weeks. It was concluded that it is advisable to feed milk long enough to give the calves a good start. After the age of eight weeks the calves thrived on grain and hay. The grain ration was a mixture of corn, 4 parts; oats, 4 parts; and bran and linseed oil meal, 1 part each. The total amounts fed per animal were whole milk, 134 pounds; skim-milk, 422 pounds. The total value of the milk used was $4.62 for each calf.[1]

These results show clearly that the milk can be reduced to an amount that does not make the cost of raising the calf excessive. When grain is substituted for milk under the conditions discussed, it must not be expected that the calf will appear as fat and thrifty as one receiving milk. However, there is no reason for believing that the dairy qualities of the cow are injured in any way. If a good ration is fed as the calf grows older, it will make up any deficiency in size that may result from the lack of more milk in the ration when young.

[1] Illinois Agricultural Experiment Station, Bulletin 164.

112. Feeding for Veal. To make a good veal requires liberal feeding of fresh whole milk. So far no substitute for whole milk has been found for this purpose. The best quality of veal is produced when the animal receives nothing but whole milk and is slaughtered at the age of two months. The regulation of the United States Government for interstate commerce requires that the calf be at least three weeks old before being put on the market. Many cities also have regulations regarding either the age or the weight of veal calves. Where such regulations are not enforced the tendency is to market the calves younger than this age, since when milk is high priced, the younger the calf is sold the greater the profit. The first question to be answered is whether the calf can be raised profitably for veal. It often happens, especially with the breeds having small calves, that the milk fed is worth more than the market value of the calf when sold. For this reason some do not attempt to raise the calf for veal but destroy those not wanted for breeding purposes at birth.

TABLE 16. — FEED CONSUMED AND GAIN FIRST 30 DAYS

Breed	No. Calves	Average Birth Weight	Weight at End of 30 Days	Average Daily Gain	Pounds of Milk Consumed	Pounds Milk per Pound Gain
Jersey . . .	10	49	88.9	1.33	376	9.42
Holstein . . .	8	83	127.0	1.47	441	10.02
Ayrshire . . .	2	70	107.0	1.23	344	9.31

The average daily gain of a dairy-bred calf is from 1.2 to 2 pounds during the first few weeks. About 10 pounds of whole milk are required for each pound of gain. The data in Table 16 show the average gain and weight for calves of three breeds as found by the author.

113. Feeding the Dairy Heifer. No special difficulties are experienced in raising heifer calves from the time of weaning until they come into milk. If pasturing is practiced, no further attention or additional feed is necessary so long as the grass is abundant. The winter ration should consist of a good quality of roughage with a small amount of grain. A good ration is corn silage and clover or alfalfa hay, with a grain allowance of about 2 or 3 pounds daily per animal. A more liberal grain ration will cause a more rapid growth of the young animals and earlier maturity. It is possible by heavy grain feeding to have a heifer as mature at the age of 18 months as another fed entirely on roughage is at 24 months. Liberal feeding during the growing period and the better condition of the animal which follows result in a larger milk yield during the first year than is the case when less is fed. The size of the animal when mature is influenced to some extent by the manner of feeding during the growing period. In experiments by the author, heifers fed a liberal ration measured over an inch more in height when mature than did heifers fed a ration with less nutrients.[1] At the age of 18 months the difference was nearly 3.5 inches, but the group receiving the lighter ration continued to grow for several months after the heavier fed group had ceased growing. The lighter fed group, however, remained slightly smaller. Another factor that has some influence on the size of the cow when mature is the age at which she comes into milk. A heifer that freshens at an early age, for example, 20 to 22 months for a Jersey, and 22 to 24 for a Holstein, will not develop into so large an animal as she would if she

[1] Missouri Agricultural Experiment Station, Bulletin 135.

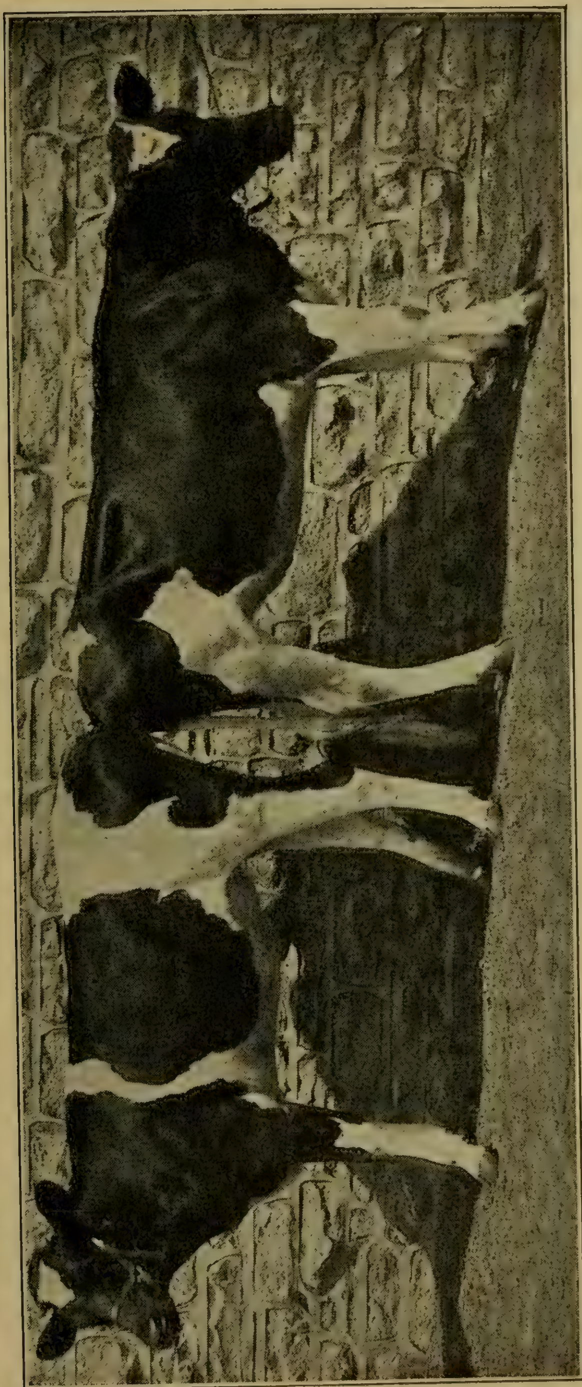

FIG. 34. — Yearling heifers ready to go on grass in the spring. The one on the left is in the proper condition of flesh for a heifer of a dairy breed. She has gained 1.1 pounds daily during the winter. The one on the right received a different ration and is thinner than is desirable. Her gain was .75 pounds daily for the winter. Her growth has been checked somewhat.

were somewhat older. The difference will not be very marked unless the animal has also been fed a light ration up to this time and is therefore immature for the age.

Heavy grain feeding when young, accompanied by late breeding, will develop a heifer to her maximum size. A ration that does not supply an abundance of food in an easily digestible form, as, for example, hay and silage alone, together with early calving will result in a slower growth of the animal and a somewhat smaller size at maturity. The best practice to follow is one between these two extremes. A heifer fed exclusively on roughage is too slow in reaching maturity, while the heavy feeding of grain is too expensive. A good development can be had by feeding good roughage together with about 2 or 3 pounds of grain per day during the winter season. The figures in Table 17, as found by the writer, will be of assistance to the farmer who wishes to know whether his young animals are being fed so that their development is up to the average of the breed.

TABLE 17. — AVERAGE HEIGHT AND WEIGHT OF DAIRY HEIFERS

Age	Jerseys		Holsteins	
	Height at Withers	Weight	Height at Withers	Weight
	Inches	*Pounds*	*Inches*	*Pounds*
6 months	31.7	265	40.8	350
9 months	41.2	378	43.4	444
12 months	43.4	468	45.6	548
15 months	45.2	556	47.4	620
18 months	47.0	598	48.8	710
24 months	48.4	750	50.0	900

Sufficient data are not at hand for the Guernsey and Ayrshire breeds, but they fall between the two breeds given.

It is well to breed the heifer so that she will come into milk at 24 to 26 months of age if a Jersey or Guernsey, and at 28 to 30 months if a Holstein or an Ayrshire, the variations suggested being made to allow for the size of the animal.

The milking tendency of the cow when mature is not influenced to any appreciable extent by any ordinary variations in the ration fed during the growing period. The dairy characteristic of a cow is a matter of inheritance and does not seem to be influenced to any great extent by over- or underfeeding when a heifer. In experiments by the author with over 40 animals some of the best milk producers, as well as some of the worst, were in a group fed excessively from birth to first calving. Another group receiving a light ration up to calving time showed the same variation in quality.[1]

114. Salt Requirements. All animals that consume large quantities of vegetable food require salt. It is not merely an appetizer but a necessity. Animals that live upon meat do not have this craving. A cow kept without salt shows a strong craving for it during the first few weeks, then quiets down into an emaciated condition of low vitality, which will result in a complete breakdown after several months.

The amount of salt needed varies with the amount of feed consumed. A dry cow needs about .75 ounce per day. The cow in milk needs the same amount for maintenance and in addition about .6 ounce per day for each 20 pounds of milk. The amount required therefore for cows yielding from 20 to 30 pounds of milk per day is about 1.5 ounces. Salt may be supplied by mixing the proper amount regularly in the feed or it may be placed where the animal can have access

[1] Missouri Agricultural Experiment Station, Bulletin 135.

to it. If the cattle run out every day, the best way to salt them is to keep a constant supply in a box in the yard. The plan of salting the cattle at intervals of one or two weeks is not to be recommended.

115. Feeding the Cow when Dry. The milk yield of a cow throughout her entire lactation period is influenced by her condition of flesh at calving time. For good results it is very important that she be in good flesh at this time. A high producer will yield fully 20 per cent more during the year if in good order at calving time. Less trouble is also experienced when the calf is born. All mammals naturally take on flesh before the young is born. This reserve store of food is needed to aid in the production of milk. We expect a dairy cow to give several times as much milk as the calf requires. The importance of her being fat is therefore all the greater. The grain given to a dry cow is not lost. It is used to store up fat in the body for the purpose of milk production. If when a good cow is dry, she is fed sufficient grain to get her in good flesh, it is just as sure to be returned in milk as is the grain fed when the cow is giving milk. The astonishing records of milk and fat production obtained within recent years from cows under official test are due in no small measure to a realization of the importance of having the cow well fed before freshening and in a high state of flesh.

The feeding of the cow when dry will depend upon her condition when milking ceases. If in good flesh, only a little more than a maintenance ration should be given. If not in good condition, a more liberal ration is advisable, sufficient to insure her being in good flesh when she freshens. The character of the ration fed at this time need not vary materially from that given to the cows in milk. Good pasture, legume hay, and roots or silage are adapted for use as roughage. As the time for freshening approaches, the cow should by all means have a laxative ration if she has not been receiving it before; if on pasture, no special attention is called for in this respect. The cow should have exercise, and nothing is better than freedom in a smooth pasture or freedom in a barnyard in winter.

Feeding the Cow in Milk

116. Water for Cows. Large amounts of water are necessary for producing the milk itself and for the digestion and assimilation of the larger quantities of feed required to make it. The author found by experiments that a cow producing 27 pounds of milk per day drank 77 pounds of water. The same cow when dry drank only 15 pounds per day. Another cow producing over 100 pounds of milk per day used an average of 250 pounds of water. These figures show that the water requirement is in proportion to the milk produced and the food consumed. They also show that the question of water supply is much more important for the cow in milk than for the dry cow. Dry cows need not be watered more than once daily in winter time and do not seem to want it oftener. During the summer the demand for water is greater on account of the greater evaporation from the skin. Cows on heavy feed, producing large quantities of milk, should always have access to water at least twice daily. For the best results, water of good quality should be supplied close at hand, since if the animals are required to walk long distances in cold weather, they may not drink a sufficient amount and the milk flow may be reduced for this reason. Water contaminated by drainage from barnyards or with sewage should be avoided for sanitary reasons, as well as for the additional reason that cows may not drink as much as is needed for the best results.

In very cold climates it is profitable to warm the water for dairy cows. It is cheaper to warm the water with a tank heater by burning coal or wood than to supply the necessary heat by allowing the animal to burn high-priced feed in its body for this purpose. A cow producing 25 pounds of milk daily requires about 1 pound of corn daily to warm the water used if it be given at the freezing point. Larger producers would require a correspondingly larger amount for this purpose. An even more important reason for warming water is that a heavy-milking cow will not drink enough water if it is near the freezing temperature. The activities of the organs of digestion and milk secretion are almost stopped for a while if a cow drinks 30 or 40 pounds of ice water. Where water is warmed it is generally brought to a temperature of about 60° F.

117. Turning on Pasture. Cattle are pastured in summer over the greater part of this country and every owner of a cow welcomes the time when the cow may be turned out to pasture. In changing from dry to green feed it is best to go somewhat slowly, especially with heavy-milking cows. The young immature grasses are mostly water and it is almost impossible for a heavy-milking cow to eat enough to supply the necessary nutrients.

Another reason for making the change slowly is the effect upon the taste of the milk. When a cow is changed suddenly from grain to grass, the milk may be given a strong taste; while if this change is made gradually, little or no change in taste is noticed.

A common mistake is to pasture too closely in the fall and to turn out too early in the spring. The cows should be kept off the pasture until the grass is well started. Grass can only grow by having leaves above the ground in contact with the air and sunshine. If the cattle are turned out to graze while the grass is very short, its growth is slow since it has no chance to get enough leaves to prepare its food.

118. Feeding Grain while on Pasture. The cow that produces a small quantity will give but little if any more if fed grain while on pasture. However, with the very heavy-producing cow the case is quite different, and it is necessary that she be fed some grain or she will not continue long on the high level of milk production. The high-producing cow cannot eat and digest a sufficient amount of grass to supply the necessary nutrients and must have some concentrated feed in order to continue to produce large quantities of milk.

Experiments made by the Cornell University Experiment Station covering four years showed that while an increase of milk yield was obtained from grain feeding it was not economical to produce it in this way. Only about one additional pound of milk was obtained for each pound of grain fed. In these experiments the pasture furnished an abundance of grasses. It was observed, however, that the cows that had grain during the summer gave better results after the grazing season was over than those that received no grain. This is also a matter of common observation by dairymen and should be taken into account in considering the question of summer feeding. The practice of the writer in regard to grain feeding on pasture is represented in the following statement:

Jersey or Guernsey cow, producing:

20 pounds milk daily	2 pounds grain daily
25 pounds milk daily	3 pounds grain daily
30 pounds milk daily	6 pounds grain daily
35 pounds milk daily	8 pounds grain daily

Holstein, Shorthorn, or Ayrshire, producing:

25 pounds milk daily	2 pounds grain daily
30 pounds milk daily	3 pounds grain daily
35 pounds milk daily	5 pounds grain daily
40 pounds milk daily	7 pounds grain daily

It must be kept in mind that this applies only when pastures are abundant. When a small amount of grain is fed as a supplement to pasture, little attention is necessary as to the relative amount of protein and carbohydrates that it contains. When corn is the cheapest grain, it may be fed alone if desired. Any mixture of common concentrates serves the purpose, since it is total digestible nutrients that is needed and the protein is usually supplied in ample amounts by the grass. When larger amounts of grain are fed, more care must be taken to have enough protein.

119. Providing for Periods of Short Pasture. Unfortunately the season of abundant pastures is often short. In many localities a dry period of several weeks often occurs at times during the summer season. It is probable that as much loss occurs from improper feeding at such times as is caused by improper feeding during the winter. As long as the cows are on pasture, and other work is pressing, the farmer is inclined to let the cows get along the best they can.

It is well known to all experienced dairymen that if a cow is once allowed to decline in her milk production, it is difficult to bring her back to normal. To make a large profit from the cow, a large yearly production must be had and to obtain this ordinarily requires that the flow of milk be kept up for 10 months out of the year. It is possible to supplement short pasture by the feeding of grain, but this is as a rule unnecessarily expensive. It will pay, however, if no other feed is available. Provision for short pasture is best made either by having green crops on hand that may be cut for feed, or by feeding silage or alfalfa hay during this period. The use of green crops cut and taken to the animals is known as the soiling system. In recent years the use of corn silage for summer feeding is meeting with the greatest favor and promises to displace the practice of soiling to a large extent, because it is much less expensive. For summer feeding a silo of small diameter is recommended in order that the silage may be fed fast enough to prevent spoiling. If the silage is not needed it can be kept for winter use.

120. Amount to Feed. One of the most common mistakes made in feeding cows is in not feeding them enough. If a cow does not respond in milk yield when well fed, she should be sold. The cheapest production is obtained from a high-producing cow well fed. The cow may be looked upon as a milk-producing machine, which we supply with the raw material in the form of feed. This raw material is manufactured into milk. The same rule holds as with any manufacturing plant; it is run most economically near its full capacity. One should understand that, first of all, the animal must use a certain amount of its food to maintain the body. This is called the ration of maintenance and is practically the same whether the animal is being utilized for full capacity or merely being kept without producing any milk at all. About 50 per cent of all the feed she can consume is used by a medium dairy cow for this purpose. It is evident that after going to this expense it is the poorest economy to refuse to give the other 50 per cent of a full ration, which would be used entirely for milk production. Since only half of a full ration is available for making milk, it is clear that if through mistaken ideas of economy the cow is fed 75 per cent of a full ration the amount she has available for producing milk is reduced 50 per cent. The heavy-milking cow is the one most commonly underfed. It is often observed that heavy-milking cows rapidly get thin in flesh after calving and may drop greatly in the amount of milk within a short time. This is the result of underfeeding. If a certain cow has a capacity to produce only 25 pounds of milk daily and is already receiving enough feed for this amount, it is a waste of feed to increase her ration as she will not correspondingly increase in milk. If a cow of this type is given more feed than she needs, she uses part of it for laying on fat and soon commences to appear smooth and beefy. The practical question arises then as to what means may be employed to determine how much feed a certain cow needs. The most accurate plan is to calculate the ration according to the feeding standard as described in paragraph 92.

There are in addition certain observations that may be made the basis of practical feeding operations. One is the condition of the animal in regard to flesh. The inclination to give milk is so strong in a good cow that when underfed she will continue for some time to give more than is provided for by her ration and will supply the remaining material that is required from her body. This results in a gradual loss in weight. When a cow in milk loses weight, it means that she is underfed and unless her ration is increased soon she will drop materially in milk yield. On the other hand if a cow in milk is gaining in weight, it is evident that she is getting more feed than she is using and her ration may be cut down.

Another suggestion is to note carefully the amount of milk the cow produces at her best, which will be within a short time after calving. Then be sure to feed enough to support this amount of milk production. Later, as she declines, due to the advance in the lactation period, reduce the feed to correspond to the decline in milk.

The following rules serve as a general guide for practical feeding:

1. Feed all the roughage the cows will eat up clean at all times.

2. Feed 1 pound of grain per day for each pound of fat produced per week, or 1 pound of grain per day for each 3 pounds of milk produced by Jersey; 3½ by Ayrshire; and 4 by Holstein.

3. Feed all that the cows will take without gaining in weight.

It is best to become accustomed to thinking in terms of weight rather than in terms of measure in calculating rations and feeding dairy cows. It is often more convenient when feeding to measure than to weigh the feed. The most practical plan generally is to feed with a measure and weigh the feed mixture used often enough to make it possible to estimate closely how much is required by measure to give the weight desired.

121. The Balanced Ration. The most common mistake made in feeding dairy cows, next to underfeeding, is giving too little protein. This mistake is especially common in the corn-belt on account of the wide use of corn and timothy hay, both very deficient in protein. Where alfalfa hay is fed the ration nearly always has enough protein. A milking cow must use a certain amount of protein, and no other material can take its place. A ration is said to be balanced when the protein and carbohydrates are in the right proportion.

It is not possible to make a good ration by using corn and timothy hay unless large quantities of mill feeds rich in protein are fed. In formulating a ration the roughage is the first consideration, since the character of this portion largely determines the kind of grain to be fed. The cheapest source of protein is generally leguminous hay, such as clover, alfalfa, or cowpea. If an abundance of any one of these can be grown, the problem of making an economical ration is greatly simplified. If alfalfa hay is fed, it is not necessary to use concentrates that are rich in proteins. If mixed hay and corn silage are used, at least one-third of the grain should be rich in protein.

122. Succulent Feed. In order to obtain the best results it is necessary to have a portion of the ration of a succulent character. This term is applied to feeds that contain much water, such as green grass, corn silage, roots, and cabbage. Such feeds seem to have a value outside of the actual nutrients they contain on account of the favorable effect upon the digestion of the animal. In the corn-belt, corn silage furnishes the cheapest and best succulent feed for winter. In other sections, especially north of the corn-belt, the growing of root crops is generally practicable. They supply this desirable element of the ration in an entirely satisfactory form.

123. Palatability of the Ration. An animal will give better results if it relishes its ration. Sometimes even if a feed containing enough nutrients is offered, a sufficient amount is not eaten on account of a lack of palatability. Hay and other coarse feeds show the most variation in this respect, depending upon time of cutting and manner of curing. It is advisable to have the grain composed of a mixture of two kinds or more as this increases palatability. A ration for very high-producing cows should be a mixture of five or six feedstuffs. Succulent feeds are always palatable and they aid digestion by keeping the animal in good condition. When a good ration has been selected there is no reason for change for the sake of variety. If the animal craves a change in ration, it is an indication that the ration it has been receiving is deficient in some particular.

124. Order of Feeding. Regularity in feeding is of greater importance than any special routine. The common practice is to feed twice daily giving about one-half the grain and roughage at each feed. The grain is generally fed first and the hay feeding reserved until the milking is done to avoid having dust in the barn. Silage should also be fed after milking to prevent possible odors in the milk. The cow readily becomes accustomed to a certain routine and this should not be varied any more than is absolutely necessary. She may be accustomed to receive grain either before or after milking, or be easily taught to demand it while the milking is being done.

Feeding Cows for the Maximum Production in Official Tests

125. Obtaining the Maximum Production. The maximum production is obtained from high-producing cows by a combination of expert handling and the best possible ration. Such cows cannot be fed entirely by any rule, nor can their ration be calculated by a formula. The individual animal and her characteristics must be taken into account. One of the essential things is having the animal in the proper condition of flesh at calving. She should be dry for two months or more for the best results, and be fed a liberal amount of grain during this period. Some form of succulence is absolutely necessary as a part of the ration. Roots, such as common beets, sugar beets, or mangels are even better than silage for this purpose, and may be fed up to 50 pounds or more per day.

The cow must be brought up to the full ration carefully after calving, using about three weeks for this purpose. The grain ration should consist of a mixture of several concentrates, all of which are palatable. So long as the animal remains in normal condition, no change in the grain ration is necessary. Special attention must be given to the physical condition of the cow. A careful herdsman always closely observes the character of the dung excreted, and learns to judge when the digestion is normal. At the first indication of lack of a keen appetite the ration is cut down until the animal is again in condition to utilize the full amount. If the digestion gives indication of even slight disorder, a purgative, such as Epsom salts, 1 to 1½ pounds at a dose, should be administered at once. The grain should always be eaten with a relish, and the animal should show a disposition to want a little more than she receives.

A ration for a heavy-milking cow must be rich in protein. Much more grain should be fed in proportion to the roughage than with an ordinary producer. In fact, for the maximum production of a great producer, the nutrients will need to be largely supplied by concentrates.

The following daily ration was fed by the writer to a Jersey cow that was producing daily 40 pounds of milk, containing 2 pounds of fat. The cow weighed about 900 pounds and produced during the year 13,895 pounds of milk and 680 pounds of fat. The same grain mixture was fed during the greater part of the milking period, including the pasture season.

	Pounds
Corn silage	15.
Alfalfa hay	15.
Corn meal	3.5
Bran	3.5
Oats	3.5
Oil meal	1.5
Total roughage per day	30.
Total grain per day	12.

A Holstein cow under charge of the author was fed the following amounts daily while producing an average of 100 pounds of milk daily.

	Pounds
Corn silage	15.
Alfalfa hay	20.
Dried beet pulp	4.
Corn meal	6.1
Bran	6.1
Oats	6.1
Gluten feed	1.9
Linseed meal	1.9
Cottonseed meal	1.9
Total roughage	35.
Total concentrates	28.

The grain ration was prepared by mixing 100 pounds each of corn, bran, and oats, and 30 pounds each of the last three named above. One pound of dried beet pulp was added to six pounds of the grain mixture and the entire mass moistened with water some time before feeding. The cow was fed and milked four times each twenty-four hours.

QUESTIONS AND PROBLEMS

1. Distinguish between composition of a feed, digestible nutrients, and production value.
2. Define concentrate, succulent, roughage, corn stover.
3. What succulent winter feeds are used in your region?
4. What common feeds of your region are high in protein?

5. Calculate the amounts of corn and clover hay required to maintain a cow weighing 1000 pounds.

6. Find the amount of protein and energy required for a 1250-pound cow producing 40 pounds of milk daily, containing 3.5 per cent of fat.

7. From the feeds in Table 15, calculate a ration that will satisfy the conditions in problem 6. How does the ration agree with the standards on page 304?

8. Find the protein and energy in the following rations:

Ration 1		*Ration 2*	
Corn silage	30 lb.	Timothy hay	12 lb,
Alfalfa hay	10 lb.	Corn fodder	10 lb.
Corn	6 lb.	Corn	6 lb.
Cottonseed meal	1 lb.	Bran	1 lb.

What is the limiting factor in the second ration?

For how much 3.5 per cent milk does each ration supply protein in addition to maintaining a 1000-pound cow?

9. Calculate a ration for a 900-pound Jersey cow giving 23 pounds of milk daily, using the common feeds of the region.

10. When bran is worth $20, cottonseed meal $30, clover hay $10 per ton; and corn 70 cents, and oats 50 cents per bushel, find which is the cheapest source of protein. Which is the cheapest source of energy?

11. Obtain the local prices of purchased feeds in the region. Which is the cheapest source of energy? Of protein?

12. With prices given in problem 11, calculate the cheapest possible satisfactory ration for a Shorthorn cow weighing 1200 pounds and giving 30 pounds of milk daily.

13. Is skim-milk usually available for calf feeding in this region? What are the common calf feeds used?

14. Let each student find the approximate amounts of milk and other feeds used in raising a calf to six months of age for his own farm or some other farm. At normal prices, what is the feed worth? Have all these reports compared and averaged. Compare with results on pages 115, 250 and 252.

15. Proceed in a similar manner to find the usual method of feeding heifers in the region.

16. What is the usual date for turning cows to pasture in your region? About what times are they taken off of pasture in the

fall? At what time are the pastures not likely to furnish enough feed?

17. What effect does the manner of feeding the heifer have on the amount of milk that she is likely to give as a heifer? As a mature cow?

18. What conclusion would you draw from observing that a cow when giving milk was gradually getting thinner? What conclusion if she were gaining in flesh?

LABORATORY EXERCISES

9. Raising a Calf. Let each student who can arrange to do so, raise a calf, following the directions that apply to the conditions. Keep track of all the feed used, and see if the calf can be raised at less than the usual cost. This is particularly important in regions where whole milk is sold.

10. Study of Feeding on a Dairy Farm. Obtain permission to visit a dairy farm, preferably one where the farmer has scales that will weigh cattle; or students may do this work for herds on their home farms. A spring balance and tape measure will be required.

Make a list of the cows in the herd, and find out the following facts about each. Or if the herd is too large, use five or six cows that are giving different amounts of milk. Each student may do the work for one cow.

	Cow 1	Cow 2	Cow 3	Cow 4
Age				
Breed				
Weight				
Pounds milk				
Per cent fat				
Protein for maintenance				
Protein for milk				
Total				
Protein of food				
Energy for maintenance				
Energy for milk				
Total				
Energy of food				
Gaining or losing flesh				

How much milk is each giving? If the farmer does not know, arrangements can be made to have one student or the farmer weigh the milk for one or two days. What mixture of grain is fed? How much grain is each getting? If the farmer does not know the weight of a day's feed, he can measure out what he is using and this can be weighed. What does the grain mixture weigh per quart? In the same way the amounts of silage and other feeds may be obtained. Weigh each cow. Ask the farmer's opinion as to which cows are gaining and which losing in flesh. Obtain samples of milk for each cow, and test for fat.

Calculate the amount of energy and protein for maintenance of each cow, the amount necessary for milk production, and the amount in the feed. The results may be summarized in a table like the one shown on page 137.

Does it seem probable that any one of the cows is not obtaining enough protein or enough energy? Are there practical ways in which the ration may be cheapened by using different feeds? It may be that the farmer will be willing to experiment with increasing or decreasing the feed or with using a different mixture. If he is willing to do so, the results should be followed carefully.

11. Raising Heifers. Obtain measurements of a number of heifers, and compare with the results on page 122.

COLLATERAL READING

Computing Rations for Farm Animals by Use of Energy Values, U. S. Dept. Agr., Farmers' Bulletin 346.

Handling and Feeding Silage, U. S. Dept. Agr., Farmers' Bulletin 578.

The Feeding of Farm Animals, U. S. Dept. Agr., Farmers' Bulletin 22.

Feeding Skim-milk Calves, U. S. Dept. Agr., Farmers' Bulletin 233, pp. 22–25.

Feeds and Feeding, Henry and Morrison.

Cyclopedia of American Agriculture, L. H. Bailey, Vol. III, pp. 56–118, 308, 310, 313–317.

The Feeding of Animals, W. H. Jordan.

Dairy Cattle and Milk Production, C. H. Eckles, pp. 254-294.

CHAPTER 6

THE DAIRY BARN

C. H. ECKLES

It is only within recent years that the arrangement and construction of the dairy barn has been given the attention that its importance justifies. It pays to have a comfortable

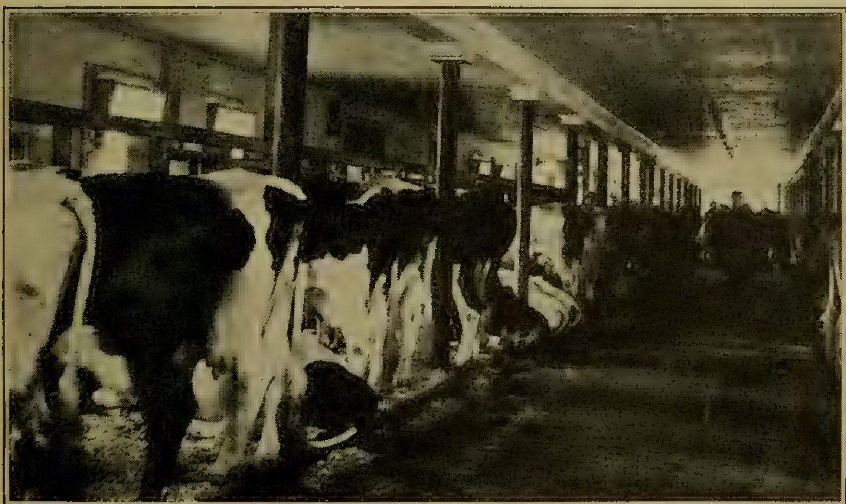

FIG. 35. — Interior of a well-arranged barn.

barn on account of the larger production of milk which results. The arrangement of the barn is also an important factor in efficient use of labor and in keeping the workers contented. There is a growing demand for better sanitary conditions surrounding the milk supply, and this means that barns must be constructed with more attention to those details that make it possible to keep milk clean.

126. General Arrangement of Barns. The style of barn construction will necessarily vary with the locality, climate, and many other factors. The interior arrangements of the cow barn, however, may be much the same in barns differing widely in general plan of construction. The most common arrangement of dairy cows in a barn is in two rows,

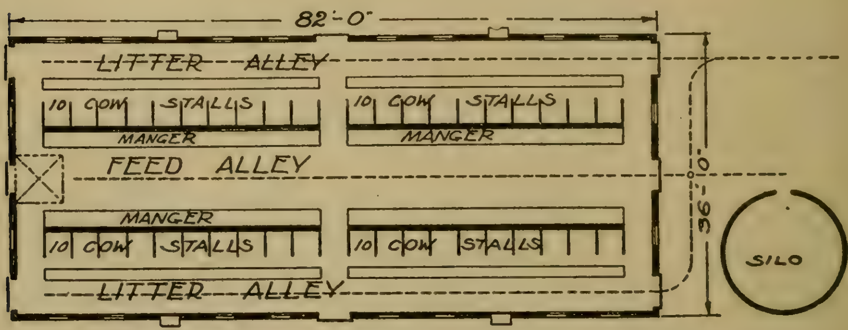

FIG. 36. — Floor plan of a good barn in which the cows face the center. The calf pens and milk room are not shown.

facing either towards the center or towards the wall. If a manure carrier is used, it is most convenient to have the heads together, as this saves time in feeding with no loss in cleaning. If a wagon is to be driven through the barn for cleaning, the cows should face the wall. More than two rows require that the barn be too wide for efficient lighting and for convenience in handling the cattle. The barn should be located where there is good drainage and where it is convenient from the standpoint of labor.

127. Lighting. One of the most serious defects in many barns, especially in old ones, is lack of sufficient light. A light barn is more healthful for the animals, and it is the first step toward removing the objectionable features often connected with dairy work. A dark barn is almost always a dirty barn. By having plenty of sunlight, dirty conditions are easily seen and are usually corrected. There should be about four square feet of glass per cow. The best arrangement is to have the windows extend from the ceiling about

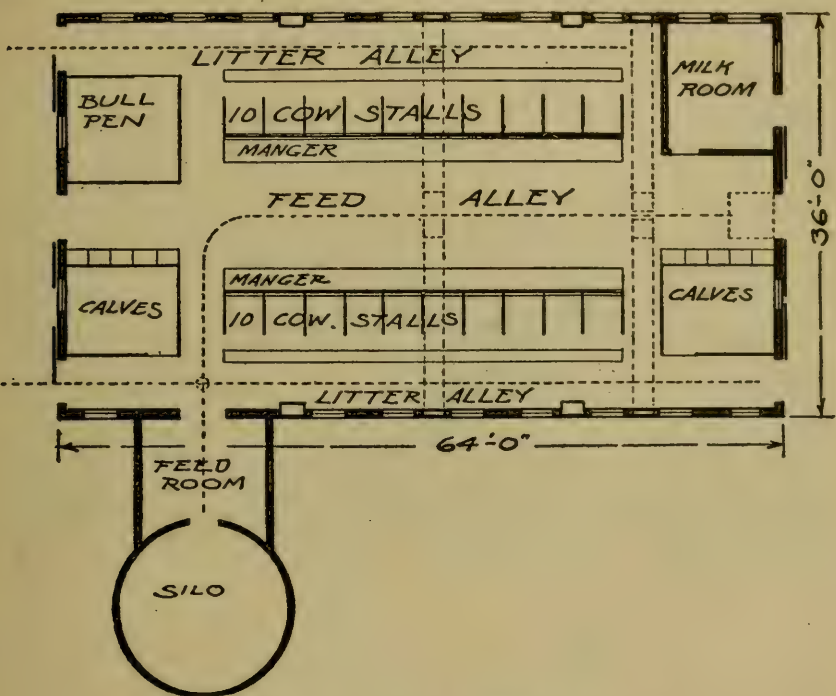

FIG. 37. — Floor plan of a barn for 20 cows.

halfway to the floor, as this makes it possible for the sunlight to reach farther into the barn.

128. The Floor. One of the most important considerations of all is the floor. A satisfactory floor is comfortable for the cows, sanitary, easily cleaned, durable, and not too expensive. The floors most commonly used are wood, concrete, or dirt, with wood or concrete gutters. A floor of dirt, although comfortable for the cows, is only allowable under conditions where it is not possible to have a better one. The main objection, of course, is that it cannot be kept clean. A fairly good arrangement in a cheap barn is a dirt floor for the cows to stand upon with a cement gutter behind, provided with a strip extending forward about one foot to catch the urine. A tight wooden floor is comfortable for the cows and may be kept in good sanitary condition if

FIG. 38. — A well-lighted barn.

in good repair. The main objection to this material is its high first cost and lack of durability. Concrete is durable and sanitary, but not so comfortable for the cows as the others. It requires a liberal use of bedding. In putting in a concrete floor care must be taken to have the surface given a rough finish, otherwise the animals will slip and sooner or later seriously injure themselves. It is not necessary to make the floor as thick as is sometimes recommended. On solid earth four inches is as good as more.

129. The Platform. The best arrangement for keeping cows clean is the platform and gutter. It is well to have the platform about 6 inches wider at one end than at the other so that the cows may be arranged in order of size and fit the platform. The same result may be accomplished by having the platform on one side of the barn wider than that

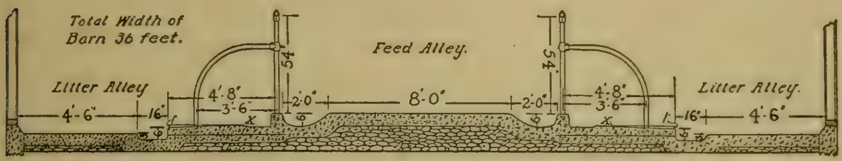

FIG. 39. — Cross section of a barn with cows facing the center. The style of manger may be varied as shown in Fig. 41. The length of the platform should be varied to suit the breed.

on the other. The width of the platform from manger to gutter should vary to suit the breed. The length of platform needed for animals from 2 years old to the largest cows is given in Table 18.

TABLE 18. — LENGTH OF PLATFORM REQUIRED FOR DIFFERENT BREEDS

BREED	SHORTEST	LONGEST	AVERAGE
Jersey	48 inches	56 inches	54 inches
Guernsey . . .	50 inches	58 inches	56 inches
Ayrshire	50 inches	58 inches	56 inches
Holstein	54 inches	62 inches	60 inches
Shorthorn . . .	54 inches	62 inches	60 inches

The platform should slope about one inch from the manger to the gutter. It is better to have it rise half the way back and then slope to the gutter. This helps to prevent the front feet from slipping and causing injury to the knees. A very good platform can be made by laying 2 inches of concrete, then a layer of tar paper, and on this place $1\frac{1}{2}$ to 2 inches of concrete. The paper extends to within about 4 inches of the gutter. The tar paper prevents moisture from rising and, by stopping the loss of heat, also makes the concrete warmer for the cow to lie on. One of the best floor arrangements is one in which the floor, manger, and passageways are of concrete with a wooden platform on top of the concrete under the cows. In this case two inches of concrete under the plank is sufficient if placed on solid ground.

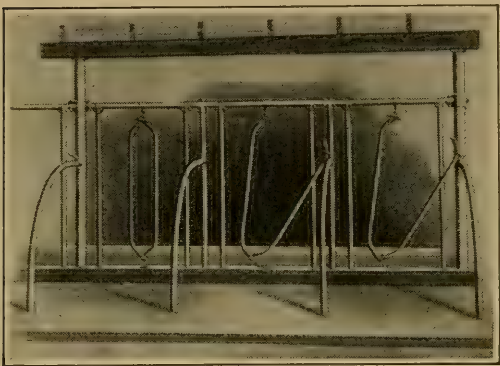

FIG. 40. — Modern stalls and ties. Steel construction gives a neat appearance, is sanitary, strong, and durable.

130. The Gutter. The gutter is often made too shallow. It should be preferably about 8 or 9 inches deep and about 16 inches wide and should be tight to prevent urine from getting under the floor. A common plan is to have the passageway behind the animals 2 to 4 inches lower than the platform.

131. The Stalls. When the cow is tied in a stanchion, the stall should be 42 to 44 inches wide for the large breeds, while 36 to 42 inches is sufficient for the smaller breeds. Partitions are used in many barns, but some dairymen prefer to dispense with them for the sake of facilitating the movement of the cows in getting in and out of the stalls, and for convenience in doing chores.

132. Mangers. Concrete is the best material for mangers from the standpoint of sanitation and durability. The most common type of concrete manger is the continuous, which is built in the form of a trough before the cows. By having the feed alley raised, feed can be swept into the manger without lifting. (See Fig. 36.) The main advantage of this style is the ease of feeding and cleaning. It may also be used for watering in the barn. Some objections are made to this style of construction on account of the chance it affords for one cow to rob another of a portion of its feed. Partitions

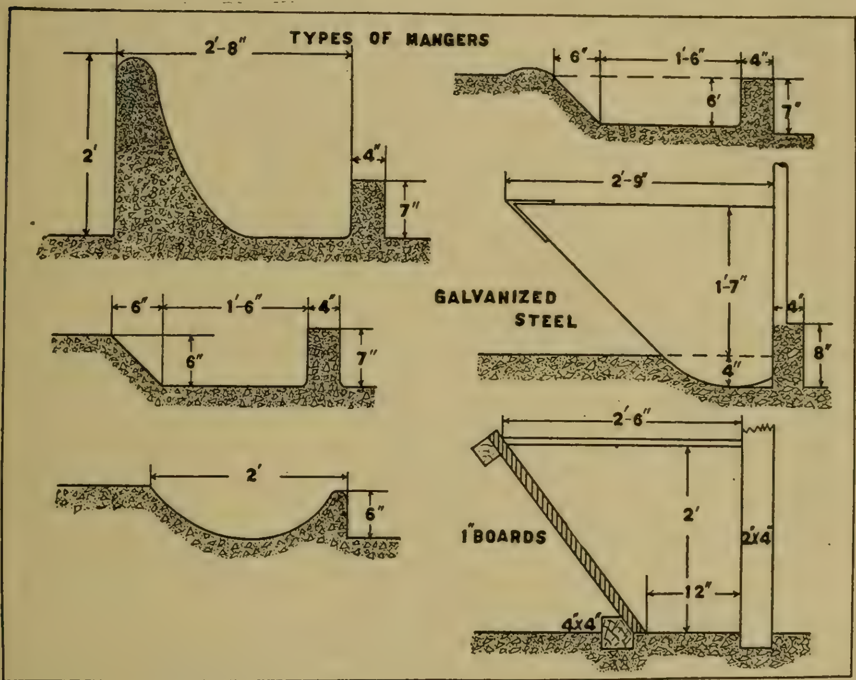

FIG. 41. — Types of mangers.

of sheet iron or concrete are sometimes used to overcome this difficulty.

133. Ties. The cow should be fastened so that she lies down exactly where she stands or a little forward if possible. The most objectionable way is to tie a cow to a manger so that she must back up to lie down. This results in covering the cow with filth. The most common ties in use are various forms of stanchions. There is no better way to keep the cow clean than to tie her with a stanchion, properly constructed, and stand her on a platform of the right dimensions provided with a gutter of sufficient depth. The old style rigid stanchion is not a satisfactory tie, as the cow has no freedom and cannot lie in a natural position. Many forms of stanchions are in use that are entirely satisfactory. These are generally hung on short chains at top and bottom and are constructed of either wood or steel. The double post slip chain tie is equally comfortable for the animals, but not so convenient for use. Stanchion or chain ties may be attached to either iron or wooden framework as supports.

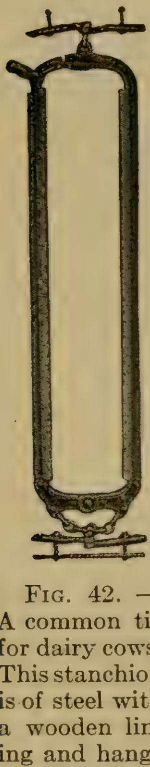

FIG. 42. — A common tie for dairy cows. This stanchion is of steel with a wooden lining and hangs on chains at the top and bottom to allow freedom of movement.

134. Ventilation. An abundance of fresh air is as essential as plenty of feed. The most simple form of ventilation is by windows. This works best when the sash is hinged in the middle or at the bottom so that the air can be admitted by tipping the top of the window sash slightly into the room. This throws the air towards the ceiling and away from the animals. This form of ventilation can be used satisfactorily in mild climates. In northern latitudes it is not satisfactory during severe weather on account of the difficulty of properly controlling the intake of air during rapid changes of wind and temperature.

The best form of ventilation yet devised is the King system. This consists of a large flue, opening near the floor and extending above the roof, for taking out foul air. A number of smaller openings arranged at intervals of 10 to 12 feet along the walls allow for the intake of air. The intakes open to the outer air near the ground, pass upwards inside the wall and open into the barn near the ceiling. These openings should be provided with means for closing if the wind pressure causes too rapid movement of the air.

135. Cost of Barns. The price of milk, climate, cost of lumber, and many other factors influence the cost of dairy barns. Where milk is high in price and where a corresponding quality is demanded, a very different barn will be required from the kind needed when milk goes to the creamery. If valuable pure-bred stock is kept, a somewhat more expensive barn may be justified than would be needed for ordinary cows, because a good barn may help one to sell the stock. Some very good dairy barns have been built where lumber is moderate in price at a cost of $50 per cow. Unless milk sells at a very high price, one should certainly hesitate to spend more than $100 per cow for the barn, including milk room, and silo, and storage place for the other dairy feeds.

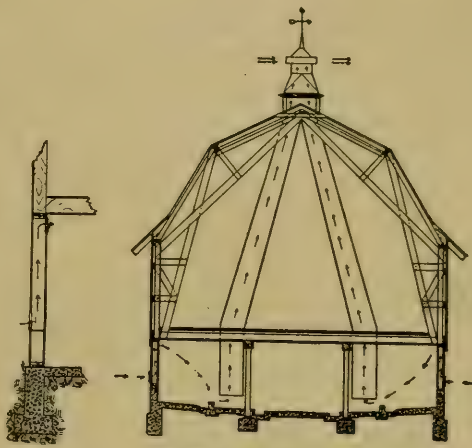

FIG. 43.— Cross section of a barn showing the King system of ventilation. The air enters near the ceiling on the sides and is drawn out through large flues opening near the floor.

On the corn-belt farm, where few cows are kept and where there is an abundance of straw, the cows may run in an open shed. If there is a milking shed in which the cows are milked and fed grain, very clean milk may be obtained. No system is better for the health of the animals than running loose in a good shed, but where dairying is made the primary business a regular dairy barn is ordinarily desired.

QUESTIONS AND PROBLEMS

1. What materials are used for barn floors in your region? Describe the floor in some good barn, and tell how it was made.

2. What different kinds of stanchions are used?

3. Are manure carriers used in any barns? If so, what kind is used, and what did it cost?

4. Does any barn in the region have the King system of ventilation? If so, describe it.

5. If any barn has been built in the region in the past few years, find the cost per cow.

6. Draw a floor plan for a barn to hold 6 horses, 15 cows, and young stock. Or change the numbers of stock to suit the conditions. Show dimensions of stalls, mangers, etc., and location of milk house.

LABORATORY EXERCISES

12. Study of a Barn. Arrange with the owner to visit a good dairy barn in the region, and study its general arrangement. A tape measure and thermometer will be required.

Some of the points to be determined are as follows:

Length, width, height of posts, height of peak, height of ceiling in cow barn.

Capacity for hay, silage, grain. See page 305.

Make a diagram of a cross section of the floor similar to figure 39, indicating the dimensions of the feed alley, manger, platform, gutter, etc.

How wide a place is allowed for each cow?

What kind of stanchions are used? What did they cost?

How many cubic feet of air space is there per cow?

What system of ventilation is used? Did the air appear to be good when you entered the barn? What is the temperature in the barn?

How are the windows arranged? How many square feet of glass is there per cow?

Is there a milk house? How many feet must be traveled with the milk from each cow?

Are the arrangements for feeding the cows and for cleaning the barn convenient?

COLLATERAL READING

Cyclopedia of American Agriculture, L. H. Bailey, Vol. I, pp. 245–260.

Ice Houses and the Use of Ice on the Dairy Farm, U. S. Dept. Agr., Farmers' Bulletin 623.

A Plan for a Small Dairy House, U. S. Dept. Agr., Farmers' Bulletin 689.

Lightning and Lightning Conductors, U. S. Dept. Agr., Farmers' Bulletin 367.

Homemade Silos, U. S. Dept. Agr., Farmers' Bulletin 589.

Ventilation for Dwellings, Rural Schools and Stables, F. H. King.

Cost of Fencing Farms in the North Central States, U. S. Dept. Agr., Bulletin 321.

CHAPTER 7

COMMON AILMENTS OF CATTLE

C. H. Eckles

The author makes no attempt at giving directions for the treatment of such diseases and accidents as call for the services of the competent veterinarian. The farmer should depend largely upon the qualified veterinarian as his adviser in matters concerning the health of his animals, but there are certain common troubles that every manager of dairy cows should know how to handle. The discussion which follows aims to present a few of the facts that every dairyman should know. The discussions are in the nature of advice for the owner of dairy stock and are not expected to take the place of expert advice by the veterinarian.

Normal Conditions

136. The Pulse. The heart of the cow normally beats 50 to 60 times per minute. It is more rapid in young animals than in old, and is increased by excitement or exercise. The most convenient way to take the pulse of a cow is to stand on her left side and reach over the neck and feel the pulse on the lower side of the right jaw. A quick, bounding pulse indicates inflammation at some point in the body. The trained veterinarian becomes very skillful in diagnosing disease by the feeling of the pulse.

137. Temperature. The normal temperature of a cow usually varies between 99° and 103° F. The temperature is taken by means of a self-registering, or clinical, thermometer. Before using it the mercury is shaken down. The instrument is placed in the rectum for at least three minutes before the reading is made.

A rise in temperature indicates fever due to inflammation at some point in the body. A rise of 4 degrees is serious, while as much as 6 degrees is dangerous. A sudden fall in temperature is also serious. The dairyman should provide himself with a good clinical thermometer and become familiar with its use.

138. Respiration. A cow normally breathes from 10 to 25 times per minute. Rapid breathing may be caused by exercise, heat, or excitement, or by distention of the stomach with gaseous food to such an extent that the lung capacity is diminished. Rapid, short, or difficult breathing usually signifies trouble with the respiratory organs.

139. The Excretions. The excretions of an animal, the urine and feces, or dung, show the general condition of the digestive tract and kidneys. The stockman should be quick to observe any abnormality in this respect and determine the cause if possible. It is especially important to observe the feces of the cow when she is under conditions of high feeding as this is the best index of the state of her digestion. The knowledge necessary to interpret the various conditions that appear can only be had by experience and observation.

Instruments and Medicines

140. Instruments and Medicine. Every manager of a herd of dairy cattle should be prepared for the ordinary emergencies. If a competent veterinarian is not readily accessible, this is all the more important. The following instruments and medicines are most often needed, and it is advisable to have them on hand :

Milk fever outfit, if high-producing cows are kept

2 milk tubes of different sizes

3 teat plugs of different sizes

Trocar, if there is much trouble from bloating

Syringe

Drenching bottle

Clinical thermometer

A liberal amount of carbolic acid or some other good disinfectant should always be on hand, as frequent use will be found for it. Crude carbolic acid can be used in a 2 per cent solution, when applied to the animal's body, or in a 5 per cent solution for disinfecting other objects, such as the floor of the barn, or instruments.

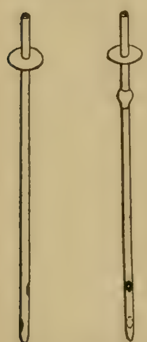

FIG. 44. — Milking tubes, used when teats are injured or sore.

An abundant supply of Epsom salts should also be provided, as occasion for using it will come often. In most herds entirely too little use is made of this important medicine. A dose of 1 to $1\frac{1}{2}$ pounds of salts for the grown animal should be the first treatment in nearly all cases of sickness. In every case where an animal shows loss of appetite or sickness the cause of which is not known, a physic should be given at once and the feed reduced. A second dose after three or four days is often beneficial. If the appetite of the animal has returned, the ration can again be increased to the normal.

141. Drenching a Cow. The common method of administering medicine to a cow is to mix with water and give from a bottle. This is known as a " drench." When giving a drench, the head of the animal should be elevated by tying, or it may be held by an assistant. The operator stands on the left side, and grasps the nose with the thumb and fingers in the nostrils. The bottle used should be adapted for the purpose, having a long, strong neck. The mouth of the bottle should be inserted in front of the back teeth resting on the tongue as far back as the middle. If the animal coughs, the head should be at once lowered to allow the liquid to escape from the windpipe. If this is not done, the medicine may pass down into the lungs, and cause sickness. Unless there is some special reason for doing so, it is not customary to give over 1 to 2 quarts at a time. Unless the herdsman is thoroughly informed regarding the treatment of cattle ailments, he will seldom have occasion to administer medicine other than Epsom or Glauber salts except under the direction of a veterinarian.

Common Ailments

142. Milk Fever. Milk fever occurs only with high-producing cows. It never affects a cow with her first calf and rarely with the second. The well-fed, heavy-milking cow is the one most likely to be stricken. The disease is so typical that it is easily recognized. In practically every case it occurs within 48 hours after calving. Every heavy-milking cow should be watched carefully until this time has elapsed. The first symptoms are restlessness and excitement. Within a short time paralysis of the hind legs begins, resulting in a staggering gait. The animal soon falls and is unable to rise. The cow assumes a characteristic position, which is of great value in diagnosing the disease. The head is turned to one side and rests on the chest with the muzzle pointing towards the flank. When this position is assumed, the cow becomes unconscious and remains so until death, which occurs within about 24 hours if treatment is not given. Fortunately the air treatment, which was discovered a few years ago by Anderson in Denmark, makes it possible to relieve nearly every case. When this is properly applied, the cow will recover completely within a few hours and no bad effects follow. Without treatment, recovery seldom occurs.

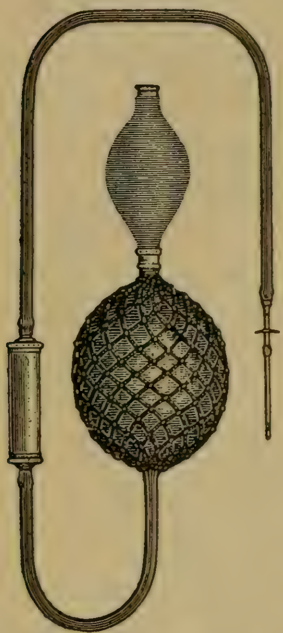

FIG. 45. — Milk Fever outfit. The milk tube is inserted in the milk duct of the teat and air is pumped through sterilized cotton placed in the small cylinder.

An approved apparatus is shown in Fig. 45. The essential parts are a milk tube, a receptacle of some kind in which clean cotton is placed to catch the dust in the air pumped through it, and a rubber bulb or pump of some kind. In case a regular apparatus is not at hand, one that will serve the purpose can be improvised from materials generally found in a drug store.

In using the apparatus the operator should first thoroughly clean his hands, likewise the cow's udder and teats, with warm water and soap, followed by a 2 per cent solution of carbolic acid or creolin. That portion of the apparatus which holds the cotton, the rubber tube, and milk tube, must be clean, and preferably boiled for 15 minutes before using, then disinfected by the use of the carbolic acid or creolin. The receptacle for holding the cotton is filled with ordinary cotton, or, better still, absorbent cotton, which may be purchased at most drug stores. The milk tube is inserted into one of the teat openings without drawing any milk, and air is pumped through the cotton into the udder. This is continued until the quarter is well distended with air, when the tube is carefully withdrawn and a tape tied around the teat tight enough to prevent the escape of the air. The same treatment is applied to each quarter. The teats are allowed to remain tied. Ordinarily within two or three hours the cow will regain consciousness and be able to stand on her feet. If the air is absorbed or escapes, so that the udder is not tightly distended, the tape should be removed and another injection of air made as before. Usually two injections are sufficient. The udder should remain full of air fifteen hours at least, and longer if any sign of the trouble remains. The calf of course is not allowed to suck during this time. If inflammation of the udder follows, sufficient care was not taken in disinfecting the apparatus.

143. Abortion. This term is used by cattlemen to indicate the premature birth of the calf. Abortion may be accidental or the result of a contagious disease. The non-contagious cases may occur as the result of injury, such as a fall, the kick of a horse, or being crowded in a gate or doorway. Severe sickness, such as indigestion or bloat, may cause the trouble. If a single case occurs, it may be attributed to some accidental cause. If a number occur in the same herd, it is almost certain that the specific disease known as contagious abortion is present.

This disease causes more loss financially to the dairymen of the country than any other disease to which cattle are subject. As a result of the work of Dr. Bang of Denmark it is now definitely known that this trouble is due to a certain species of bacteria. The presence of these living organisms in many cases, but not in all, results in premature birth of the calf. It is thoroughly proved that the disease is contagious and may spread through a herd from a single infected animal brought into the herd. From 50 to 75 per cent of the cows in an affected herd often abort. The remainder are either naturally immune or carry the calf to full time in spite of the disease. The calf is usually born at the sixth or seventh month and, at this early stage, always dead. After having once aborted many of the cows are immune and afterwards carry the calf in a normal manner. Others abort twice before becoming immune. Some as the result of abortion become sterile or shy breeders. The disease is spread either by the male or by the germs from an affected animal getting on the feed consumed by another.

Two methods of testing cows for infection with this disease have recently been devised. These methods as yet can be carried out only by a skillful operator supplied with the facilities of a scientific laboratory. It is probable that these methods will be adapted for use by a large number of veterinarians. Such a test may make it possible to keep herds free from abortion by excluding animals having the disease.

No satisfactory treatment has yet been discovered for contagious abortion. The main precaution now is prevention as far as possible by keeping the disease out of the herd. It is not safe to buy an aged bull or a cow from a herd where the disease exists. If an abortion occurs, the fetus and afterbirth should be burned or buried. The aborting cow should be isolated and the stall where she stood disinfected with a 5 per cent solution of carbolic acid.

144. Tuberculosis. This disease is caused by a certain species of bacteria. The bacteria cannot develop from the surroundings or conditions of handling, but must come from another animal having the disease. The germs that cause the disease escape from an infected animal in the slobber from the mouth, with the manure, and, sometimes in the case of udder infection, with the milk. As a rule a cow does not die quickly from tuberculosis. The disease usually progresses slowly. The animal may have it for years without any indication of ill health. The disease may attack almost any organ of the animal's body but is common, as with human beings, in the lungs. Animals that have plenty of feed and fresh air may sometimes recover. Good ventilation and good feed and care are important in control of the disease.

It is impossible to tell by external appearances, except in extreme cases, whether the animal is affected or not. Fortunately we have in the substance known as tuberculin, an agent that is fairly reliable in showing the presence of the disease even in the smallest degree. The test is made by first taking the temperature of each animal three or four times at intervals of two hours. Tuberculin is then injected beneath the skin. After eight or nine hours temperature readings are again taken and repeated five to eight times at two-hour intervals. A rise in temperature suggests that the disease may be present, but experience is necessary for accurate interpretation of the results. The interdermal method, which is also used, consists in injecting the tuberculin in soft skin, usually on the under side of the tail. If the disease is present, a swelling appears and remains for several days.

A dairyman accustomed to the use of instruments can conduct the test himself after first assisting a competent operator. It is safer, however, to have the work done by a trained veterinarian in order that no mistakes may be made and that the test may be recognized by health officers and prospective buyers. Many states have laws governing the use of tuberculin. These laws are often changed, and are sometimes far from satisfactory. For these reasons one should understand the law before he tests his herd.

The tubercular organism in cattle is slightly different from the human form, but sometimes the bovine form is found in human beings. It is thought that tuberculosis of the lungs is rarely if ever contracted from cattle, but some of the cases of tuberculosis in the intestines and glands, especially in young children, are thought to be so contracted.

145. Inflammation of the Udder. This is one of the most common troubles with dairy cows. It varies in severity from a mild case, when the milk is only slightly stringy for a few days, to severe cases, where the udder becomes so swollen that no milk can be drawn. It may end with the permanent loss of the udder.

Inflammation of the udder is not the same as the congestion that occurs in heavy-milking cows just after calving. Congestion at this time is to be expected and need not cause anxiety, as long as the milk can be drawn from each quarter and the milk appears normal. When the udder is inflamed, the cow should not receive much grain until the udder softens. The ration fed should be laxative in nature and of a light character, such as bran. The milk should be drawn several times daily and the cow carefully protected from cold and exposure.

Garget is a common name for mild cases of inflammation of the udder. Sometimes there are swellings in the udder, or the milk may be stringy or lumpy. In many cases no special cause can be discovered, although exposure to severe weather, lying with the udder on a cold floor, injury by bruises, or too heavy grain feeding may bring it about.

Certain cows at times have it as a chronic condition, giving stringy milk at intervals for months or years. Mild cases, if not chronic, usually respond readily to treatment. A physic should be given at once and the grain ration reduced to one-third the usual amount. An ounce of saltpeter per day for two or three days is generally beneficial after the purgative has begun to work. If the udder is very sensitive, a milking tube should be used for a few days.

Occasionally severe cases of inflammation of the udder develop. These usually come on suddenly and are most likely to affect the heaviest milkers. One or more of the quarters of the udder swell and become very hard, while the whole gland is decidedly hot and tender and no milk can be drawn. Usually a small amount of yellowish watery fluid replaces the milk. If the inflammation cannot be reduced within a short time, that part of the udder affected will not secrete any milk during that lactation period and will probably be permanently lost. In some cases a fibrous mass develops in the udder following such an attack, in others an abscess may result.

Treatment must be prompt and thorough. The cow suffers greatly from the weight of the udder. This should be remedied as much as possible by passing a sheet around the body to support the udder. Hot water applied for an hour or more by packing soft rags around the udder, followed by rubbing and kneading is often found beneficial. After this is done, the best treatment is probably an application of antiphlogistine. This is warmed and applied in a layer about one-fourth inch thick leaving the teats protruding so that the milk may be drawn. In about twenty-four hours the antiphlogistine loosens and may be removed. A second application is sometimes advisable. If it is impossible to apply antiphlogistine, the udder may be packed in ice, which is replenished as fast as it melts and allowed to remain several hours.

In the beginning of any treatment of this trouble a drench should be given containing from 1 to $1\frac{1}{2}$ pounds of Epsom salts. One ounce of saltpeter is also given in many cases to stimulate the action of the kidneys and may be continued two or three days.

146. Scours in Calves. The most common trouble experienced in calf raising is indigestion, which shows its presence by scours. Care should be taken to distinguish between common scours resulting from indigestion, and navel infection, one symptom of which is scours.

Navel infection is sometimes called either white scours or calf cholera. It is a contagious germ disease which gains access to the calf's body through the navel cord soon after birth. It appears within one or two days after birth. The calf is very sick from the first and nearly always dies. The eyes are sunken, and a common symptom, although it is not always observed, is the passage of white, foul-smelling dung. If one case occurs, others are likely to appear, especially if other calves are born in the same stall. Often several cases occur in succession in the same barn. The trouble may be avoided by making sure that the calf is dropped in a clean stall and that the navel cord is not allowed to come in contact with any manure or dirt until the cord is dry. If the calf is dropped in the pasture, there is little danger unless it is brought at once to the barn. If it is born in a barn where previous cases have occurred, the only safe plan is to tie up the cord at birth in a clean bandage, having applied a mild disinfectant, such as weak creolin or tincture of iodine.

Calves raised by hand should be watched closely for signs of indigestion. The main treatment, as pointed out in the discussion of calf feeding, lies in prevention. Often the first indication of disorder is foul-smelling dung. If this is noticed, the ration should be at once cut down to one-half or one-third the usual amount. Often light feeding for a few times will remove the trouble with no further treatment. It is well to add to each pint of milk one teaspoonful of a mixture of one-half ounce of formalin in 15½ ounces of water. The formalin should be given for two or three days at least. After two or three feedings, if the calf improves, the milk may be increased to the usual quantity.

When a severe case of scours occurs, the feed should be at once reduced. A drench of three ounces of castor oil in a pint of milk may be given with advantage. It is well to give the formalin mixture for several days during recovery from a severe attack.

147. Lice. During the winter season especially, cattle are often affected with lice. Calves and young cattle are most often affected, but older cattle are not exempt, and they may suffer badly from this pest. The presence of lice may be suspected if the cows are seen rubbing the neck and shoulders on trees and posts. When they are badly infested, their hair usually begins to come out in spots. Several substances may be used to kill the lice. Any of the coal tar dips and compounds on the market may be employed with success. The most satisfactory treatment is kerosene emulsion. To make this, dissolve one-half pound of hard soap in one gallon of boiling soft water. As soon as the soap is dissolved, add two gallons of kerosene. Mix by pumping with a spray pump or by stirring or by other means until a thick creamy emulsion is formed from which the oil does not readily separate. Before using, add this mixture to 19 gallons of water. The emulsion may be applied with a spray pump, or with a brush, wetting the entire animal thoroughly. The above amount is enough for twenty cows.

148. Bloat. This trouble comes from the formation of an excessive amount of gas in the paunch. It often results from pasturing on alfalfa or clover, but may occur with any kind of feed. It is known by the excessive swelling of the left flank. If relief is not obtained in time, the animal may die from suffocation due to the great pressure on the lungs. In mild cases driving the animal at a rapid rate for some distance may be sufficient. Cold water thrown in quantities upon the cow's sides may reduce the pressure.

The Kentucky Experiment Station recommends for acute bloating that a quart of $1\frac{1}{2}$ per cent solution of formalin be given as a drench followed by placing a wooden block in the animal's mouth for a short time.[1]

In case relief cannot be obtained otherwise, the gas must be removed without delay. This is best done by the use of a trocar. In using this instrument a spot is selected on the left side equally distant from the last rib, the hip bone, and the backbone. The skin is cut for about an inch, then the trocar is thrust into the paunch. The sheath of the trocar is allowed to remain in the opening as long as any gas escapes, which may be several hours. It is generally advisable to give a dose of 1 to $1\frac{1}{2}$ pounds of salts after a case of bloating.

149. Cowpox. This trouble is common with dairy cattle. It appears as pustules especially on the udder and surrounding parts. The virus used in the vaccination of human beings against smallpox is obtained from cows that have had

[1] Kentucky Agricultural Experiment Station, Circular 5.

the disease. The first indication of the disease is the appearance of small pimples on the skin. These at first contain a watery fluid which later thickens and becomes pus. The pustule becomes flattened at the center and about the ninth day breaks and the pus escapes. After it has broken, a thick dark scale appears, usually with a depression in the center. This comes off later, leaving a small pit similar to the scars of smallpox. The disease is contagious to other cattle, but an animal once afflicted with the disease is immune for some time at least, and perhaps for life.

Fig. 46. — Trocar, used as a last resort in relieving bloat.

No special treatment is necessary, as the animal will soon recover. About all that can be done is to apply some disinfectant, such as zinc ointment, or a weak solution of some one of the coal tar products commonly used on the farm as stock dips. The affected animal should be milked last so that the milker will not carry the disease to other cows. After milking, the hands should be thoroughly cleaned and disinfected. The milk from a cow suffering from this disease should not be used for human food.

150. Blackleg. This disease is also known as "black quarter." It attacks calves and young cattle from the age of a few weeks up to the age of 2 or even 3 years. It is distributed more or less over a large part of this country but is largely localized. Certain neighborhoods or farms after once becoming infected often remain so for long periods, and any young stock exposed are liable to develop the disease. It is caused by a bacterium that gets into the animal's body from the food or water. This bacterium can survive outside the animal's body for long periods, so that the disease may appear even though no cases have been known for a long time. Calves in good flesh are the most subject to its attack. Calves affected with the disease live a few days but seldom recover.

The disease is easily recognized. The calf at first appears merely lame and stiff. Swellings will usually be formed on some part of the body, and when these are rubbed a peculiar crackling sound is noticed resulting from the gas that has formed in the tissue. When the calf is examined after death the affected quarter will be found to be congested with dark blood and almost black in color, which condition gives rise to the common name of the disease. It is useless to attempt to treat the animals already affected. When a case occurs, those not sick should be vaccinated at once. There is then little danger that the trouble will spread. In localities where the disease is common, vaccination should be practiced on all calves, as a preventive, without waiting for the disease to appear. The vaccine used for the purpose may be purchased and applied by the owner himself, or a veterinary surgeon may be employed if the owner prefers.

151. Sorghum and Kafir Corn Poisoning. Sorghum and kafir corn are important forage crops in that part of the country bordering on the semiarid. Under certain conditions these plants develop a poison, which is frequently the cause of losses of stock, especially cattle. The danger occurs when the growth of the crop is checked by dry weather and at times in second growth sorghum or kafir. The trouble occurs only when the animal eats the green plant. The damage usually happens when the stock break through the fences and eat the green crop in the field, although occasionally cattle are turned into such a field by some one who is ignorant of the possible danger. Death will sometimes occur within half an hour after the food is eaten. As small a quantity as two pounds sometimes causes death.

The Nebraska Experiment Station[1] records a case where 21 cows out of 32 died within an hour after being turned into a field of stunted kafir corn. When these crops are put into the silo or made into hay for some reason the danger disappears. Little can be done to treat an animal affected. In fact, as a rule the animal is dead before the owner knows it is sick. Prevention, by excluding stock from such fields during seasons when the presence of the poison is suspected, is the only safe course.

152. Corn-stalk Disease. In the states of the Middle West, where corn is grown in large quantities, the common practice is to husk the corn from the standing stalks and leave the stalks in the field. Later the cattle are turned into the field to gather as much of the stalks and leaves as they will utilize. Stalk fields are generally pastured during the early part of the winter. Frequent losses of cattle occur during the time they are given access to the stalk fields. The ailment is known as the corn-stalk disease. It most commonly occurs during periods of cold or wet weather and always after the stalks have become thoroughly dry. The trouble usually occurs during the first few days after the cattle are put into the stalk field.

The disease appears suddenly. The animal afflicted is reluctant to move and when forced to do so shows an unsteady gait. Later there are indications of severe pain such as kicking towards the body, bellowing, and moaning. The animal may froth at the mouth and attempt to attack any one coming near. Death usually occurs within one or two

[1] Nebraska Agricultural Experiment Station, Bulletin 77.

days. All attempts to find the specific cause of the disease have so far failed. It has been proved that smut in corn is not the cause. Those who have given the subject most attention believe the trouble is the result of acute indigestion caused by eating too much coarse indigestible food. It is possible that under certain conditions some poisonous substance is developed in the stalks.

No satisfactory medical treatment has been found. As with many other diseases, attention has to be directed towards prevention. Cattle should always be watered and well fed before being turned into a stalk field for the first time, and some laxative food, such as alfalfa or clover hay, should be given daily. Plenty of water should be readily accessible. The animals should be turned into the field for only a short time the first day, gradually lengthening the time each day as they become accustomed to the feed. Fortunately this trouble does not occur from feeding corn fodder cut and shocked in the field, or from corn put in the silo.

QUESTIONS AND PROBLEMS

1. Let each student make a list of as many cases of deaths of cattle in the community as he can find, giving the cause of death and telling whether a calf, cow, steer, or bull. Combine these reports to find the comparative number of deaths from each disease.

2. What is the cause of each of the diseases found? How may each be controlled?

3. Similarly report on as many cases as possible of cows that were sold or slaughtered, giving the reason why they were discarded.

LABORATORY EXERCISES

13. Miscellaneous Exercises. If possible make arrangements to do the following work with a cow that is not very valuable. A clinical thermometer, drenching bottle, carbolic acid, teat plugs, and milk tube will be required.

Each student should learn how to perform the following operations:

Take the temperature.

Take the pulse.

Count the respiration.

Give the cow a drench of pure water in order to learn the method.

Prepare a 2 per cent solution of carbolic acid.

Insert a teat plug after sterilizing it with the carbolic acid solution.

Insert a milking tube after sterilizing it.

14. Treatment for Lice. Prepare a kerosene emulsion by the direction given on page 161. If possible arrange to use this on a herd that needs it.

COLLATERAL READING

Milk Fever, Its Simple and Successful Treatment, U. S. Dept. Agr., Farmers' Bulletin 206.

Anthrax with Special Reference to its Suppression, U. S. Dept. Agr., Farmers' Bulletin 439.

Tuberculosis, U. S. Dept. Agr., Farmers' Bulletins 351 and 473.

Practical Method of Disinfecting Stables, U. S. Dept. Agr., Farmers' Bulletin 480.

Texas Fever, U. S. Dept. Agr., Farmers' Bulletins 498, 569, and 603.

Eradication of the Cattle Tick Necessary for Profitable Dairying in the South, U. S. Dept. Agr., Farmers' Bulletin 639.

Foot and Mouth Disease, U. S. Dept. Agr., Farmers' Bulletin 666.

Diseases of Cattle, U. S. Dept. Agr. (A 550-page book, costing $1.)

Cyclopedia of American Agriculture, L. H. Bailey, Vol. III, pp. 122–146, 321–330.

The Diseases of Animals, N. S. Mayo.

CHAPTER 8

MILK AND ITS PRODUCTS

C. H. Eckles

Composition of Milk

153. Average Composition. Milk is composed of water, fat, protein, sugar, and ash or minerals. The milk of all species of animals and of every individual within the species contains these same constituents, but the proportions are subject to wide variations.

Cow's milk weighs approximately 2.15 pounds per quart. (Density is 1.032.) It is not possible to give any single statement that will give more than a general idea of its composition on account of the wide variations due to the influence of breed and other factors. If a quantity of milk be taken as representative of the total amount sold for city trade or of that sold to butter or cheese factories, it would have approximately the following composition:

	Per Cent
Water	87.3
Fat	3.7
Protein	3.5
Sugar	4.8
Ash	.7

154. Water. Milk contains on an average about 87.3 per cent of water. The extreme variations are from about 83 to 90 per cent. The water in milk serves the same purpose as food as ordinary water. It should not be concluded from the high water content that milk has a low food value.

155. Fat. The fat is commercially the most valuable part of milk. It is also the most variable in amount. It may range from 2.5 to 7.5 per cent and occasionally even beyond these limits. The fat exists in the form of minute

FIG. 47.—Photomicrograph showing fat globules in Shorthorn milk. Magnified 400 diameters.

globules, too small to be seen by the naked eye but readily seen under a microscope. It is in a state of suspension, that is, the fat globules are floating in the milk. When milk stands undisturbed for some time, the fat rises to the top in the form of cream. Churning of cream is the uniting of these fat globules by mechanical means until they form a lump of butter. The main factors influencing the amount of fat are: (1) breed, (2) stage of lactation, (3) individuality of the cow, (4) interval between milkings, (5) portion of the milking, fore milk or strippings.

As food, fat serves as fuel to supply heat for the body, and energy to keep up the body functions. The surplus is stored as body fat, which serves as a storehouse of reserve material for future use. Fat does not make growth of bone or muscle.

156. Protein. The protein varies in amount from 2.5 to 4.2 per cent in extreme cases. Mixed milk usually varies between 3 and 3.5 per cent. Protein contains nitrogen combined with hydrogen, carbon, and small quantities of phosphorus and sulphur. The proteins in milk are a mixture of several kinds. Two only need to be mentioned since they make up nearly the entire amount. These are casein and albumin. The casein is that part of milk which curdles on souring. It also gives the white color to the milk. In cheese making rennet is added to the milk to coagulate the casein, which takes most of the fat with it in a mechanical way. The albumin is present to the amount of about 0.7 per cent. It is much like the albumin of an egg or that in blood. It is coagulated by heating and may be seen as a scum on the surface of boiled milk. It goes into the whey in cheese making.

The protein may be said to be the most valuable food constituent of milk. It supplies material necessary for the growth of bone and muscle and to keep up the repair of the body. Part of the casein is in a semi-dissolved condition. A portion of the undissolved part, and insoluble impurities that were in the milk, make up the well-known separator slime.

157. Sugar. The form of sugar known as lactose is found only in milk. Its chemical composition is practically the same as that of cane sugar, although it is less sweet in taste. It has the same food value as ordinary sugar and like it furnishes a source of heat and energy for the body. When acted upon by certain bacteria, a portion of it changes into lactic acid and makes the milk sour. The lactic acid unites with the lime in the casein. This results in precipitating the casein as the curd of sour milk.

When milk is used for butter making, the greater part of the sugar goes with the skim-milk, another part with the buttermilk, and only a very minute quantity into the butter. In cheese making a very small amount goes into the cheese and the remainder into the whey.

158. Mineral Matter or Ash. This is the portion remaining if milk solids are burned. It varies little in quantity or composition. It seldom falls below 0.6 or exceeds 0.85 per cent. It is composed largely of potassium, calcium, and phosphorus, with smaller quantities of several other elements, including iron and sodium. When milk is used as food, the ash serves to furnish material for the bones and to supply other necessary demands for mineral matter in the body.

159. Color of Milk. The white color is due to some extent to the fat, but mostly to the casein. The yellowish color observed to some extent in milk is associated with the fat. This yellow coloring matter is carotin. Its source is the plants used by the cow for food.[1] This pigment is found along with the green pigment in growing plants. It passes from the stomach through the circulation of the cow and into the milk-fat in an unchanged condition. When the feed is low in coloring matter, as for example dry hay and grain, the color of the milk-fat is reduced, and the butter may appear almost white as it often does in winter. The yellow coloring matter has no food value, neither does it give any taste to the milk or fat. The preference for yellow

[1] Missouri Agricultural Experiment Station, Research Bulletins 9, 10, 11, 12.

butter and for cream of a somewhat yellow color is based entirely upon looks.

Factors Influencing Composition

160. The Kind of Animal. As already stated, the milk of all species contains the same constituents but in different proportions. Table 19 gives the average composition of human milk and of that from several domestic animals.

Table 19. — Composition of Milk of Different Animals

Species	Dry Matter	Fat	Protein	Sugar	Ash
Human	11.2	3.1	2.0	6.3	0.2
Cow	12.7	3.7	3.5	4.8	0.7
Goat	14.5	4.8	5.0	4.0	0.7
Sheep	16.3	6.1	5.1	4.2	0.9
Mare	9.3	1.2	2.0	5.7	0.4
Sow	15.9	4.5	7.2	3.1	1.1
Camel	11.8	2.5	3.6	5.0	0.7
Reindeer . . .	28.8	14.5	9.8	3.0	1.5
Bitch	23.0	9.3	9.7	3.1	0.9
Cat	18.4	3.9	9.1	4.9	0.5

The composition of human milk is of great importance in connection with the problem of infant feeding. Within recent years it has become more and more the practice to modify cow's milk when used for infant food so that it approaches the normal milk of the human mother. The most marked difference in composition between human and cow's milk is the decidedly lower protein and higher sugar content in the former.

The general plan followed in modifying cow's milk for infant feeding is to add sufficient water to reduce the protein content to that found in human milk. Cream is then added to restore the fat content to from 2.5 to 3.5 per cent and sufficient sugar, usually milk sugar, to raise the content of this constituent to that found in human milk.

A knowledge of the composition of milk produced by the common domestic animals will be found of value at times. For example, if it becomes necessary to raise a colt by hand, a study of the table giving the composition of mare's milk will show clearly that even average cow's milk should be diluted with water before being used for this purpose. Cane sugar is often added.

The exceedingly rapid growth of small animals is explained by the very rich milk that small species always produce. As a general rule the larger the species, the slower the growth of the young, and the smaller the amount of solids in the milk. Animals living in arctic regions or in the ocean are exceptions. These conditions require a large amount of fat for fuel to keep the young animal warm. This interesting fact is illustrated by the composition of the reindeer's milk and also by that of certain marine animals such as the walrus and the porpoise which secrete the richest milk known.

161. Breed. The milk from different breeds of cows differs in composition. Table 20 gives a summary of all the published records of American Experiment Stations on this subject up to 1913:

TABLE 20. — COMPOSITION OF MILK BY BREEDS [1]

BREED	TOTAL SOLIDS	FAT	PROTEIN	SUGAR
Jersey	14.70	5.14	3.80	5.04
Guernsey	14.49	4.98	3.84	4.98
Ayrshire	12.72	3.85	3.34	5.02
Holstein	12.00	3.45	3.15	4.65

[1] U. S. Dept. Agr., Bureau of Animal Industry, Bulletin 156.

It will be noted that the main variation is in the fat, although the protein shows sufficient variation to be of importance. Sugar varies but slightly, and the ash practically none. The breed of the cow also has a marked influence upon the size of the fat globules. Those of the Jerseys and Guernseys are much larger than those of the Holsteins. The larger fat globules in Jersey milk result in quicker and more complete separation of the cream by gravity; also in a slight difference in the ease of churning. The breed of the cow likewise has a marked influence upon the color of milk and especially upon the color of the butter. In amount of color the Guernsey ranks first, followed by the Jersey, Shorthorn, Ayrshire, and Holstein in the order named. There is no basis for the common claim that certain breeds produce milk or butter of a better flavor than others. Outside the possible variation in color, the most expert judge cannot distinguish the product of one breed from that of another when other conditions are the same.

162. Stage of Lactation. The stage of lactation stands second only to the breed in importance as a factor influencing the composition of milk. The amount of the different constituents and also the nature of the fat itself is influenced in this way. The most marked effect is upon the amount of protein and fat.

The figures in Table 21 obtained by the author show the average for eleven cows representing three breeds which were kept on a uniform ration for an entire lactation period to eliminate changes due to feed. A decided increase in the amount of fat and protein is shown, but little change in the sugar content.

The stage of lactation also has a marked effect upon the size of fat globules. After the cow has been in milk ten or eleven months, the fat globules average about one-third the size of those in the milk when the cow is fresh. This is one reason why difficulty is often experienced in churning the cream from cows that have been in milk a long time.

TABLE 21. — EFFECT OF STAGE OF LACTATION ON COMPOSITION OF MILK

FOUR WEEKS PERIODS	PROTEIN	FAT	SUGAR
Weeks	*Per Cent*	*Per Cent*	*Per Cent*
1–4	3.25	4.00	4.87
5–8	3.06	3.85	4.84
9–12	3.06	3.79	4.94
13–16	3.13	3.77	4.82
17–20	3.25	3.82	4.80
21–24	3.25	3.79	4.75
25–28	3.32	3.83	4.88
29–32	3.32	3.85	4.83
33–36	3.57	3.97	4.62
37–40	3.83	4.11	4.55
41–44	3.89	4.22	4.74
45–48	4.08	4.54	4.91
49–52	4.34	4.66	4.50

163. Individuality of the Animal. The writer has kept complete records for one year or more for 76 Jersey cows. The lowest average fat content for a year was 4.47 and the highest 7.00 per cent. Among 40 Holsteins the lowest was 2.6 and the highest 3.81. The records of 25 Shorthorns show a variation from 3.59 to 4.31 in the averages for one year. These give an idea of the extent of variation within a breed. The variation in the other constituents is always less than the variation in fat.

164. Interval between Milkings. If a cow is milked twice daily at equal intervals, the quantity and quality of milk

[1] U. S. Dept. Agr., Bureau of Animal Industry, Bulletin 155.

are usually about the same at each milking. If the intervals are not equal, the larger yield of milk and a lower percentage of fat follow the longer interval. When the milking is done three times or more daily, the variation in fat content is generally considerable, even though the intervals between milking are equal. As a rule, the milk drawn near the noon hour has the highest fat content. Where the composition is varied by unequal intervals, the variation is confined mostly to the fat.

165. Fore Milk and Strippings. The first milk drawn from the cow contains a low percentage of fat, while the last is several times richer in this constituent. The first milk as a rule contains from 1.5 to 2.5 per cent, while the strippings range from 5 to 10 per cent. The other constituents of the milk are practically the same in all parts of the milking. Numerous variations occur from day to day that cannot be explained by any of the factors described. A single sample of milk from a cow may be entirely misleading.

166. Effect of Feed. The error is often made of assuming that the richness of milk varies with the feed. While it is possible under certain conditions to make a variation of possibly 0.2 to 0.4 per cent by giving certain feeds, it is only under conditions so abnormal that it is of scientific interest only and has no practical bearing. As far as the ordinary practice is concerned, the feed has no influence upon the richness of the milk. If a certain cow averages 3.4 per cent fat for a year, no one knows how to feed her to make her milk average 4.0 per cent for the following year. The richness of a cow's milk is fixed by heredity and cannot be permanently changed by any means. It is a well-known fact, however, that a cow in a high state of flesh at time of calving gives richer milk for a short time than does one thin in flesh.

Market Milk

167. Sanitary Milk. Milk sometimes acts as the carrier of human disease germs. The danger that such germs will get into milk during handling is much greater than is the danger of the transmission of any disease directly from the cows. While the danger of carrying disease is great, it is

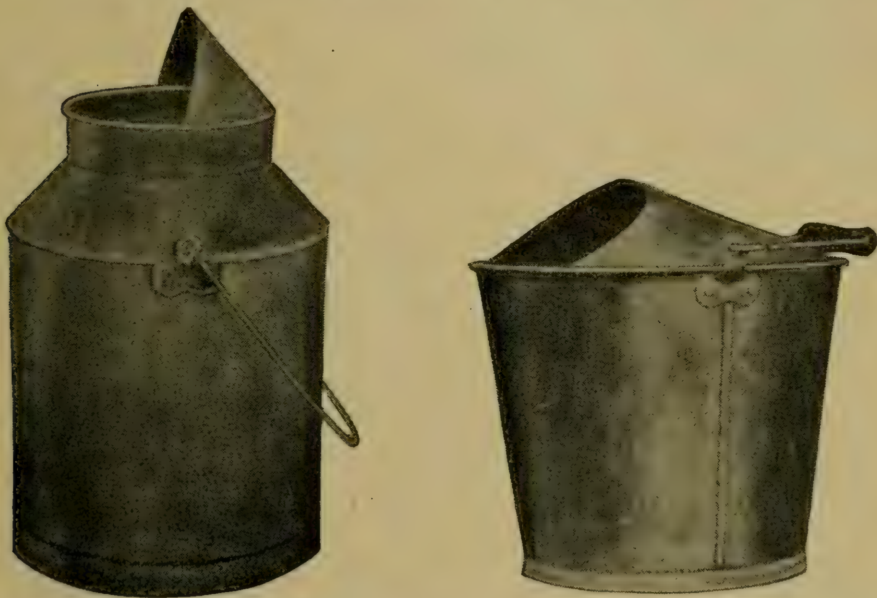

Fig. 48. — A small top milk pail helps to prevent contamination during milking. Strainers and cloth over the opening are of little value. Some of the most sanitary dairies use the types illustrated.

certain that dirty or partly spoiled milk is even more serious and is responsible for much sickness and many deaths among children.

The production of market milk that is reasonably safe for food, is not difficult and need not involve heavy expense, except that more intelligence is necessary for its production and greater intelligence demands higher wages. It is certain that if the public wants good clean milk the price must be somewhat higher than it has been in the past. The first requirement is that the cows must be healthy. The milk from a cow suffering from sickness of any kind, including garget in the udder, should not be used. The milkers should be in good health and should take special pains that no possible chance is given for the germs of typhoid fever to get into the milk. Care should be taken that contaminated water is not used for washing the utensils.

Sanitary milk means primarily clean milk. In fact, the requirements for producing sanitary milk can be described in two words. The first is cleanliness, and the second is coldness. The source of most of the dirt that finds its way into milk is filth from the cow's body. A dirty cow invariably means dirty milk. The stable should be so constructed that it is possible to keep the cow clean. A cow should be brushed daily to keep the loose dirt off the body. The stable and yard should, of course, be kept in a good condition of cleanliness. The milker should wear clean clothes and should milk with dry hands.

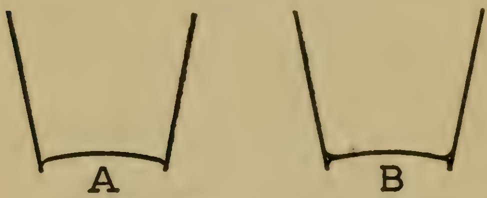

FIG. 49. — Milk pails and cans should have all seams filled with solder as in *b*. Utensils with seams like *a* are very difficult to keep clean.

Next to cleanliness of the cow stands cleanliness of the pails, strainers, and other utensils. These should be first cleaned with a brush, using warm water and some washing powder. Special attention should be given to the seams. After being thoroughly cleaned, they should be scalded with boiling water or better heated in steam when this is available. After being scalded, they should be placed where they will dry quickly. It is well to set them in the sun during the day.

Coldness is as important as cleanliness. Keeping milk clean keeps most of the bacteria out. Cooling it prevents the growth of those that do get in. Effective cooling means bringing the temperature of the milk, not later than an hour after milking, and preferably sooner, to a temperature of 50° F., or lower.

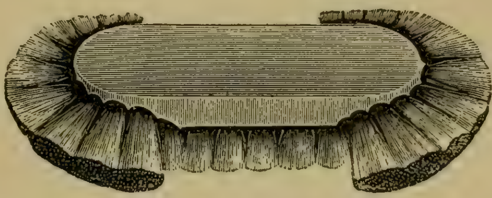

FIG. 50. — Brush for cleaning milk utensils. The brush is much better than a cloth.

In an experiment by the author a sample of fresh milk was divided into two parts, one of which was cooled at once to 50° F., while the other was placed at 75° F., with the following results:

	HELD AT 50° F.	HELD AT 75° F.
Bacteria per c.c. in fresh milk . .	21,000	21,000
Bacteria per c.c. after 12 hours .	20,000	110,000
Bacteria per c.c. after 24 hours .	32,000	10,450,000
Age of milk at first souring . . .	3 days	28 hours

Putting warm milk in an ordinary ice box is not an effective method of cooling, as can be readily determined by testing it with a thermometer. The importance of the statement regarding the necessity for sudden cooling and the inefficiency of cold air as a means of cooling is illustrated in a striking way by an experiment conducted by students under the supervision of the author. Sixteen gallons of fresh warm milk was received from the barn, mixed, and then placed in two cans. Plate cultures were made from the milk, according to the method used in bacteriological laboratories, to determine the number of bacteria present. There were found to be 13,000 bacteria per cubic centimeter in the fresh milk. This is a low count, showing that the milk had been taken under excellent sanitary conditions. One can was cooled at once to 50° by placing it in ice water and stirring. The other can still showed a temperature of 90°. Both were now put in a room cooled with ice to a temperature of 50°, which is a typical temperature for a good ice box. The results are tabulated below:

Fig. 51. — Influence of temperature on the growth of bacteria. *a* represents one original bacterium; *b*, the descendants of one bacterium in milk kept 24 hours at 50° F.; *c* represents the number of descendants when milk is not cooled.

	Cooled Milk	Uncooled Milk
Number of bacteria at beginning	13,000	13,000
Temperature of room	50°	50°
Temperature of milk at beginning	50°	90°
Temperature after 12 hours	50°	70°
Temperature after 24 hours	50°	58°
Temperature after 36 hours	50°	51°
Number of bacteria after 36 hours	15,000	52,500,000

The bacteria counts were made in both samples at the end of 36 hours. The cooled sample contained 15,000 bacteria per cubic centimeter, and the uncooled the enormous number of 52,500,000 in the same quantity. The sample cooled slowly soured within 40 hours, while the other remained perfectly sweet for five days.

If a large quantity of milk is handled, it should be cooled by means of a water cooler, many styles of which may be purchased at reasonable prices. The next best plan is to set the cans in ice water and stir the milk frequently.

The general subject of milk sanitation may be summarized in the following statements:

1. Use only healthy cows.
2. Milk should not be handled by any one suffering from a contagious disease or associated with a person so affected.
3. The cow's body should be kept free from manure.
4. The milker should have clean clothes and should milk with dry hands.
5. The utensils must be properly washed and sterilized.
6. The milk must be thoroughly cooled immediately and kept cold until consumed.

168. Certified Milk. This name is applied to milk produced according to a set of rules prepared by a medical milk commission. Such organizations have no relation to either state or city inspection. Representatives of the association make chemical analyses and bacteria counts of the milk at frequent intervals. They also examine the sanitary conditions of the premises where the milk is produced and the health of the cattle and of the milkers at regular intervals.

If all rules are complied with and the number of bacteria is below the maximum number fixed by the rules, the commission certifies to the condition of the milk and allows the dairyman to sell it with its approval. The rules are very strict, requiring great cleanliness in every detail. As a result certified milk means the highest possible quality from a sanitary standpoint. Such milk usually retails at about

15 cents per quart, and the producer receives possibly 8 cents at the farm. At present only a very small amount of milk is produced under these conditions, as the market is limited.

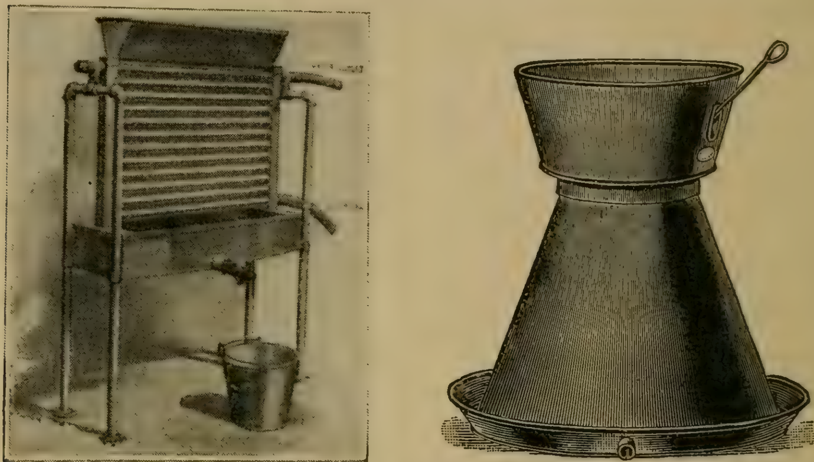

FIG. 52. — Practical milk coolers for farm use. The one on the left is more efficient, but more expensive. Cold water, preferably ice water, is used for cooling.

It is only practicable to conduct such a business where a large city market is easy of access and when suitable arrangements can be made to market the product.

BUTTER MAKING ON THE FARM

169. Butter Making on the Farm. Although the creamery has become a factor of great importance in the dairy development of the country, still according to the last census, 994 million pounds of butter per year, or 61 per cent of the total, was made on farms. The greater part of this was produced on farms where fewer than ten cows were kept. The quality of farm-made butter varies from the poorest to the best. The average quality, however, is far below that made in the creameries. This is due largely to the fact that little attention is given to having proper utensils and facilities, on account of the small amount of cream available on most farms. Lack of interest and of knowledge as to the proper methods also affects the quality of the product. When proper facilities are provided and the right methods are followed, the quality of butter made on the farm may easily be superior to that made in the average creamery. To do this it is necessary to have sufficient cream to make it possible to churn at least twice and preferably three times each week.

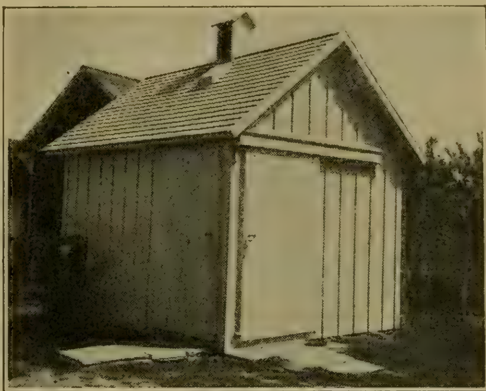

FIG. 53. — A good milk house, an important part of the equipment on a dairy farm.

170. Facilities Needed. It is very desirable, but of course not absolutely necessary, to have a separate room arranged for butter making. Sometimes a basement room, if it is well ventilated and lighted, can be utilized with advantage. A concrete floor provided with a drain saves a great deal of labor in cleaning apparatus. Some means of cooling, either ice or an abundance of very cold water, is indispensable.

171. What is Good Butter. Butter that has the qualities which make it satisfactory to the consumer always sells readily. While there is some variation in individual taste, the general market demands the same quality everywhere. The following is the common score card for judging butter.

Flavor	45
Body	25
Color	15
Salt	10
Package	5
	100

172. Flavor. The proper flavor is hard to describe, but may be said to be a pure butter taste and odor. It should be entirely free from any other taste, such as might be described as rancid, stale, or strong. The flavor of the butter, whether it be good or bad, in at least nine cases out of ten, is produced during the souring, or ripening, of the cream. There are a few exceptions to this rule. A few feeds, such as onions, turnips, or new rye pasture, will give a taste to butter. In a few cases, butter made from the milk of a cow near the end of her milking period, has a slightly objectionable taste.

173. Body, Color, and Salt. Body, color, salt, and package may be said to depend upon mechanical conditions. They are entirely under the control of the butter maker, provided suitable facilities are at hand. Faults in these qualities are not to be attributed to the feed, breed, or season of the year.

The body should be waxy and firm, but not brittle or salvy. It should not stick to the knife when cut, neither should it crumble. Proper body results from having the churning temperature right, stopping the churning at the right stage, and working the butter the proper amount.

The color should be that of butter produced by cows on pasture. During the season when dry feed is used, a sufficient amount of vegetable coloring should be added to the cream to give the proper shade of yellow. The most common defects in color are having it too high or too low, or having a streaky or uneven color known as mottles. The latter condition is due to uneven distribution of the salt, a result of insufficient working.

The salt should be sufficient so that a person eating the butter does not notice either a deficiency or an excess. In addition to too heavy or too light salting, the most common fault is gritty or undissolved salt.

The amount of water left in butter is somewhat variable. The usual rule is to estimate that a given number of pounds of butter-fat will give one-sixth more pounds of butter.

174. Separation of Cream. In certain localities it is the practice to churn the whole milk, but this results in an unnecessary loss of butter-fat in the buttermilk. Until recent years cream has been secured entirely by allowing it to rise to the top of the milk. Since the introduction of the cream separator, about 1885, the separator method has become more and more general.

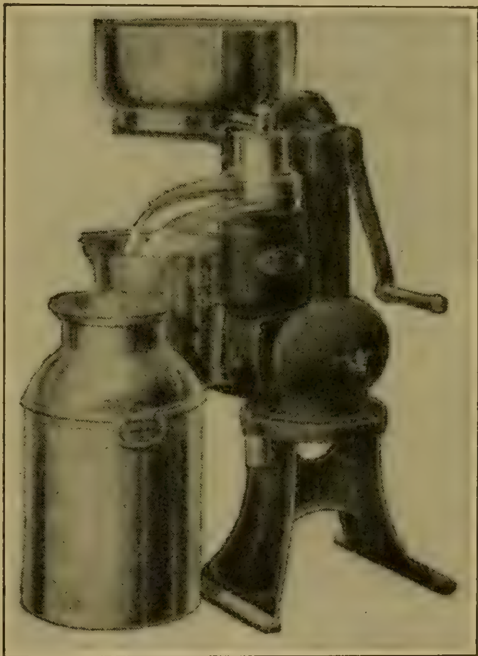

FIG. 54. — For butter making purposes four cows with a cream separator are equal to five when shallow pans are used to raise the cream.

The most efficient gravity method consists in using a narrow deep can set in ice water or very cold spring or well water, and skimming the cream at the end of 12 or 15 hours. A widely used but very inefficient way of securing cream is the shallow-pan system, which consists in placing the milk in pans and crocks not over four inches deep and keeping it at a moderate temperature. The cream is then skimmed from the surface at the end of 24 or 36 hours. By use of the deep-setting method it is possible to recover about 90 per cent of the cream. By the shallow-pan method from 75 to 80 per cent is recovered.

The centrifugal cream separator is now practical where five or more cows are kept although it is often used for even a smaller number. The separator makes it possible to recover about 98 per cent of the butter-fat and to obtain the cream in a condition that makes it possible to produce the highest grade of butter. It also results in a considerable saving of labor, and the skim-milk is in the best possible condition for feeding to calves.

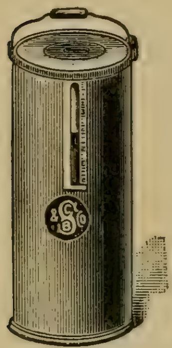

FIG. 55. — Can used for raising cream by deep-setting system.

175. Ripening of Cream. This subject requires considerable attention since the market value of the butter is largely controlled by the cream ripening. Cream should not be held too long. When churned, it should have a pure, sharp, sour taste with no objectionable taste, such as bitter, rancid, or stale. Cream ripening is due to the development of bacteria. Butter factories use a starter to help control the souring, but this is not generally practical for the small farm, unless considerable cream is handled. The proper ripening of the cream is controlled by two things: first, by observing proper cleanliness in every detail of milking, separating, and handling the cream; second, by proper control of the temperature of the cream during the ripening process.

The following statement is based upon the assumption that churning will be done two or three times weekly and not daily. The best procedure under these conditions is to keep the cream from the first milking at a temperature of 70° but not colder. This can be done by setting the can in well water or standing it in a room at ordinary temperature. The cream from the next milking is added to this without cooling. If by the time the cream from the third milking is added, the cream in the can tastes sour, the entire lot should be placed in cold water or a cold place where it will cool to a temperature of between 50° and 60°. It should be kept at this temperature until churned. The fresh cream as separated is added to the sour until within about twelve hours of churning, after which no more is added in order that the cream may be kept cool until churning time.

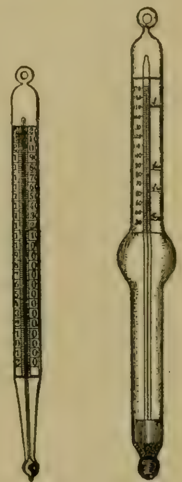

FIG. 56. — Floating dairy thermometers. A thermometer should always be at hand where milk is cooled or cream churned.

176. Temperature for Churning. No definite temperature can be given covering all conditions. The best rule is to use such temperature as is necessary to get the cream to churn within 30 to 45 minutes. Quicker churning means soft butter or too much loss in the buttermilk. Longer churning is of no advantage. When cows are on pasture, a temperature of from 52° to 56° F. is usually found best, while under dry-feed conditions 58° to 64° F. is more suitable.

A thermometer should always be used in bringing the cream to the proper churning temperature. Guessing at the temperature often means poor quality of butter and much waste of time. The churn should be not over one-third full, and the cream should have about 25 to 30 per cent of fat for the best results. Difficulty in churning is generally to be attributed to having the temperature too low, the cream too thin, or the churn too full. At times trouble that cannot be attributed to these causes is experienced. This occurs when the cream is from cows far advanced in the stage of lactation and generally during the season when dry feeds are fed exclusively. Under these conditions the fat itself is hard, the fat globules small, and the amount of casein in the milk large. All these conditions combine to make churning difficult. If a cream separator is in use, the trouble may be partly removed by mixing the cream while still sweet with three or four times its volume of warm water and running this mixture through the separator. This affects the flavor of the butter somewhat, but makes the churning easier by removing part of the casein.

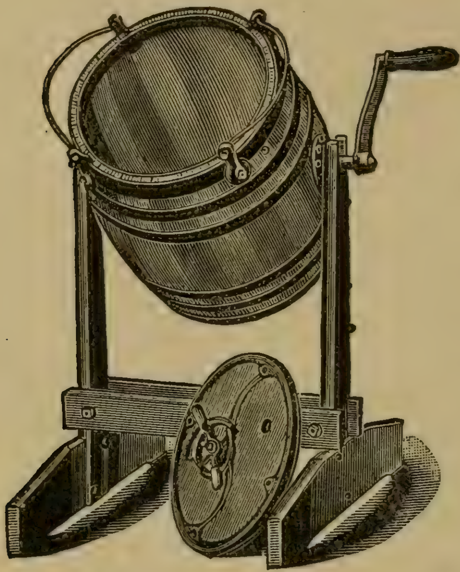

FIG. 57. — The most widely used, and most satisfactory churn for farm use.

177. Churns and Churning. For farm use nothing is better than the ordinary barrel churn without any inside fixtures. Large farm dairies can advantageously use a small-sized combined churn and worker. The cream should be strained into the churn through a wire or hair strainer to remove particles of curd, which if not removed show

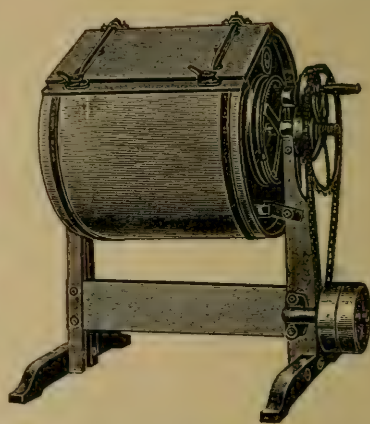

FIG. 58. — Combined churn and butter worker, adapted for use on the farm where large amounts of butter are made.

as white specks in the butter. If butter color is used, it should be added to the cream in the churn. The churn should be stopped when the butter granules are about the size of kernels of corn, or a little smaller in thin cream.

The buttermilk is drained off through a strainer. The butter is next washed to remove the remainder of the buttermilk, by adding about as much water as there was

FIG. 59. — Butter in proper condition to stop churning.

buttermilk. This should be at a temperature of 50° to 56° F.

178. Salting and Working. After washing, the butter is placed on the worker and the salt distributed over it. The worker and the ladles used are previously put to soak in hot water, then thoroughly cooled in cold water before using, to prevent the butter from sticking to them. The amount of salt may vary some with the market, but usually one ounce per pound of butter is the amount preferred. The butter is next worked to distribute the salt and to make the butter into a compact mass. If there is trouble in getting the salt dissolved, the butter may be allowed to stand a few hours in a cool place after the working is partly done. A second working is then given. The working should be done slowly and mostly by pressure rather than by sliding the ladle or working utensil over the butter. The working should stop when the salt is all dissolved and the body of the butter compact and waxy. Observation of the condition of the butter and of the time required is the best way to learn the proper stage at which to stop working. Overworking makes the butter sticky and soft in texture, underworking results in mottled butter.

179. Package. When butter is placed on the market, the package is of great importance. It should be neat and attractive and of proper size. The rectangular one-pound prints meet with the most favor everywhere. They should be wrapped in good parchment paper, which may be purchased in the proper size, 8 × 11 inches, at very low cost. When butter is shipped or handled in quantities, it is also well to use a paraffined paper box over the parchment paper, known as a carton, which protects the butter. To secure and retain a good retail trade requires a uniformly high quality of butter and a constant supply during the year.

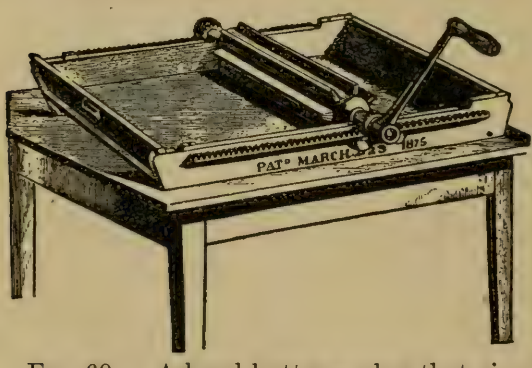

FIG. 60. — A hand butter worker that gives good results when butter is made on the farm.

Factory Products

180. Creameries. This name is commonly applied to factories manufacturing butter on a large scale and from milk supplied by several or many herds. The amount of butter made on farms decreased 7 per cent in the 10 years 1899–1909, but the amount made in factories increased 49 per cent. The great advantages of the factory system are the saving in labor and the higher price obtained for the product.

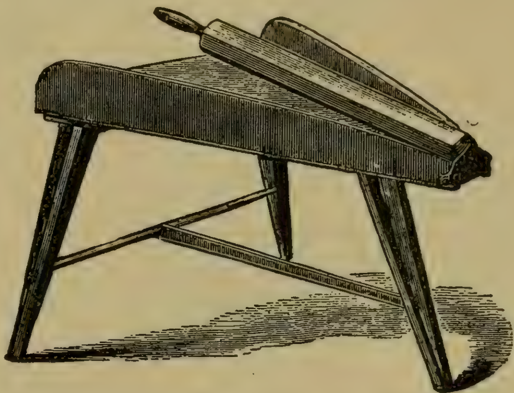

Fig. 61. — A hand butter worker. Where butter is made in lots of five pounds or more a worker should be used.

In some places the milk is taken from the farm to the creamery for separation. This is known as a whole-milk creamery. In others the farmers separate the cream at home with small separators and deliver the cream to the factory. Some creameries are owned by the farmers and operated on a coöperative basis, while others are owned by individuals or companies.

Fig. 62. — Good butter ladles. Butter should not be touched with the hands.

Many centralizer creameries have recently originated in the Central and Western States. Such creameries are located in cities where shipping facilities are good, instead of in a cream-producing neighborhood. Cream is purchased by local agents or shipped direct to the company by the producer. Shipments are at times made as far as 400 miles, but generally within a 50-mile radius. Some of these factories have the capacity of forty average-sized local creameries. The cream received is usually sour and too old for the best results in butter making. However, by skillful methods of handling, in the way of pasteurizing and neutralizing the cream with lime water, it is possible to make a fair grade of butter. This type of creamery is most common where the producers of cream are widely scattered so that a local creamery cannot obtain sufficient raw material. Under these conditions the centralizer creamery serves a useful purpose, but where the supply of cream is sufficient a local factory is to be recommended.

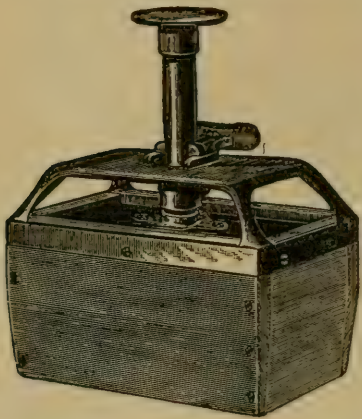

Fig. 63. — Butter print. The rectangular print sells best.

181. Cheese Making. This important industry is carried on most extensively in Wisconsin and in New York. In 1909 these two states produced over 79 per cent of the total product in this country. The milk of about 850,000 cows is used for this purpose in the United States and the value of the product is nearly 50 million dollars annually. Only about 3 per cent of the cheese is made on farms. Milk for cheese making must be well cared for. This requires a fairly liberal supply of milk within a small area. On the average 10 pounds of milk are required for 1 pound of cheese. Common American Cheddar, which is the most common kind, contains about one-third water, one-third fat, and one-third casein.

In the process of cheese making the milk is coagulated while it is in a perfectly sweet condition by the addition of rennet extract. Rennet is a substance obtained from the wall of the stomach of calves that have been slaughtered for veal. It is secreted by glands in the lining of the stomach in all young animals that live on a milk diet. The casein as it is coagulated by the rennet incloses the fat with it and forms curd. This curd is cut into small pieces, and the water gradually expelled by careful stirring and heating. When the proper stage is reached, the curd is put into a press and sufficient pressure is applied to cause it to unite into a solid mass. When the pressing is completed, the cheese is put away for ripening. Newly made cheese is not good to eat. It lacks flavor as well as digestibility. It is kept for a period of from six weeks to six months for curing and ripening.

The temperature of the curing room must be carefully controlled, as too much heat will injure the quality of the cheese. The difficulty of proper control of the ripening is the most serious objection to making cheese on the farm, and the greatest difficulty to be overcome in operating a factory in a climate subject to great extremes of heat. During the ripening, the protein largely changes from an insoluble to a soluble form and in this way becomes much more digestible. The typical flavor is developed at the same time.

182. Condensed Milk. The process of condensing milk was invented by Borden in 1856. For the year 1909 the value of condensed milk in the United States was nearly 34 million dollars. The process consists in removing a portion of the water from the milk by heating it in a partial vacuum. The milk used must be fresh and in good condition. The milk is condensed until $2\frac{1}{2}$ parts of the fresh milk make 1 part of the condensed. Two classes of condensed milk are commonly made. One is known as sweetened, since cane sugar is added until the finished product contains 40 per cent sugar. Condensed milk of this class is preserved chiefly by the large amount of sugar present. The other class is the unsweetened. Nothing is added to the milk. The preservation depends upon heating the product after it is in cans in a steam oven under pressure until it is completely sterilized. Several grades of this class are made. A condensed milk factory can only be operated where a large supply of perfectly fresh milk can be obtained. The condensary is usually a good market for milk, but the farmer supplying the milk has the same trouble raising his calves as in the case where whole milk is sold in any other form.

183. Milk Flour. A few factories make powdered milk, or milk flour. For this a part of the fat is removed, and the milk is dried to make a fine white powder that keeps well. When water is added, the powder dissolves.

QUESTIONS AND PROBLEMS

1. Which is heavier, cream or skim-milk?
2. What purpose does each of the constituents of milk serve when used as food? Which is the most important constituent?
3. Compare the amount of fat in Holstein milk with the amount in Jersey milk when the latter is considered as 100 per cent. Compare the protein in the same way.
4. Why is the percentage of fat not an accurate measure of the value of milk as food?
5. Is it possible to increase the percentage of fat in milk by changing the feed?
6. Is the color of milk a sure indication of the percentage of butter-fat contained?
7. Where does each constituent of the milk go when milk is used for butter making? For cheese making?
8. What reasons are there for stripping a cow?
9. What are the legal standards of your state for milk and butter? Some of this information is given on page 297. What are the restrictions on the sale of oleomargarine?
10. What principle of physics is the basis for the operation of the cream separator and of the Babcock milk test?

11. How many cows would be required where the shallow-pan system is used, to supply as much cream as would be secured from 6 cows when the centrifugal separator is used?

12. Why is butter yellow in summer, and much lighter in color in winter?

13. What is a farrow cow? Why is cream from her milk likely to be hard to churn?

14. What is the leading dairy product in your region?

15. Is more or less of the butter in your region made in factories than formerly?

16. What butter or cheese factories are there in the region?

17. What dairy products are sold in your local stores? Where do they come from?

18. The following table gives results for 1909. Using data given in this chapter, fill in the blanks.

	Butter			Cheese		Condensed Milk	
	Pounds Produced	Butter-fat Required	Pounds of Milk Required	Pounds Produced	Pounds Milk Required	Pounds Produced	Pounds Milk Required
Made on farms	994,650,610			9,405,864			
Made in factories . . .	624,764,653			311,126,317		494,796,544	
Total . . .	1,619,415,263			320,532,181		494,796,544	

LABORATORY EXERCISES

COMPOSITION OF MILK

15. Butter-fat. Examine some milk under the microscope, using preferably a one-sixth objective, and make drawings of the fat globules showing the variations in size.

16. Casein of Milk. This part of milk is precipitated by dilute acids. Place 10 c.c. of skim-milk in a 200 c.c. beaker and add 90 c.c. of water at a temperature of 100° F. Immediately add 1.5 c.c. of a 10 per cent solution of acetic acid. Let it stand 20 minutes with occasional stirring. Filter, using ordinary filter paper, saving the filtrate in another beaker. The residue on the paper is the casein. The albumin, sugar, and ash are in the filtrate.

17. Albumin of Milk. Heat the filtrate from the above rapidly, and boil until the solution can be filtered with a clear filtrate. Filter while hot. The residue on the filter paper is the albumin. The sugar and the ash remain in the filtrate.

18. Milk Sugar. The milk sugar is not easily separated from the ash. Its presence may be demonstrated by using Fehling's solution as follows. To 10 c.c. of the filtrate add 5 c.c. of Fehling's solution and boil. The red precipitate shows the presence of sugar.

19. Ash of Milk. The presence of ash may be demonstrated as follows. Take 25 c.c. of milk in an evaporating dish. Add a few drops of acetic acid. Place evaporating dish and contents on a sand bath and evaporate to dryness. Allow to char slightly, then place on a wire gauze over a gas burner and heat until contents char. Remove the gauze and heat over a full flame until all of the carbon is burned off. The gray residue is the ash, or mineral matter.

THE BABCOCK TEST FOR MILK

20. Test of Whole Milk. Apparatus needed: a hand power centrifuge or testing machine, 4 to 6 milk test bottles, a pipette to measure the milk, an acid measure, ordinary commercial sulfuric acid, a small sample of milk, and some hot water. The apparatus may be purchased from any dealer in dairy supplies. Sulfuric acid may be obtained at any drug store.

Sampling the Milk. The accuracy of the test depends largely on the sample taken. The milk to be tested should be thoroughly mixed, preferably by pouring several times from one jar to another. The milk should be at ordinary room temperature. The small end of the pipette is placed in the milk and the milk drawn in by sucking slowly at the upper end. The milk is drawn somewhat above the mark which indicates 17.6 c.c., and the first finger is then quickly slipped over the top of the pipette. The milk is then allowed to escape slowly until the surface is at the mark on the pipette. The small end of the pipette is now placed in the neck of the test bottle and the milk allowed to flow into the test bottle. The last drop remaining in the point of the pipette should be blown out into the test bottle. It is always well to make duplicate tests of each sample.

Adding the Acid. When all the samples are measured out, the acid should be added. The acid measure is filled to the 17.5 c.c. mark with acid that is at room temperature. The acid is now poured into the test bottle, holding the bottle in an inclined position so that it runs down the neck and side of the bottle and forms a clear layer at the bottom. Next take the bottle by the neck and give it a gentle rotary motion until the curd of the milk is entirely dissolved, and the mixture of acid and milk is of a uniform dark coffee color and very hot. This change in appearance and in temperature is the result of the action of the acid upon the constituents of the milk, all of which are dissolved except the fat, which is not affected.

Whirling the Bottles. The bottles are now put in the centrifuge. They should be quite hot throughout the whirling. Testing should not be done in a cold room. It is generally necessary to place some boiling water in the bottom of a hand centrifuge to keep up the heat during the whirling. The test bottles should be placed in the machine so that they balance each other. The machine is operated for five minutes at the proper speed for the machine, 700 to 900 revolutions of the disk per minute, depending upon the size of the revolving parts. At the end of five minutes the machine is stopped, and hot water is added to each bottle by means of the pipette until the contents come up to the bottom of the neck. Then whirl the machine two minutes more and add hot water to bring the fat column near the top of the graduations on the neck. Whirl one minute and the tests are ready for reading. The fat should be clear and free from black sediment below, or foam on top.

Reading the Test. The test bottles should be placed for a few minutes in a deep pail or pan of water, the temperature of which is regulated to 130° F. The fat should be in a fluid condition. In reading, the test bottle should be held in a perpendicular position on the level with the eye.

The reading on the graduated scale should be noted at the top and bottom of the fat column. This reading is made from the extreme bottom of the fat column to the straight line which is seen across the top, and not to the curved line which appears just below. The difference between the two readings is the percentage of fat in the milk. The neck of the bottle is graduated into large divisions which represent per cent, and these again into smaller divisions, each of which may be 0.1 per cent, or 0.2 per cent, depending upon the style of the bottle.

Suggestions on Making the Babcock Test. 1. Use the index finger, not the thumb, for closing the pipette. Keep the finger dry.

2. Draw the milk above the mark when measuring, and then hold the pipette on level with the eye as the milk is allowed to flow a drop at a time until the mark is reached.

3. Hold the bottle in a slanting position when adding acid, and do not allow the mouth of the bottle to point toward any one while the milk and acid are being mixed, as occasionally the contents may be forced out suddenly.

4. Wash the pipette thoroughly, and dip it in hot water after using.

5. The testing machine must be fastened securely to a heavy table or bench. Start and stop the machine slowly.

6. If black sediment appears in the fat column, the indications are that the acid was too strong. Use slightly less. If white specks are present, it is probable the action of the acid was too weak. Use a little more, or warm the milk 10 or 20 degrees before adding the acid.

7. Wash the test bottles at once after using by means of hot water and some washing powder. Rinse thoroughly in clean water to remove all traces of washing powder.

8. Remember the acid is poison and will burn the clothing or skin. If spilled on anything, pour on plenty of water and add some lime, soda, or washing powder to neutralize the acid.

21. Cream Testing. When cream is sold on the basis of the fat content, the samples for testing must be weighed rather than measured. A test may be made by the following method, but it must be kept in mind that the results are not entirely accurate and tend to be lower than the true reading.

Mix the cream thoroughly and by the use of the milk-testing pipette, place 17.6 c.c. in a clean cup or beaker. Next fill the pipette to the mark with water and add to the cream. Add a second pipette full of water in the same manner. Mix thoroughly and test in the same manner as would be done for milk. Since the mixture tested is only one-third cream, the percentage of fat found must be multiplied by three to give the percentage of fat in the cream.

VARIATIONS IN AMOUNT OF FAT IN MILK

22. Fat in Milk of Different Cows. Obtain samples of milk from several different cows and determine the percentage of fat in each with the Babcock tester. If the weight of milk can be taken at the same time, calculate the amount of butter-fat each cow produced. Samples for testing should be taken by thoroughly mixing all the milk produced by the cow before taking out the small portion from which the test is to be made.

23. Fat in Milk of Different Breeds. Take samples from cows of as many breeds as are available and test each for fat.

24. Fat in First and Last Milk. Take a sample from a single cow by milking the first few streams of milk from each teat into a jar or bottle. Take the last strippings from the same cow in the same manner, and test both for fat.

25. Fat in Milk Sold on the Local Market. Students from homes where milk is purchased should each bring a sample for testing, taking special care to get a fair sample in order that injustice may not be done the milk dealer.

26. Modified Milk. Using one of the samples of milk previously tested, modify it by the addition of water and milk sugar to make it suitable for infant feeding. Modify another sample to make it suitable for a colt.

27. Milk of Different Animals. Obtain milk from as many different kinds of animals as possible, mare, sheep, etc., and test for fat.

ESTIMATION OF TOTAL SOLIDS

28. Total Solids. For this exercise a Quevenne lactometer and a glass cylinder are required. Bring the milk sample to a temperature of exactly 60° F., and place in the cylinder. Place the lactometer in the milk slowly and carefully. When it comes to rest, note the reading at the surface of the milk. By placing 1.0 before this reading we have the specific gravity of the milk. For example, if the reading is 32, the specific gravity of the milk is 1.032, or that of average milk. The solids not fat and the total solids may be estimated from this and the Babcock reading by using Babcock's formula as follows, in which l is the lactometer reading and f the per cent of fat.

$$\frac{l}{4} + .2\,f. = \text{solids not fat.}$$

$$\text{Solids not fat} + \text{fat} = \text{total solids.}$$

Now add one-fourth water to the milk, and repeat the test as described. The results will illustrate one method of detecting water in milk. No attempt should be made to use this method for detecting water, except in an experimental way, unless the user is a trained chemist.

KEEPING QUALITY OF MILK

29. Effect of Temperature. When practicable the following experiment can be made advantageously.

Obtain a quantity of fresh milk, preferably not more than 3 hours after milking. Divide into two parts, cool one part to 50° F. at once and store in ice water or in an ice box. Adjust the temperature of the other sample to between 70° and 80° and leave in a warm room. How long before each sours?

CREAM SEPARATORS

30. Separation of Cream. The students should obtain samples of skim-milk from as many sources as possible, some from cream separators, and others from places where the cream is separated by gravity. Make the Babcock test, preferably using a special skim-milk test bottle. What was the loss of butter-fat by each method of separation?

BUTTER AND CHEESE

31. Study of a Factory. Visit a butter, cheese, or condensed milk factory, and learn as much as possible of the methods of manufacture, also of the methods of buying, selling, and management.

32. Judging Butter. If the assistance of a creamery man or other competent judge of butter can be had, the class may gather a number of butter samples representing the local supply, and judge them with his assistance.

CHEESE

33. Making Curd. Dissolve a rennet tablet according to the directions of the manufacturer, add it to milk and observe the effect. Compare the curd formed with that from sour milk in taste and condition. Curd made in this way is used in cheese making.

34. Fat in Cheese. Weigh out 5 grams of cheese, cut it into small pieces, and put in a milk test bottle. Add 10 cc. of warm water and acid as in testing milk. After the cheese is dissolved, complete the test as for milk.

Since the test bottle is graduated for 18 grams, the percentage of fat for the cheese must be calculated for that amount by dividing the fat reading by the weight of cheese taken in grams and multiplying the result by 18.

COLLATERAL READING

The Production of Clean Milk, U. S. Dept. Agr., Farmers' Bulletin 602.

Bacteria in Milk, U. S. Dept. Agr., Farmers' Bulletin 490.

The Care of Milk and Its Use in the Home, U. S. Dept. Agr., Farmers' Bulletin 416.

The Use of Milk as Food, U. S. Dept. Agr., Farmers' Bulletin 363.

The Application of Refrigeration to the Handling of Milk, U. S. Dept. Agr., Bulletin 98.

Farm Butter Making, U. S. Dept. Agr., Farmers' Bulletin 541.

Cream Separators on Western Farms, U. S. Dept. Agr., Farmers' Bulletin 201.

Household Tests for the Detection of Oleomargarine and Renovated Butter, U. S. Dept. Agr., Farmers' Bulletin 131.

Cheese Making on the Farm, U. S. Dept. Agr., Farmers' Bulletin 166.

Cyclopedia of American Agriculture, L. H. Bailey, Vol. III, pp. 175–246.

Medical Milk Commission and Certified Milk, U. S. Dept. Agr., Bulletin 1.

Condensed Milk and Milk Powder, O. F. Hunziker.

Milk and Its Products, H. H. Wing.

CHAPTER 9

CONDITIONS AFFECTING THE DEVELOPMENT OF DAIRYING

G. F. Warren

184. Cattle and Grass. Cattle raising goes with the raising of hay and forage crops. How closely the growth of these crops limits the production of cattle is shown by Figs.

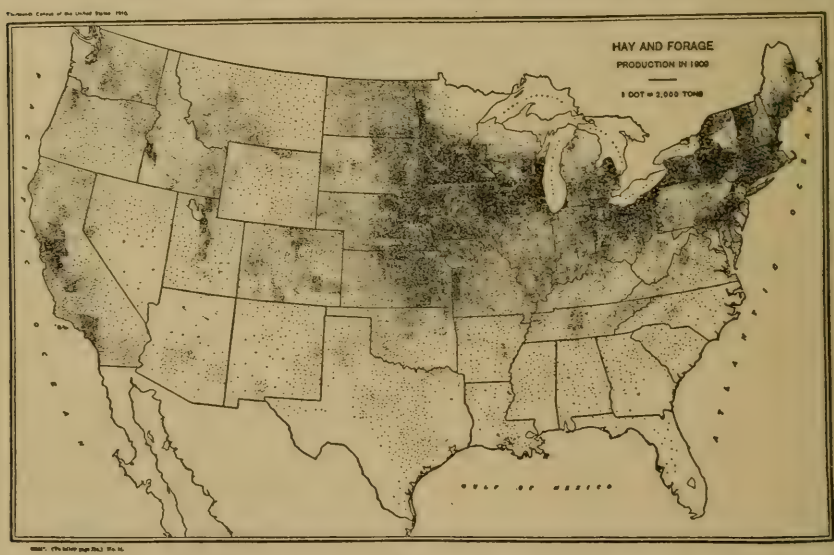

Fig. 64. — Distribution of the hay and forage crops of the United States. Compare with Fig. 65.

64 and 65, taken from the United States Census reports. In the South and in the arid regions there are a few more cattle than the hay and forage crops would suggest, because some of the cattle in these regions are pastured all the year and therefore require little or no hay.

TABLE 22. — CATTLE AND HAY AND FORAGE (CENSUS OF 1910)

REGION	CATTLE	DAIRY COWS	TONS HAY AND FORAGE
New England	1,336,550	841,698	4,659,906
Middle Atlantic	4,232,521	2,597,652	11,302,178
East North Central . . .	9,819,097	4,829,527	20,391,562
West North Central . . .	17,647,714	5,327,606	36,326,167
Pacific	3,204,400	826,115	7,306,590
Mountain	6,060,725	514,466	8,600,736
South Atlantic	4,839,321	1,810,754	2,917,870
East South Central . . .	3,942,526	1,628,061	2,565,716
West South Central . . .	10,721,012	2,249,553	3,383,010

185. Topography and Climate. As has already been indicated cool regions are more favorable than hot ones for the dairy cow as well as for the manufacture of dairy products.

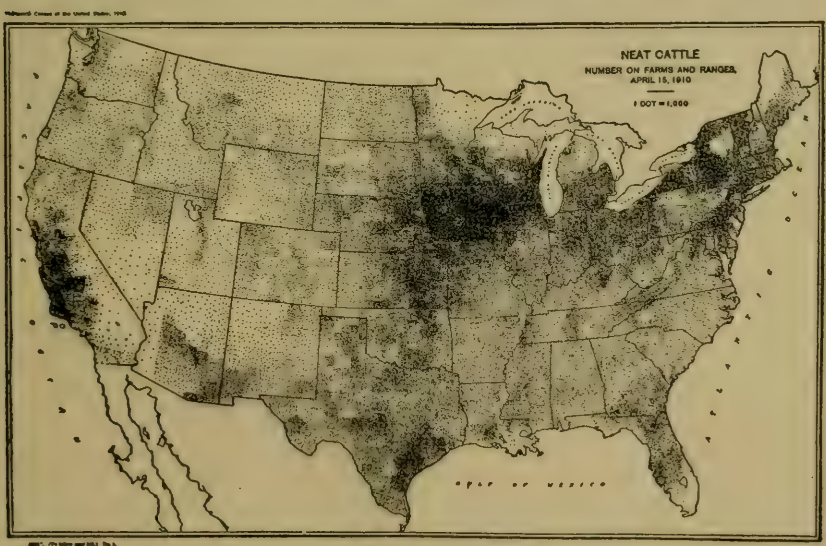

FIG. 65. — Distribution of cattle in the United States.

Most of the cattle of the world are grown on pastures on land that is too dry, too wet, too steep, too stony, or otherwise not adapted for the growth of crops. All regions that have such pastures keep cattle or sheep. In regions where all the land is well adapted to crops, cattle production is usually but not always a minor business. But cattle are often fattened in such regions. Very frequently the final factor in determining whether cattle shall be kept is the presence or absence of land that is good for pasture, but not good for crop production. For instance, in parts of the corn-belt there is so little rough pasture land that fewer

FIG. 66. — Using the stony land for pasture.

cows are kept than otherwise would be. Most of the milk supply for Chicago and for New York comes from north of these cities, partly because of the presence of pastures and partly because of the cooler climate.

186. **Location of Beef and Dairy Cattle.** It is apparent that the number of cattle in a region is directly dependent on the presence of hay and forage crops, or on ranges. Whether the cattle shall be of the beef or dairy type depends primarily on the distance to the centers of population. Beef animals can be shipped long distances. They are therefore grown farthest from the centers of population.

Seventy-four per cent of the steers and bulls in the United States are west of the Mississippi River, but only thirty per cent of the population is in that region.

The relative weight and bulk of the feed and of the human food made from it, the perishability of the product, and the cost of feed are the primary factors that determine where different animal products shall be raised. When a liberal

FIG. 67. — A dairy region where the level land is used for crops, the side hills for pasture and the poorest land is left in woods.

use of corn silage and pasture is made, and if we include the feed for the young stock as well as for the mature animals, a pound of butter represents approximately 100 pounds of feed. A pound of cheese or dressed beef represents about 50 pounds of feed, and a pound of milk 5 pounds of feed.

If drier feeds are used, the quantities will be less, but approximately the same proportions will still hold. With hay and grain a cow sometimes gives a pound of milk for each pound of feed. A steer fed in a box stall for three years used 38 pounds of feed for each pound of dressed beef.[1]

[1] Ontario Agricultural College, Report, 1893, p. 122.

Evidently cattle may be used to condense large quantities of roughage into beef and butter for shipment to distant markets.

Another factor favoring the location of beef cattle in the regions of least population is the fact that beef animals can thrive on ranges that are too poor to support a good dairy cow. In the irrigated valleys of the Northwest that have

FIG. 68. — Distribution of dairy cows in the United States. The largest numbers of dairy cows are kept in the cool regions that have good blue-grass pastures.

excellent blue-grass pastures dairy cows have practically displaced beef cattle, but the dry range grasses that are just above the irrigation ditch are given over to beef cattle or sheep. Most of the beef animals are raised west of the Mississippi River, although many of them are fattened east of it.

In 1910 the New England, Middle Atlantic and East North Central States had over 4 out of each 10 dairy cows in the United States, but had less than 1 out of each 10 other cows.

The adjustment that the farmers have made to meet the conditions is shown in Table 23. On April 1, 1910, Nebraska and Iowa had more than one-fourth as many yearling steers and bulls (3 months to 15 months) as they had cows and heifers (15 months old or older). Practically all the calves born in these states are raised. Illinois, Indiana, and Ohio had less than one-sixth as many yearling steers or bulls as

TABLE 23. — STEERS ON FARMS ON APRIL 1, 1910

STATE	STEERS AND BULLS BORN IN 1909, PER 100 COWS[1]	STEERS AND BULLS BORN BEFORE 1909, PER 100 COWS
Colorado	18	46
Nebraska	26	40
Iowa	28	36
Illinois	15	20
Indiana	15	15
Ohio	14	15
New York	4	3
Massachusetts	3	3

cows, and New York and Massachusetts had only one steer or bull for 15 to 16 cows. In these two states practically no steers are kept. The number reported represents practically the number of bulls. Instead of raising steers, these two Eastern States sell practically all their bull calves as veal. Near the cities, both the heifer and bull calves are often killed at birth, as feed is too expensive to make it pay to keep them even up to the legal age for veal. The East Central States sell many of their calves for veal, but raise some steers. The West Central States raise nearly all their

[1] Number of steers and bulls for each 100 cows and heifers born before Jan. 1, 1909. Since many heifers too young to have calves are included with cows, the figures are all low in terms of milch cows.

calves. The age at which the steers are sold also shows an adjustment to feed prices. The Western States keep their steers to two or three years of age, as is shown by the fact that they have twice as many of the older ones as of the yearlings.

During the past few years there has been some discussion about introducing beef cattle in the Northeast, but there

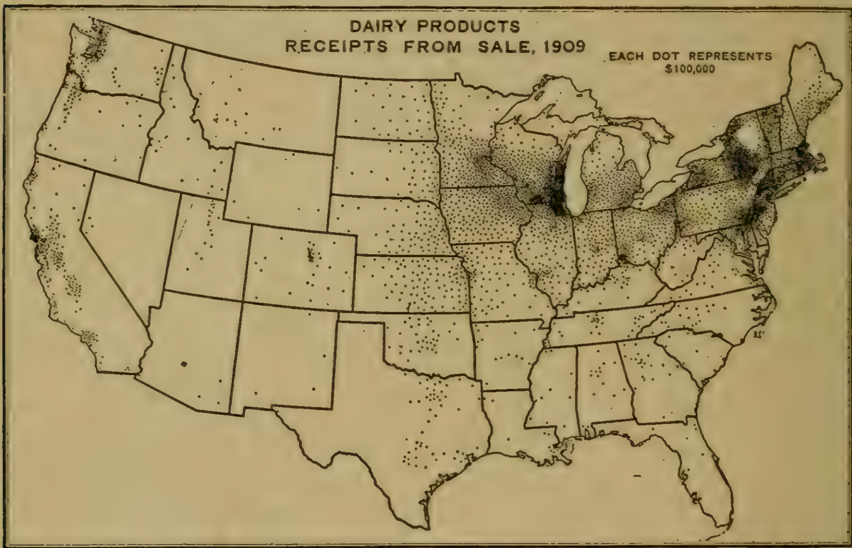

FIG. 69. — Receipts from the sale of dairy products. This map shows the location of the centers of commercial dairying, as contrasted with those in which cows are kept to supply products for home use only.[1]

is little chance for such an enterprise to succeed. The summer pastures are fairly cheap, but the cost of winter feed for a beef cow is more than the value of her calf.

187. Relation of Transportation to Dairying. Not only are the relative positions of beef and dairy cattle determined by the problem of transportation, but in dairy regions the kind of product that is to be produced is controlled by the distance that the products must be shipped. Butter, cheese,

[1] U. S. Dept. Agr., Yearbook, 1915, p. 395.

milk flour, and condensed milk are concentrated for their value and can be shipped long distances. Cream for direct use can be shipped farther than milk because it is more concentrated for its value. It is sometimes shipped from St.

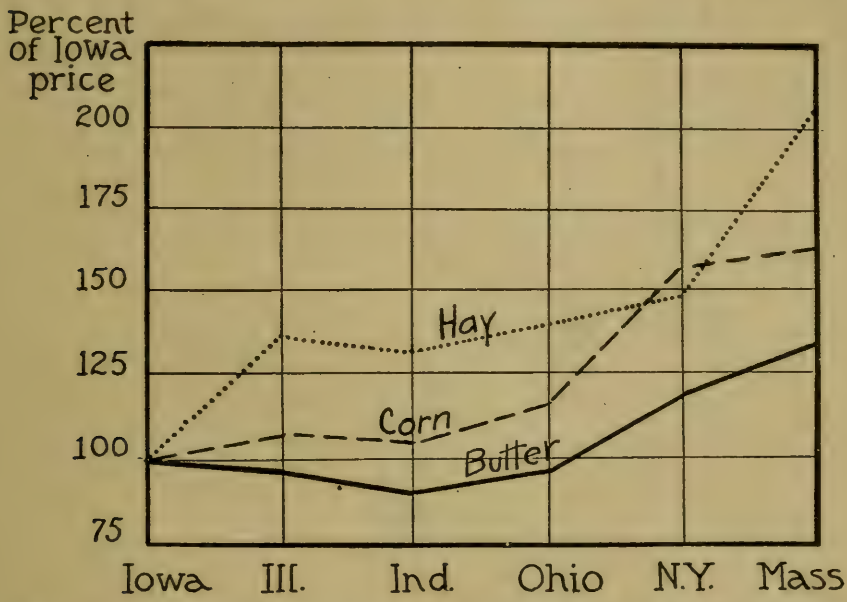

FIG. 70. — Average farm prices for five years, 1910–1914. As we go eastward the prices of hay and corn rise faster than does the price of butter. This favors the production of butter where feed is cheap.

Lawrence County, New York, to Washington, D. C., about 500 miles.

Milk is the most bulky of the dairy products for its value and is also very perishable, so that it is produced nearest to the places where it is to be consumed. The city must reach out just far enough to obtain its necessary supply. Milk is now regularly shipped to New York City from points over 300 miles away.

Farms that are favorably situated for the sale of milk cannot afford to produce butter for sale on the wholesale market. Hay and other feeds are too valuable nearer the cities.

One who under such conditions produces butter or cheese is using more expensive raw materials and gets little if any more for his product.

In 1912 farmers who sold milk to cities in different parts of the United States received an average of 3.57 cents per quart above all shipping costs. The averages varied from 2.9 to 4.4 cents for different cities.[1] In the same year the average farm price of butter was 26.1 cents per pound.[2] The price received for the milk was probably equal to 36 cents per pound for butter.

How difficult it is for farmers near cities to compete in butter production with those who have cheaper feed is shown by a comparison of prices in New York and Iowa. The average farm prices in 1914 are given in Table 24.

TABLE 24. — AVERAGE FARM PRICES IN IOWA AND IN NEW YORK [3]

	IOWA	NEW YORK	
			Per Cent of Iowa Price
Butter	$ .26	$ .31	119
Hay	10.10	14.60	145
Corn	.55	.83	151

Butter was only 19 per cent higher on New York farms than on Iowa farms, but hay was 45 per cent higher and corn 51 per cent higher than in Iowa. Other feeds are in about the same proportion. It is evident that butter and cheese production must shift to the regions of cheap feed. This shift is most strikingly shown by census figures. All

[1] U. S. Dept. Agr., Weekly News Letter to Crop Reporters, Sept. 24, 1913.
[2] U. S. Dept. Agr., Yearbook, 1912, p. 686.
[3] U. S. Dept. Agr., Yearbook, 1914, pp. 516, 570, 626.

of the northern states east of Indiana produced much less butter in 1909 than they did ten years before. The Chicago demand for milk was strong enough to cause a decrease in butter production in Illinois.

In New York, butter production decreased 40 per cent and cheese production decreased 19 per cent in ten years. At

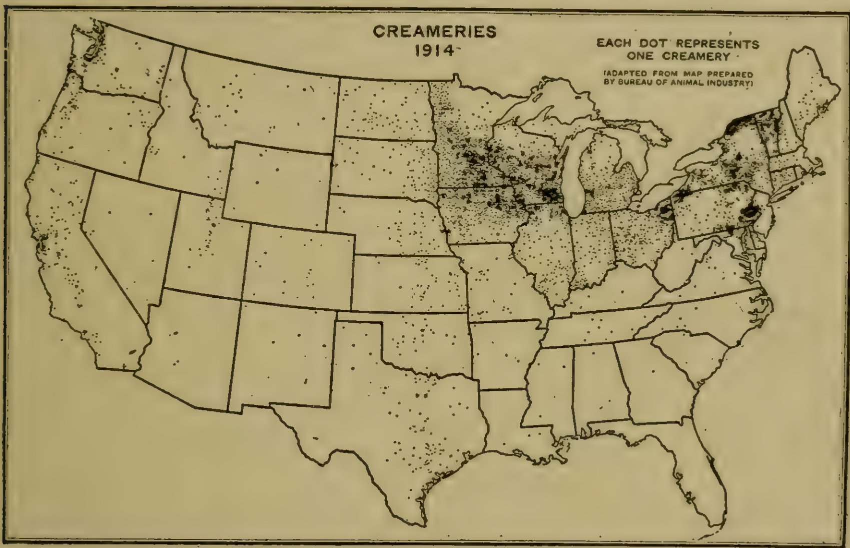

FIG. 71. — Location of creameries in the United States.[1]

the same time cheese production increased 88 per cent in Wisconsin, and butter production increased 50 per cent in Minnesota.

The great center of butter production is west of Chicago. More butter is shipped from Chicago to the Eastern States than is produced in the nine North Atlantic States.[2] Wisconsin, Iowa, and Minnesota are the leading butter states, in the order named. From the rapid rate of increase, it is probable that Minnesota will rank first at the next census

[1] U. S. Dept. Agr., Yearbook, 1915, p. 396.
[2] U. S. Dept. Agr., Bulletin 177.

period. There is no reason to suppose that any other state will be a close competitor with Wisconsin in cheese production.

TABLE 25. — POUNDS BUTTER AND CHEESE MADE ON FARMS AND IN FACTORIES [1]

State	Butter			Cheese		
	1899	1909	Per Cent Increase	1899	1909	Per Cent Increase
New York	115,408,222	69,358,918	–40	130,010,584	105,584,947	–19
Wisconsin	106,552,649	131,085,193	23	79,384,298	148,906,910	88
Minnesota	82,363,315	123,551,515	50			

These declines in New York do not mean that the dairy business has declined. They merely show that the readily

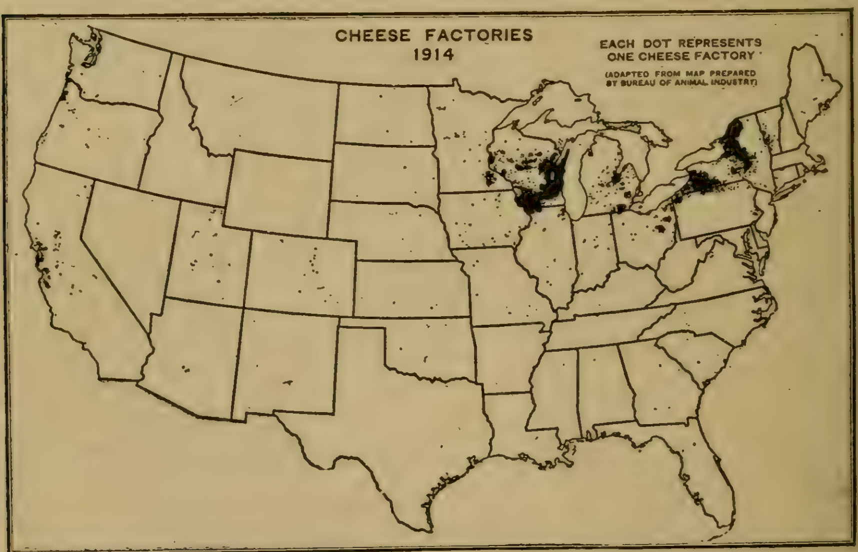

FIG. 72. — Location of cheese factories in the United States.[2]

transportable dairy products are coming from regions of cheaper feed. At the same time that these decreases have

[1] Thirteenth Census, Vol. V, p. 489.
[2] U. S. Dept. Agr., Yearbook, 1915, p. 397.

taken place in butter and cheese production, the amount of milk sold to be consumed as milk has more than doubled (increased about 121 per cent). There is still much butter and cheese produced in New York and other eastern states and will be for some time to come. The amount of land that is good for pasture but not good for crops is more than enough to supply all the milk needed in the cities. The

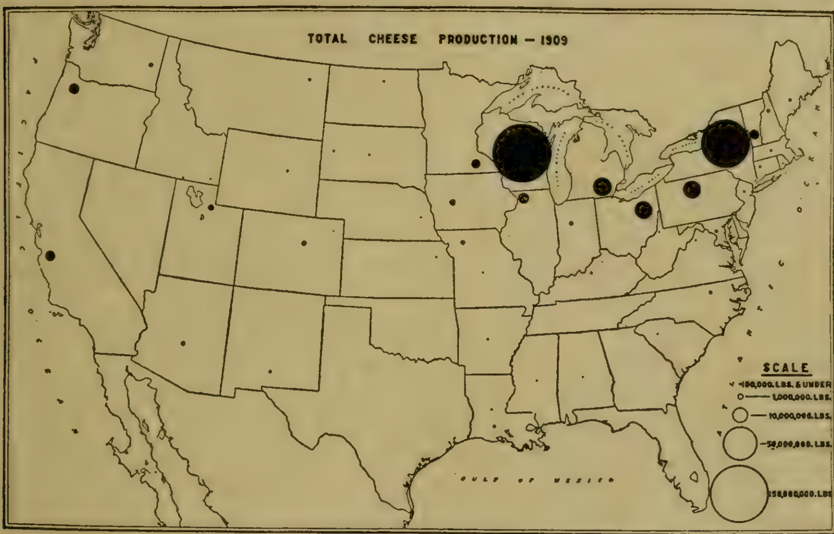

FIG. 73. — Distribution of cheese production in the United States. Most of the cheese is produced in regions that are cool, and that have good pastures on soils well supplied with lime.[1]

remaining land is used for the production of cheese and butter. As the populations of the cities increase, the production of both of these will decrease. Some butter will always be made because the milk supply cannot be just right for each day's demand. The excess is usually made into butter.

188. Other Adjustment due to Transportation. Because of differences in prices of feed and kinds of products sold, the

[1] Wisconsin Agricultural Experiment Station, Bulletin 231.

methods of dairying are very different in different regions. Near cities the cost of feed is so high and the value of the protein in milk (skim-milk) is so great that the raising of calves is very expensive. Many farmers who are thus situated regularly buy their cows. This is certain to continue to be the general practice. This provides a steady market for mature cows from regions where feed and milk are both cheaper. Such men can raise more calves than they need and can sell some of them as cows.

Because of the expense of raising cows where feed is high priced, the tendency in such regions is to keep the cows longer. On New York farms, there were 7 cows for each yearling heifer in 1910, indicating that the average cow is probably kept until she is 8 or 9 years old. In Wisconsin there was one yearling heifer for each 4.7 cows. In Iowa there was one heifer for each 3.6 cows. In these states the cows are kept about half as long as they are in New York.

189. Marginal Regions. There are of course many regions where the conditions are about equally favorable for each class of dairy products. The region may be at the end of the milk-shipping region so that the freight charges on milk make the net price of milk about the same as that of butter. Such regions tend to prevent the price of milk from rising. If it rises much, farmers stop making cheese or butter and ship the milk; and if the price drops, they go back to butter or cheese making.

190. Effect of Distance to Railroad. Back from the railroads on which milk or cream is shipped there are sometimes communities or farms that find it better to make butter than to haul milk too far. In many of the milk-selling regions there are such examples. Sometimes the farmers get calves from men living near the railroad, take them to the distant farm to be raised, and then sell the cows back to the dairymen nearer the railroad. It is often more profitable for the farmers in such regions to coöperate and haul the milk to the railroad.

191. Soil and Climate as Determining the Kind of Product. There are no important dairy regions that do not

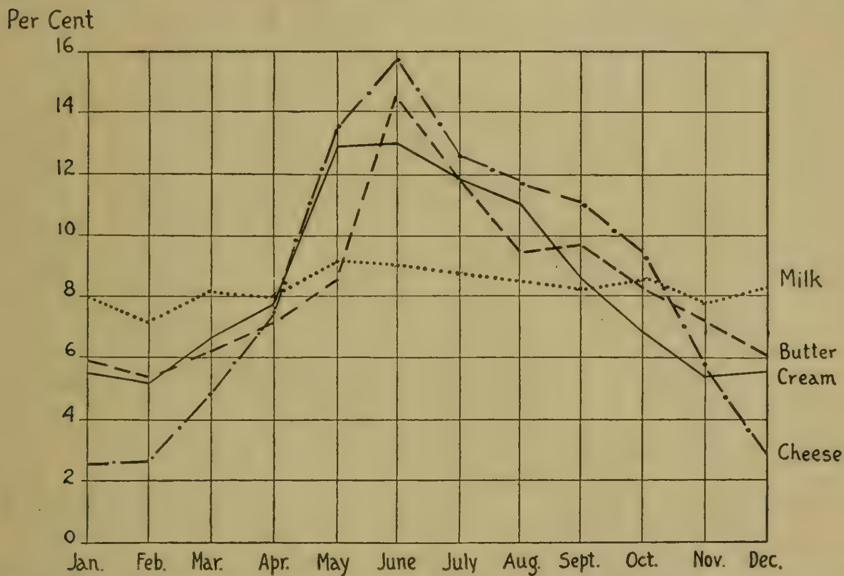

FIG. 74. — Proportion of the year's product made in each month. Record for cheese made in Wisconsin, butter received in Chicago, and milk and cream received in New York. Most of the cheese and butter is made in summer and stored for winter use.

have good pastures. Cheese production appears to have a further limitation. Nearly all the cheese is produced in cool regions that have a limestone soil or that have a soil fairly well supplied with lime. Butter is produced on all kinds of soils, but most of the commercial product is from regions where the soil and climate will grow good pastures.

192. Kind of Product and Season for Production. The demand for milk in the cities is practically constant. Fifty-two per cent of the total milk shipped to New York City is received during the six months beginning May 1. But almost two-thirds (64 per cent) of the cream is used during the summer months.[1]

Because pasture is so much cheaper than winter feed, the products that are readily stored, such as condensed milk,

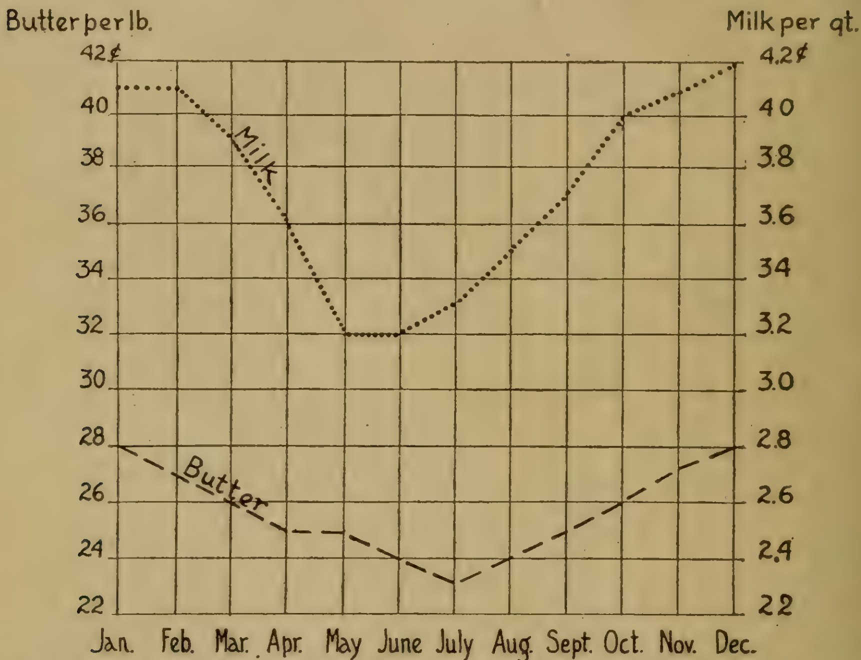

FIG. 75. — Average farm prices of butter and of market milk at shipping stations for the five years 1910–1914. In order to secure a constant supply of milk the prices in the different months have to be in proportion to the costs of production in each month, but the amount of stored butter prevents the winter price of butter from rising as high as it otherwise would.

butter, cheese, and milk flour, are most largely produced on grass. About 75 per cent of the cheese in Wisconsin is produced in the six months beginning with May.[2] Over three-fifths (63 per cent) of the butter received in Chicago is received during these six months.[3]

[1] The Milk Reporter, Feb., 1915, p. 16.

[2] Wisconsin Agricultural Experiment Station, Bulletin 231, p. 21.

[3] Chicago Dairy Produce, Jan. 16, 1915, p. 5.

Of course some butter and cheese is produced in all months. The problem is whether to have the cows freshen in the spring, and thereby have most of the production made on pasture; or to have them freshen in the fall, and therefore have most of the production made in winter. It is perfectly clear that the majority of farmers find that the summer dairy pays best for cheese and butter. Many of those who sell market milk have the cows freshen in the fall.

TABLE 26. — FIVE-YEAR AVERAGE FARM PRICES OF BUTTER IN THE UNITED STATES, 1910–1914; AND THREE-YEAR AVERAGE PRICES OF MARKET MILK AT SHIPPING STATIONS, 1913–1915

	MILK [1]		BUTTER [2]	
	Cents per Quart	Per Cent of Dec. Price	Cents per Pound	Per Cent of Dec. Price
January	4.13	99	28.4	100
February	4.06	97	27.2	96
March	3.90	93	25.9	92
April	3.61	86	25.4	90
May	3.21	77	24.7	87
June	3.16	75	23.5	83
July	3.33	79	22.9	81
August	3.49	83	23.6	83
September	3.66	87	24.7	87
October	3.98	95	25.8	91
November	4.14	99	26.7	94
December	4.19	100	28.3	100

The average farm price of butter in the United States by months is given in Table 26, also the average farm price of milk that is shipped to the leading cities. The highest price of milk is reached in December. The June price is

[1] U. S. Dept. Agr., Weekly News Letter to Crop Correspondents, Sept. 24, 1913, Jan. 20, 1915, Apr. 28, 1915.

[2] U. S. Dept. Agr., Yearbooks.

only 75 per cent of the December price. Butter is less variable in price. The butter held in storage prevents the winter price from rising as high as it would otherwise go. Under normal conditions this stored butter prevents the winter price from rising high enough to cover the increased cost of feed as it must do in the case of milk. The winter prices of butter and cheese are based not primarily on the cost of winter feed, but on the cost of summer feed plus the cost of storage.

In spite of this difference in favor of production of butter on pasture, there are some farms that can produce it in winter to the best advantage. Occasionally a farmer sells butter at retail at such a high winter price that it more than covers the higher feed cost. If the farmer is very short of pasture and has an abundance of cheap winter feed, winter production may pay. Sometimes the pressure of other work in the summer is enough to more than offset the difference in feed cost. Occasionally a farmer has such profitable summer work and so much of it that he cannot afford to milk cows in the summer, but may be able to milk them for butter production in winter.

193. Animal Unit Defined. In order to compare the amount of live-stock on different farms, it is necessary to reduce all kinds of animals to some common basis. One cow, bull, or horse is called an animal unit. Two head of young stock are counted as one unit. Seven sheep, fourteen lambs, five hogs, ten pigs, one hundred hens, are each counted as one animal unit. In each case the numbers given represent a group that eats approximately as much food as a cow or horse, and produces manure worth as much as that produced by a cow or horse. Similarly, the number of cattle units on a farm are the approximate equivalent in grown cattle. To find the number of cattle units add half the number of young stock to the number of cows and bulls.

QUESTIONS AND PROBLEMS

1. Is your region more or less favorable for cattle production than the average of the country? Consider the ease with which permanent pastures are maintained, length of the pasture season, amount of pasture land that is not good for crop growing, amount of good forage crops grown, cost of winter feed, and total cost of feed for the entire year.

2. Is the region relatively better for beef or for dairy cattle? Some of the points to consider are: cost of feed, coolness of the climate, whether the pasture grass is luxuriant enough to maintain a good flow of milk, and the market for dairy products.

3. What form of dairy products are usually most profitable in this region? Why?

4. From the railroad agent find the amounts shipped in a car-load of cattle, of butter, of milk, of cream. What is the freight on a car-load of each to the nearest large city? Use the same city in each case.

5. From farmers, find about how many pounds of feed are represented in a car-load of each of the above products.

6. From the census report for your state, fill in the following table:

Number of farms in the state
Number of dairy cows
Number of dairy cows per farm
Quantity of milk produced
Quantity of milk produced per cow[1]
Pounds of butter made on farms
Pounds of butter made in factories
    Total pounds of butter
Pounds of cheese made on farms
Pounds of cheese made in factories
    Total pounds of cheese
Amount of milk sold
Amount of cream sold
Amount of butter-fat sold

[1] Notice that this is too low because some heifers that are too young to give milk are included with cows.

Total value of all dairy products sold
Average value of dairy products sold per farm

7. Compared with the preceding census, which of the following are increasing and which decreasing: number of cows; butter made on farms; butter made in factories; cheese. In each case give the reasons for the change.

8. A similar study may be made for the county.

9. How may steers and bulls born before 1909, and born in 1909, are there in your state or county for each 100 dairy cows? Compare with Table 23, page 207. What proportion do dairy cows represent of all cattle? Compare with Table 22, page 203.

10. How many beef and dairy cows were there in your state or county? How many heifers born in 1909? How many cows for each heifer? Compare with the figures on page 214.

11. Are the calves in your region raised, or sold for veal? If sold, at what age?

12. Does your region produce all its dairy cows? Does it produce any to be shipped to other regions?

13. About what proportion of the cows in the dairy herds of your region are replaced each year?

14. At what time of the year is most of the milk, butter, or cheese of your region produced? Why?

COLLATERAL READING

Farm Management, G. F. Warren, pp. 43–103, 276–278.

CHAPTER 10

SYSTEMS OF FARMING ON DAIRY FARMS

G. F. Warren

Dairy farms may be classified according to the cropping system that they use, also according to whether they raise or buy their feed, and may be compared in many other ways. A few of these problems of organization are here discussed.

Crops for Feed

194. Corn Silage. The most striking change in the dairy industry in the last century has come in connection with the use of the silo. This provides a succulent feed in the winter and makes it possible to obtain a better production of milk at that time of year. The silo is a means of saving corn-stalks in the best possible form for winter use. It does not increase the value of the grain. In fact, there is always some loss in the silo, and the cost of putting corn into the silo is more than the cost of husking from standing stalks. Aside from its value as a succulent feed, it is primarily a substitution of corn-stalks for hay. In regions where the season is too short for maturing corn, it may still be grown for the silo. In arid regions corn and other crops that would not produce much grain are nevertheless of value for silage.

Few crops except corn and similar plants are used generally for the silo. Crops that make good hay are best stored as hay, because hay can be handled more cheaply and because the hay crops pack so loosely in the silo that the losses are considerable.

The higher the price of hay, the more important a silo becomes. The more general use of silos in the East is primarily due to the high price of hay. The average farm price of hay in New York is 86 per cent above that in Nebraska, but in every region the price is rising so that interest in silos is general.

Next to the price of hay the number of cattle is the primary consideration in building a silo. A silo that holds much less than 75 to 100 tons is expensive for its capacity. But such a silo will furnish feed for 20 to 30 cattle during the winter months. It is usually not profitable to have a silo for less than 10 cattle. If one has over 20 cattle in a region where corn grows well, a silo is usually profitable. Between these limits the price of hay, the amount of money available, the machinery that must be purchased, and whether winter or summer dairying is followed, will determine whether or not a silo will be profitable. In Livingston County, New York, only 7 per cent of the farmers who had fewer than 15 cattle units had silos, but 83 per cent of those who had 25 or more cattle units had silos.

Silage costs more than the estimates often given. In the Eastern States it usually costs about $4 to $5 per ton. It is often considered to be worth one-third as much as hay.

In the corn-belt a ton of silage often contains about five bushels of corn. To compare the cost of silage with the value of corn husked from the standing stalks, we must add to the value of the corn grain the extra cost of putting it in the silo, and interest on the money invested in the silo, and annual depreciation of the silo. These extra costs often amount to $1 per ton. On this basis silage usually costs $3 to $4 per ton.

195. Soiling Crops. Sometimes dairy cattle are kept in the barn, and green feed is brought to them rather than provide pasture for them. This system is practiced in some places in Europe and occasionally in America. The system will keep more cows on a given area of land, and it is therefore frequently advocated by persons who do not understand American farming. When land is very high in price, or labor very cheap, it is a good system. On the edge of cities it sometimes pays because land for pasture would be too expensive. The high price received for the milk may make it possible to follow this expensive method and yet make a profit. The large amount of labor involved is shown by results at the New Jersey Experiment Station. The equivalent of 50 cows was kept for 6 months on various soiling crops. During that time 278 tons of green crops were hauled to the barn. The cost of the labor to haul these crops to the barn, to say nothing of the cost of growing them, would be more than the entire cost of pasture in many dairy regions. It often pays to cut some corn-stalks or to give some other feed at times when the pasture is short, as discussed on page 128, but this is very different from following a soiling system. Such feeding is supplementing pasture, not trying to do without it. Even when land becomes high in price and labor cheap, it is not probable that a soiling system will be generally used in America, because corn silage is cheaper and is as good. Any system of barn feeding during the pasture season means that milk is being produced on the winter basis of cost, whereas the product must be sold at the summer price, which is much lower.

196. Roots. Mangels, sugar beets, or other root crops are much grown for stock food in Europe, but in regions where corn silage can be grown, such crops are not likely to be raised extensively, because corn silage is nearly as good and is cheaper. The cool moist climate of Europe and the cheap labor are favorable for growing roots. Our climate is better adapted to corn, and our labor is so costly that root crops are expensive feed. The farmer who keeps too small a herd to justify him in having a silo, sometimes finds that it pays to raise root crops to give a succulent feed in winter. Roots are a very expensive feed, but a few pounds a day will often increase the milk yield enough to pay. Persons who make advanced registry tests usually raise mangels or beets to feed to the cows while on test. Root crops also have a place in regions where the season is so short that corn silage cannot be raised.

197. Legumes. The importance of raising alfalfa, clover, or some other legume has already been emphasized. Many farms in the eastern half of the United States are better adapted to clover than to alfalfa, but where alfalfa grows without too much difficulty it is preferred. Cowpeas are the most common legume in the South. Soybeans, vetch, and many other legumes are grown by some farmers, but in most parts of the North, alfalfa or clover is more profitable.

198. Pasture. The common pasture plants in the northeastern quarter of the United States are Kentucky blue-grass and white clover. On land that is deficient in lime, Canada blue-grass or redtop is often the chief pasture plant. Blue-grass requires several years to form a good sod. If the pasture land is well supplied with lime and is fairly fertile, the pasture usually requires little attention, but if it is not fertile, more care is necessary. In the South the common pasture plant is Bermuda grass.

199. Home-grown Grain. In the corn-belt it nearly always pays to raise more corn than the cattle eat. Since there is an abundance of corn, it should be fed as liberally as possible and yet have a good ration. In the Eastern States and north of the corn-belt farm-grown oats are often ground for cow feed. Oats are nearly always too high in price to be a profitable feed to buy, but the costs of marketing the oats and hauling other feeds to take their place are often enough to make it pay to feed the oats that one has.

Cropping Systems on Dairy Farms

200. Principles of a Good Cropping System. The great majority of the dairy cows are in the northeastern quarter of the United States (see Fig. 68), east of central Nebraska and north of Washington, D.C. Most of this region is adapted to timothy, blue-grass, and clover. Permanent pastures of blue-grass and white clover are common. The usual cropping system is:

Corn or other tilled crops on sod land for one or more years.

Small grain for one or two years with timothy and clover seeded in the last year.

Hay for one or more years, or hay followed by pasture.

This is an ideal cropping system for the dairy farm. The three different classes of crops supplement each other in the control of weeds. The corn furnishes silage or grain or both. The small grain gives its best yield and at least cost when grown after a tilled crop. The grasses and clover are started by seeding in the small grain at very low cost. If the land is adapted to clover, this helps to supply the protein that is not provided in sufficient quantity by the other feeds grown in the rotation.

Everywhere a good rotation for a dairy farm should if possible provide clover, alfalfa, or some other legume for hay and should provide an abundance of roughage and pasture. It should if possible provide a cash crop, or a feeding crop for some other class of animals, such as corn for hog feed.

201. Examples of Rotations. There are many variations of this rotation plan that follow the general principles given

FIG. 76. — A good basis for profitable dairying; high-grade cows on a good blue-grass pasture; corn for the silo in the background; clover in an adjoining field; timothy and oats also raised.

above. In the southern part of the region described above, from southern Pennsylvania to Kansas, a common rotation is corn, winter wheat, clover.

A little farther north, corn is removed too late for the planting of wheat, therefore oats are grown following corn. In the Northeastern States, corn, potatoes, cabbage, and other tilled crops are usually followed by oats in which grass is seeded. The hay is usually left for about three years. In this region hay does well and is high in price.

In the best part of the corn-belt, corn is raised for several years in succession because this is the most important crop. A good rotation for much of this region is corn two years, followed by one year of oats in which clover and timothy are seeded. This may be cut for one or two years, or if there is not a permanent blue-grass pasture, it may be cut for hay one year and pastured one year.

In regions where alfalfa is grown, systems of cropping are not so definitely established. Perhaps the ideal dairy region is one that is naturally adapted to corn and alfalfa and that has permanent pastures of blue-grass and white clover.

In the South, a good rotation is cotton one or two years, followed by corn. The corn is followed by one year of oats and cowpeas, the oat crop being harvested in time to raise a crop of cowpeas the same year. Cowpeas or some other crop is sometimes planted between the rows of corn. This system, together with Bermuda grass pastures, provides legumes, corn, pasture, and a cash crop. The legume and pasture are, however, more expensive to raise than are the grasses of the North. There is room for a great development of dairying in the South, but the greatest dairy centers will remain in the regions where grass grows more readily.

These are but a few of the great variety of cropping systems followed on different dairy farms.

Cash Crops and Feed Raised

202. Feed and Cash Crops. There are many ways in which the type of farming on dairy farms may be described. Some of the most important comparisons are based on the extent to which feed is purchased and the amount of other products sold. The following are some of the different methods:

1. All feed bought, no crops raised, nothing but milk and discarded cows sold.

2. Nothing but roughage raised.

3. Roughage and all or part of the grain raised.

4. Same as 2, but with some cash crop or other product sold.

5. Same as 3, with some cash crop or other product sold.

6. With any of the above methods, the cows may be raised or may be purchased.

7. The cows may be pure-bred so that there is a considerable income from the sale of stock.

In general, each of the above types is more profitable than the preceding, provided the conditions are favorable for it.

203. All Feed Purchased. Some dairy cows are kept in cities. Most of these are kept to supply milk for home use, but some large dairies are maintained where all feed must be purchased. Usually the cows are fed largely on factory by-products that are not readily shipped. But sometimes ordinary feeds are purchased. The high price received for the milk sometimes makes such an enterprise profitable. Calves are very rarely raised in cities, because feed is too expensive. Ordinarily it is cheaper to produce the milk in the country where pastures are available. It costs less to ship milk than it does to ship the hay and other feed required to make it.

204. Nothing but Roughage Raised. This system is very common in the hilly and mountainous parts of the Eastern States. A better system is not easy to devise for some regions where the land is not adapted to any crop except hay and pasture and where the fields are all so small and rough as to prevent the profitable growth of other crops.

Because of the small amount of field work, it is not often profitable to employ much hired help. The farmer with the help of one member of the family at chore time can milk 20 or 25 cows and, therefore, under this system, the women often help with the milking. The farmer can do the remainder of the day's work alone. In haying time he may need a little extra help. Such farmers usually find that it pays best to have the cows freshen in the spring so as to produce most of the milk in summer and thus reduce the grain bill. One of the important reasons for winter dairying is to have the summer free for field work, but on farms where little field work is done this is no advantage.

Under these conditions the milk production per cow is the most important problem because profits depend almost entirely on the cow. It is sometimes possible to find some other product besides milk that can be raised without much extra cost. Berries, eggs, honey, or hay will often add much to the income. Sometimes pure-bred stock is kept and a good profit made from the sale of the surplus animals.

205. Roughage and Grain Raised. Where the land is good enough to raise grain, this system pays much better than the preceding one because the grain feed can be raised without having to hire much extra labor, and with practically the same number of horses that must be kept anyway. (See Farm Records on page 281.)

206. Roughage and Cash Crops Raised. One of the most profitable types of dairy farming is the combination of intensive cash crops with a dairy. The manure is used to grow potatoes, cabbages, apples, tobacco, hops, peas, or sweet corn for canning factories, or some other crop for sale. Where the soil and markets are favorable for one or two of these crops, this system usually pays much better than trying to raise the grain feed. It is, of course, much better to raise the grain feed than nothing. But if instead of raising the grain, one can raise cash crops that will pay the feed bill several times over, he should certainly choose the latter course. Hay is another good cash crop for dairy farms near large cities. Most of the highly successful dairy farms in New York and New England sell some crops, as do many of the farms in other sections. Some of these farms also raise all their grain feed, but most of them buy a considerable part of it. (See Farm Records on pages 242 and 285.)

Farther from the cities the cash crops are more likely to be grain or grain marketed through hogs. This is the most commonly profitable type of dairy farming in the corn-belt. It is certain to increase greatly in that region. All of the roughage and most of the grain is raised for all of the farm stock. A little cottonseed meal, or other nitrogenous feed, is purchased to balance the ration. Much more corn is raised than can be fed to the cows. This is sold or is fed to hogs. If skim-milk is available for hog feed, the conditions are particularly favorable for hog production. (See Farm Records, page 281.)

Management of Manure

The success of the dairy farm is in no small measure dependent on the use that is made of the important by-product, manure.

207. Amount of Manure Produced. Under the direction of the writer, R. E. Deuel determined the amount of manure produced by a herd of 46 cows of different breeds and ages, averaging 1008 pounds in weight. He found that excrement was produced at the rate of $13\frac{3}{4}$ tons per year. Some years ago Roberts found the amount to be 13.5 tons per 1000-pound animal. In each case a little over one ton of bedding was used, so that if the cows were kept in the barn all the time and if no manure were lost, there would have been nearly 15 tons of manure per 1000-pound cow.

Much of the year the cows are either at pasture or in the barnyard so that part of the manure is lost. About a ton of manure per cow per month is ordinarily available when cows are kept in the barn and turned out in the barnyard for a part of the day. In the Northern States 8 to 10 tons of manure a year, including bedding, are usually available for each cow or animal unit kept.

208. Fertility of Feed Returned by Cows. The proportions of the constituents of the feed that are returned in the excrement are somewhat variable. A fat animal that is not working or giving milk returns a very large proportion of the food materials. A good dairy cow from the very fact that she is an efficient machine returns a small proportion.

TABLE 27. — PROPORTION OF CONSTITUENTS OF FOOD THAT ARE RETURNED IN THE EXCREMENT OF DAIRY COWS

	DEUEL	WOLFF[1]
	Per Cent	*Per Cent*
Dry matter	45.5	43.8
Organic matter	43.3	39.5
Nitrogen	44.3	47.5
Ash	63.6	53.9

R. E. Deuel determined the average results for a herd of 46 dairy cows. These results as well as the results by Wolff are given in Table 27. Dairy cows return somewhat over 40 per cent of the organic matter and nitrogen of the food eaten, and more than half of the mineral matter. Dry

[1] C. M. Aikman, Manures and Manuring, pp. 227, 281.

cows, or cows that are giving little milk, often return a half more than these amounts.

If one wishes organic matter to plow under to make humus, he can feed cows and still have 40 per cent of the humus-making material left. For this reason, it is usually more profitable to feed stock than to plow under green-manure crops.

If one desires nitrogen as a fertilizer, he can feed cows, and still get back nearly half of the nitrogen of the feed. If he needs phosphorus and potassium, he can feed cows, and get back over half of these materials that are in the feed. In addition to the above all of the bedding may be recovered. Some of the manure may be lost, but for the time cows are in the barn, if the manure is reasonably well cared for, it is safe to estimate that over a third of the fertilizing value of the feeds will actually be applied to the land.

209. Losses of Manure and their Prevention. On many farms the manure is allowed to lie around in the barnyard until a very large part of it is lost. Exposure for five months resulted in a loss of over half of the value of the manure.[1] One of the important reasons for keeping cattle is to obtain manure, but there is no object in this if the manure is wasted. If manure is kept moist enough so that it will not heat, and yet if neither the liquid in it nor rain water that falls on it, is allowed to escape, it will keep with practically no loss.

The safest place for manure is on the land. On some farms it is possible to haul it every day. This is the best possible way to save it. When this practice is followed, it is convenient to have the barn so arranged that one can drive through between two rows of cows that have their heads toward the wall. In regions where little is done except to

[1] Elements of Agriculture, G. F. Warren, p. 141.

care for the cows and raise feed for them, the practice of daily hauling is often best.

If many acres of crops are grown for sale or for use in feeding other animals, the field work is so important that during much of the year one cannot afford to take the time to haul manure every day. There are then three ways of keeping the manure. It may be left in piles until it can be hauled, it may be kept in covered barnyards, or may be kept in a manure shed.

A cheap shed with a concrete floor will keep off the rain and prevent the liquids from leaching away. A convenient way of using such a shed is to have the barn equipped with a manure carrier so that the manure from the cows, horses, and other animals, can be put in the shed. The floor of the shed should be two to four feet below the floor of the barn to increase its capacity. The writer has found that a shed 25 feet square will ordinarily hold the manure from about 20 animal units until the time when it can be hauled. The floor need not be expensive. Three inches of concrete on solid ground will answer all purposes.

A better plan is to have the shed large so that cattle, hogs, or other stock, can run in it. This keeps the manure solid and makes a good covered shed. With either of the above plans, it is convenient to have the barn so arranged that the cows' heads are together. This saves time in feeding, and the barn can be cleaned with a manure carrier as quickly as if the cows faced the wall.

The majority of farmers throw the manure in piles in the barnyard. The rains then wash away much of the best part of it. Even with this method, considerable saving can be made by having the eave troughs and yard drainage so arranged that a minimum amount of water will run through the manure. In arid regions even this precaution is not always necessary because there may be only enough rain to keep the manure wet without washing it away. With this method of handling, it should be hauled away frequently. If possible, all of it should be hauled out in the winter and spring so that as little as possible will be lost by summer rains. In August usually it can be cleaned up again. Better care of manure by using the covered shed method, or by some other method, is well worth consideration.

210. Value of Manure. Manure is sometimes valued according to its chemical analysis. If purchased in commercial fertilizers, the amount of nitrogen, phosphorus, potassium, and calcium in a ton of manure would cost over $2. But what manure is worth to a farmer depends not on its chemical analysis but on what he is going to do with it. If it is to be left in the barnyard, it has no value. If used on some crops, it may have a very high value. On other crops its value is less. If applied in very large quantities, its value per ton is less than when used in moderate amounts.

The good returns that often come from combining dairying with such intensive crops as potatoes, cabbages, hops, tobacco, apples, and grapes are due partly to the high value of manure for growing such crops. It is just as easy by use of manure to increase the potato crop ten per cent as it is to increase a grain crop by the same proportion. But the potato crop has so much greater value per acre that the returns from such an increase are much more. Manure has a high value for growing corn and is chiefly used on that crop in regions where more intensive crops are not raised.

For raising corn, small grain, and hay, manure is often credited to the cows at about $1 to $1.50 per ton at the barn, The cost of hauling is usually about 50 cents so that these figures would make the manure cost the crops $1.50 to $2 per ton. For some new regions these figures may be high, but in the eastern half of the United States manure is always worth at least $1 per ton at the barn. Where truck crops or other very intensive crops are raised, it may be worth much more.

211. The Value of Manure Depends on the Rate of Application. The Pennsylvania Experiment Station has conducted an extensive series of fertilizer and manure experiments since 1882. A four-year rotation of corn, oats, wheat, hay is followed. On one plot 6 tons of manure is applied on the corn and on the wheat. On another plot 10 tons is used. The check plots receive no treatment. The total values of the crops per acre for 32 years were as follows: [1]

No treatment	$474
Six tons manure every other year (96 tons)	714
Ten tons manure every other year (160 tons)	747

When a total of 96 tons of manure was applied, the value of the increased crops amounted to $2.50 per ton of manure. An additional application of 64 more tons gave increased crops worth 51 cents for each additional ton. For the entire period of 32 years this extra manure would have been worth nearly five times as much per ton if applied at the lesser rate. If one kept 30 animal units and obtained 6 tons of manure from each one, or 180 tons per year, he would have 5760 tons of manure in 32 years. If this manure were applied at the lesser rate, the total value of the increased crops would be $14,400. If applied at the heavier rate, the same manure would have brought increased

[1] Pennsylvania Agricultural Experiment Station, Bulletin 90. Later data furnished by F. D. Gardner.

crops worth only $9,828. The manure would have been worth $4,572 more to the farmer if spread thinner.

The land that received the heavier application is better for future crops but by no means is it better to the extent of the cost of the heavier application. The best measure of how much better it is, is found in the results of the last few years. As an average for the last four years, the plots that had received 64 more tons of manure per acre gave crops worth only $8.63 more than the crops on the plots using the lighter application. This difference is not enough to give any promise of catching up.

The same principle is shown by results at the Ohio Experiment Station. Many different experiments have been conducted for many years. In every case a given quantity of manure has given the greatest returns when spread thinly. One test in a three-year rotation of potatoes, wheat, clover, has been continued for 21 years. Manure was applied at the rate of 4, 8, and 16 tons on wheat. The total values of the crops per acre were as follows: [1]

No treatment	$782.49
4 tons manure every three years (28 tons)	900.04
8 tons manure every three years (56 tons)	963.17
16 tons manure every three years (112 tons)	1099.31

When a total of 28 tons of manure was applied, the increased crops were worth $4.20 per ton of manure. An additional application of 28 more tons of manure per acre gave additional crops worth $63.13, or $2.25 per ton for the additional manure. A still further addition of 56 more tons gave crops worth $2.43 per ton for the last additional manure.

Of course the land that has received the heavier appli-

[1] Ohio Agricultural Experiment Station, Circular 144. Data for 1914 supplied by C. G. Williams.

cation is in better condition, but this is not enough to make up for the past difference in returns. Even with the fertility left from all the previous years of treatment the plots that had the heaviest applications were still paying least per ton of manure on the twenty-first year.

Of course if there is enough manure, the heavier application is very desirable, but with a limited amount it is better to spread it thinly. These figures also indicate the high value that one can assign to manure if he is keeping a small amount of stock.

If a farmer had 180 tons of manure a year to apply for 21 years under conditions like those in the Ohio experiment, the manure would produce increased crops worth $15,869, if applied at the rate of 4 tons every three years, but would give increased crops worth only $10,693 if applied at the rate of 16 tons every three years. If the manure is not wasted, this amount is usually available on a farm that keeps 15 cows in addition to the usual amount of young stock, horses, etc. If applied at the rate of 4 tons every three years, it would provide for 135 acres of crops. These are about the conditions on many 160-acre farms.

If the manure were applied at the rate of 16 tons every three years, it would provide for only 34 acres of crops. This would be a very small farm. Another way to provide for the larger application would be to keep four times as many cows on the larger area. But this would make a very heavily-stocked place.

From the above, we see that one of the strong reasons for keeping a moderate number of cows is the high value that can be obtained from the intelligent use of small applications of manure. One of the reasons why it may not pay to stock the farm too heavily is the smaller value that manure then has.

212. The Value of Manure Depends on the Crops on which it is Applied. At the Ohio Experiment Station, 8 tons of manure was applied on wheat as compared with the same application on potatoes. The manure gave increased crops worth $3.45 per ton when applied on potatoes, but gave only $2.72 per ton when applied on the wheat crop. If one farmed 75 acres of this land with this three-year rotation and had 200 tons of manure to use each year, he would make $3066 more in twenty-one years if he applied it on the potatoes rather than on the wheat.

With corn, wheat, and oats, each grown continuously on the same land at the Ohio Experiment Station, corn paid the best prices for manure, wheat next, and oats least.

Such experiments indicate the great importance of applying the manure on the right crop in the rotation. They also indicate the great advantage of combining dairying with the production of such intensive crops as potatoes.

QUESTIONS AND PROBLEMS

1. Make a list of all the farmers you know, with the number of cows that they keep, and state whether or not they have a silo. Lists by different members of the class can be combined to make a cow and silo census. What proportion of the farmers who have 10 cows or less have a silo? What proportion of those who have 10 to 20 cows have a silo? What proportion of those who have over 20?

2. Make a list of all the different kinds of silos of the region. Of as many as possible, find the cost (including labor by the farmer) and the cost for each ton of capacity.

3. If any farmers have cut part of a field for silage and have husked part of the same field, find the yield of silage and of grain. How many bushels of corn in a ton of silage? If the use of the silo and machinery and extra work amount to $1.00 per ton, what would a ton of the silage cost at the present price of corn?

4. Does any one in the region follow a soiling system?

5. Are roots raised for stock food by any farmers in this region?

6. What are the best legumes for the dairy farm in this region?

7. What are the common pasture plants of the region?

8. What are the usual crops grown on the dairy farms of this region?

9. What feeds do dairy farmers in this region buy? What cash crops or other products are sold from dairy farms?

10. What crop rotations are used in the region? Do they include the types of crops that make a good cropping system?

11. What are the usual methods of handling manure in this region? Is it taken out of the barns with a carrier, loaded on a wagon driven through the barn, or is it thrown out into the barnyard? Do any farmers in the region haul manure every day? Do any have a shed in which manure is kept? What proportion of the farmers clean up and haul all the manure at least twice a year? On what crops is the manure usually applied, and at what rate per acre?

12. How many months are animals usually kept in the barn here? About how many tons of manure are available for each animal unit kept? If possible find the tons of manure hauled by some farmer and number of animals kept. How many tons were there per animal unit?

13. For some farm in the region find the area, acres of crops grown, number of each kind of animals, and crop rotation. Calculate the number of animal units and probable tons of manure available. On which crops, how often, and at what rate would you use this manure?

LABORATORY EXERCISES

35. Field Trip to a Farm. Visit one or more dairy farms. Make sketches of the farms, showing location of different fields. What crops were grown on each field last year? What was done with the crops? What areas will probably be grown this year? On which field is the manure applied? How is the manure cared for? Is the pasture permanent or rotated? What are the chief plants in the pasture? Is the pasture land good land for use in raising grain? What disposition was made of the crops last year? Are the fields and pasture conveniently arranged as to size and nearness to the barn? What is the kind and amount of fencing? How many months in the year are the stock kept on pasture? For how many months does the pasture furnish all the feed? How many animal units are kept in the pasture? How many acres of pasture per animal unit?

CHAPTER 11

RENTING DAIRY FARMS

G. F. Warren

213. Cash Rent. When cash rent is paid, the tenant usually furnishes everything but the land. The landlord then has little to do with the farm. In some regions the landlord furnishes the cows and rents the farm and cows.

214. Share of Crops. In regions where grain or cotton is the major product, the landlord usually receives a share of the crop. If cows are kept, the landlord has no share in them. Only rarely does a good dairy farm develop under these conditions. The landlord is not likely to provide suitable buildings. The tenant justly feels that the manure produced by the cows he feeds increases the yield of the landlord's land with no expense to the landlord.

215. Share of Receipts. In the older states the almost universal system of sharing the products on rented dairy farms is for each party to receive half of the receipts from all products of the farm. The landlord furnishes the land and does any extensive repairing of buildings. For small repairs to buildings and fences he usually furnishes materials, and the tenant does the work. He usually pays the taxes, pays half the seed, feed, fertilizer, threshing, silo filling, hay pressing, and similar bills; and furnishes half or more of the cattle and other stock from which he shares the income.

The tenant furnishes the human labor, machinery, and horses, and half of the other stock, and pays half of the bills mentioned above. He pays such bills as horseshoeing and machinery repairs. Each party has half of the receipts and owns half of the young stock raised.

In regions where little but milk is sold, the landlord usually furnishes all cows (see page 244). When profitable cash crops are raised in addition to dairying, the tenant usually furnishes some of the cows (see farm, page 242). In either case the calves raised are usually a part of the product, to be divided equally.

Many variations occur. If the chances of making a profit are poor, the tenant obtains concessions from the landlord. If the chances are good, the tenant may make concessions to get the place. The landlord often furnishes some machinery or horses, usually what he happens to own. The tenant often owns all the hens and receives all the product from them. Usually he is then required to furnish all the feed for them. A hog or two is often kept in the same way. If hogs are an important enterprise, the feed and returns are divided. Sometimes the landlord pays all the fertilizer bill and often furnishes all the grass seed. Sometimes the tenant furnishes all the grain for horses, and sometimes this cost is shared. Colts usually belong to the tenant but are sometimes shared.

The fertility of the land, character of the buildings, quality of the cows, distance to market, price of milk, size of the farm, and many other factors must be considered before one can say what the exact terms of the lease should be. For the tenant the quality of the cows kept, the fertility of the land, and amount of good crop land available are more important than minor details in the lease.

It seems probable that this general system of rental will come to be used in most regions where dairying becomes the most important industry. One advantage of the system is that it stimulates the keeping of animals. In several counties where this has been studied the results show that the rented farms keep more live-stock per acre than do the farms operated by owners.

216. Examples of Rented Farms. The results on farms will show the method better than it can be described.

A Successful Tenant Farm in Western New York — 193 Acres. A Variety of Products Sold. Cows Shared Equally

Capital	Tenant	Landlord
Farm		$14,000
Machinery and tools	$ 500	
6 horses	750	
1 brood sow	8	8
Poultry	21	21
20 cows	400	400
Calves and bull	75	75
	$1754	$14,504

Crops	Acres	Total Crop
Corn	4	200 bushels
Wheat	32	800 bushels
Oats	16	560 bushels
Timothy and clover	33	50 tons
Potatoes	4	350 bushels
Field beans	14	252 bushels
Apples	1	50 bushels
Peas for canning factory	14	14 tons
Sweet corn for canning factory	8	24 tons
Sweet corn stalks and pea vines put in silo		

A Successful Tenant Farm in Western New York — *Continued*

	Tenant	Landlord
Receipts		
Milk	$1000	$1000
Cattle sales and increased inventory	30	30
Poultry and eggs	60	60
Hogs	116	116
Wheat	343	343
Oats		168
Potatoes	49	49
Beans	252	252
Apples	30	
Peas	175	175
Sweet corn	84	84
	$2139	$2277
Expenses		
Labor	$ 200	
Grass seed	40	$ 40
Feed	150	150
Fertilizer	60	60
Machinery up-keep	20	
Building up-keep		120
Harvesting	20	
Twine	10	
Threshing and coal	24	24
Insurance	8	9
Taxes	36	36
	$ 568	$ 439
Receipts less expenses	$1571	$1838
Interest on tenant's capital @ 5%	$ 88	
Tenant's labor income	$1483	
Landlord's per cent on investment		12.7

This farm is a large diversified business with good cows. Most of the feed raised and nearly half of the income is derived from the sale of crops. The provisions of the lease are the usual ones for a farm of this type. With a farm of this size and with good cows both parties are doing well.

A Successful Tenant Farm of 190 Acres that is Highly Specialized. The Landlord Furnishes all the Cows

Capital	Tenant	Landlord
Farm		$13,300
Machinery and tools	$ 425	375
Feed and supplies	300	300
Cows		1,725
Heifers and calves		210
Bull		200
5 horses	350	175
Colt	75	
Hog	8	
Hens	31	80
Turkeys	6	
	$1195	$16,365

Crops	Acres	Total Crop
Silage corn	24	188 tons
Timothy and clover hay	60	78 tons
Oats	30	1200 bushels
Mangels	$\frac{8}{10}$	250 bushels
Potatoes	1	120 bushels
Orchard and garden	2	

	Tenant	Landlord
Receipts		
Hay	$ 178	$ 178
Milk	1239	1239
Cattle sales and increased inventory	40	165
Hides	1	1
Colt increased inventory	15	
Outside work	207	
Hogs	33	33
Eggs	6	25
Poultry	40	
	$1759	$1641

	Tenant	Landlord
Expenses		
Labor	$ 400	
Machinery up-keep	30	
Building up-keep		$ 50
Feed	76	76
Silo filling		45
Ice	4	4
Horseshoeing	15	
Stallion service	10	
Grass seed		38
Twine	8	8
Threshing	10	10
Fuel for threshing and silo filling	5	5
Insurance	10	10
Taxes	66	66
	$ 634	$ 312
Receipts less expenses	$1125	$1329
Interest on tenant's capital at 5%	$ 60	
Tenant's labor income	$1065	
Landlord's per cent on investment		8.1

QUESTIONS AND PROBLEMS

1. What are the usual systems of renting in your region?

2. Do the systems of rental encourage the keeping of stock? Do tenant farms have as much stock as farms operated by owners?

3. Make a list of all the persons you can find who have recently changed from hired man to tenant. On the average how many years did they spend as hired men?

4. Make a list of as many persons as possible who have changed from tenant to owner in the past few years. On the average how many years have they been tenants?

5. Write a lease that seems to you to be fair to both parties and that gives a reasonable consideration to maintenance of the fertility of the land.

COLLATERAL READING

Farm Management, G. F. Warren, pp. 321–329.

Cyclopedia of Agriculture, L. H. Bailey, Vol. IV, pp. 170–185.

Farm Leases in Iowa, Iowa Agricultural Experiment Station, Bulletin 159.

CHAPTER 12

COSTS OF PRODUCTION AND METHODS OF MARKETING

G. F. Warren

Cost of Production

217. Cost of Producing Milk. Reliable figures on the cost of keeping cows are available for two regions that represent decidedly different dairy conditions.

Delaware County, near New York City, is a hilly region where the pasture season is short. Practically all grain is purchased. Because of the nearness to large cities, hay is very high in price. In this county the average cost per cattle unit for over six thousand cows was $99. The year whose records are here quoted was one of unusually high feed prices even for the region. In the following year the cost was $88. All the costs of keeping the cows and of the calves raised were charged directly to the cows, raising calves being one means of offsetting depreciation on cows. How near these two balance in this region is shown by the fact that the returns from cattle and hides sold were only $1 per cow above the amounts spent for cattle purchased. This region is fairly typical for New England and for hilly regions in other states near the large eastern cities.

Rice County, Minnesota, represents a region of very low-priced feed. The figures were obtained several years ago when feed was cheaper than it is to-day. Hay is worth less than one-third as much as in regions like Delaware County, near New York City. Because of the very low price of feed, the average cost of keeping a cow was only $60.

TABLE 28. — COST OF PRODUCING MILK

	DELAWARE CO.[1] N. Y., 6422 COWS	RICE CO.[2] MINN.
	Per Cattle Unit	*Per Cow*
Quantities		
Pounds grain fed	1662	864
Hours human labor	130	133
Pounds milk produced per cow	4514	5252
Pounds butter-fat per cow	208	188
Costs		
Feed	$66.60	$27.50
Bedding	.75	[4]
Buildings	4.41	2.46
Dairy equipment	.41	.58
Interest	2.94	2.35
Human labor	18.26	18.66 (Human labor, Horse labor, Hauling milk)
Horse labor	.20	
Hauling milk	5.01	
Bull cost	[3]	1.98
Depreciation	[3]	3.19
Miscellaneous	.91	3.28
Less cattle increase and net sales	.92	
Total cost	$98.57	$60.00

It will be observed that the costs other than feed are almost exactly the same in the two regions. The average costs other than feed for keeping cows under farm conditions vary widely on different farms, but in the great majority of cases for grade herds are between $30 and $40 per cow. In

[1] Report of the Proceedings of the American Farm Management Association, November, 1913.

[2] Minnesota Agricultural Experiment Station, Bulletin 124.

[3] This item included elsewhere. [4] Charge for this item not given.

pure-bred herds the costs are usually much more. Next to feed, labor is the most important cost. The importance of having the farm and buildings so arranged as to facilitate work is at once apparent.

TABLE 29. — COST OF PRODUCING MILK ON NEW YORK FARMS [1]

	GRADE HERDS		PURE-BRED HERDS	
	1913	1914	1913	1914
Quantities				
Number herds	17	8	5	4
Number cows	297.5	189.6	110.5	85.5
Number cows per herd	17.5	23.7	22.1	21.4
Number cattle units per herd	23.9	30.9	32.8	36.3
Average value of cows	$71.10	$70.31	$215.90	$268.89
Pounds milk per cow	6185	5584	7000	7388
Value milk per cow	$99.46	$86.42	$107.70	$105.10
Pounds grain per cattle unit	1551	1479	2339	2295
Pounds dry forage per cattle unit	3028	2480	3216	3200
Pounds silage per cattle unit	6554	5540	6791	8980
Hours man labor per cattle unit	116	100	161	183
Costs per cattle unit				
Grain	$22.71	$18.99	$34.18	$34.24
Dry forage	17.76	12.90	23.00	16.88
Silage, etc.	12.90	11.74	14.33	17.47
Pasture	4.96	4.43	4.52	4.15
Bedding	2.22	1.33	2.55	2.70
Man labor	19.26	16.63	27.86	30.78
Horse labor	2.64	3.77	3.22	2.31
Equipment labor	.91	.76	.97	.79
Interest	3.55	2.95	11.21	15.90
Buildings	2.81	2.04	2.34	3.27
Breeding fees	.003	.36	8.21	1.76
Veterinary and medicine	.20	.09	.55	.59
Miscellaneous	2.13	1.95	6.92	10.16

[1] New York State Department of Agriculture, Circular 130, p. 82.

TABLE 29. — COST OF PRODUCING MILK ON NEW YORK FARMS — *Continued*

	GRADE HERDS		PURE-BRED HERDS	
	1913	1914	1913	1914
Summary				
Feed	$58.33	$48.06	$76.03	$72.74
Man labor	19.26	16.63	27.86	30.78
All else	14.46	13.25	35.97	37.48
Total	$92.05	$77.94	$139.86	$141.00
Returns per cattle unit				
Milk[1]	$72.81	$66.24	$72.61	$61.73
Increase and net sales	18.02	13.37	87.01	90.47
Manure	10.59	7.87	10.11	10.12
Miscellaneous	.39	.06	1.79	1.95
Total	$101.81	$87.54	$171.52	$164.27
Profit per cattle unit	$9.76	$9.60	$31.66	$23.27

From these costs the value of the manure should be deducted to find the returns that the average farmer would have to get in order to make a profit on cows. For Rice County the value of the calf would also have to be deducted. This value is included in the Delaware County figures.

Accurate results of cost accounts on a number of New York farms including 673 cows are given in Table 29. These farms were not especially selected but are somewhat larger and better managed than the average farm. Most of them were located in parts of the state where feed is somewhat cheaper than in Delaware County. The accounts are with the entire dairy herd considered as a unit.

For the grade herds there is a surprisingly close agreement with Table 28 as to costs other than feed. The pure-bred herds cost more in every way, but the returns are more

[1] Notice that this is total milk divided by the number of cattle units. The value of the milk per cow is given above.

than enough to cover the greater cost. The pure-bred herds on the average pay best.

218. Cost of Raising Heifers. The cost of raising heifers on a Wisconsin farm that raised about twenty a year was kept for five years. The food costs to raise a heifer to two years of age varied from $39 to $42. The total costs varied from $60 to $65 in different years. The average cost of raising one group of about twenty heifers is given in Table 30. To these costs the value of the heifer at birth should be added and the value of the manure produced in the barn subtracted. Of course, the exact figures should not be expected to apply to another farm, but the comparative costs are worth studying.

TABLE 30. — AVERAGE COST OF RAISING JERSEY HEIFERS TO TWO YEARS OLD ON A WISCONSIN FARM [1]

	RAISING TO 1 YEAR OLD	SECOND YEAR	TOTAL 2 YEARS
Quantities used			
Whole milk, lb.	342		342
Skim-milk, lb.	3165		3165
Grain, lb.	547		547
Silage, lb.	353	3250	3603
Mixed hay, lb.	857	1120	1977
Corn stover, lb.		672	672
Days pasture	123	171	294
Hours man labor	40	23	63
Costs			
Feed	$24.58	$16.11	$40.69
Bedding	1.00	2.00	3.00
Labor	5.14	2.86	8.00
Interest	1.12	2.53	3.65
Buildings	1.57	.81	2.38
Equipment	.55		.55
Loss by discarding		.42	.42
Miscellaneous	1.99	1.38	3.37
Total	$35.95	$26.11	$62.06

[1] U. S. Dept. Agr., Bulletin 49.

The quantities of feed used in growing heifers at the Ohio Experiment Station and estimated costs are given in Tables

FIG. 77. — The heifers for which the costs of production are here given in Table 30.

31 and 32. These heifers were fed a little more whole milk and were fed over twice as much grain as the ones mentioned above. The costs were therefore higher.[1]

The costs other than feed vary from $21 to $28 in the different results here quoted. The feed costs vary from $41 to $58. In the States east of Ohio feed is higher in price, so that this cost is likely to be more. In some irrigated regions where alfalfa hay is very cheap, the feed cost may be lower. Where skim-milk is not available the feed cost is somewhat higher, but need not be prohibitive, as is shown on pages 116 to 118.

[1] Ohio Agricultural Experiment Station, Bulletin 289.

Table 31. — Cost of Raising 29 Jersey Heifers at the Ohio Experiment Station.

Average weights; at birth 55 lb.; at one year 472 lb.; at 2 years 758 lb.

	Raising to 1 Year Old	Second Year	Total 2 Years
Quantities used			
Whole milk, lb.	469		469
Skim-milk, lb.	2918	87	3005
Grain, lb.	564	785	1349
Silage, lb.	444	2426	2870
Hay, lb.	767	1038	1805
Stover, lb	37	254	291
Days pasture	118	159	277
Costs			
Feed	$27.39	$27.12	$54.51
Other costs estimated	12.79	14.89	27.68
Total	$40.18	$42.01	$82.19

Table 32. — Cost of Raising 22 Holstein Heifers at the Ohio Experiment Station.

Average weights; at birth 82 lb.; at 1 year 571 lb.; at 2 years 962 lb.

	Raising to 1 Year Old	Second Year	Total 2 Years
Quantities used			
Whole milk, lb.	445		445
Skim-milk, lb.	2661	174	2835
Grain, lb.	647	870	1517
Silage, lb.	656	2247	2903
Hay, lb.	796	1419	2215
Stover, lb	11	232	243
Days pasture	121	151	272
Costs			
Feed	$28.57	$29.55	$58.12
Other costs estimated	12.79	14.89	27.68
Total	$41.36	$44.44	$85.80

Marketing Dairy Products

219. Ways of Marketing. The milk supply in many small towns and cities is retailed by dairymen who produce part or all of the milk that they sell. There are some opportunities for retailing milk in regions where dairying is not a general industry. Such regions are likely to have beef or dual-purpose cattle, and the farmers are not likely to know how to care for a dairy animal. One who has good cows and who knows how to care for them often has a good opportunity in such a town. Every town that is near to farm land offers an opportunity for some retail dairyman. Sometimes there are too many in the business so that the business will not pay for the time spent, but retailing frequently offers a good chance for an energetic man.

Many farmers make butter to retail in a near-by town or to be shipped by parcel post. The prices received are sometimes enough to make this a good method of selling.

The great majority of dairymen have to sell on a general market at prices fixed by the purchaser. Sometimes the conditions are such that the selling part of the business calls for little thought, but often there are some points to study. Coöperation in hauling milk is often a great saving of time.

If the price of milk varies with the fat content, the farmer should be able to estimate which is the best kind of milk to produce. If he has more than one market, he should be able to make similar estimates. In regions where market milk sells for so much that one cannot afford to sell the product in any other way, one often sees farmers who persist in selling butter-fat or butter long after this has ceased to be the best practice.

220. Value of Skim-milk in Cities. When milk is sold to the creamery, the fat basis is, of course, the proper basis of payment. Argument is often made that payment for market milk should be on the same basis. The public is often accused of ignorance because it refuses to pay for milk in proportion to the fat contained.

For human food, protein is probably the most important constituent of milk. How much the cities are willing to pay for skim-milk is shown by the high price that they are willing to pay for milk when they could get the same butter-fat in cream at much less cost. If the other constituents were in proportion to the fat, then the percentage of fat would be in proportion to the value as human food, but the richness in protein does not increase so rapidly as the fat.

Common retail prices in New York City are 9 cents for milk, 40 cents per quart for 23 per cent cream, and 38 cents per pound for butter.[1] On the average, milk contains about 3.7 per cent fat. At these prices the butter-fat costs about $1.13 per pound in milk, 82 cents in cream, and 44 cents in butter.

Evidently, milk is not purchased merely for its butter-fat, else butter-fat in cream would sell at the same price that it does in milk. The value that the public places on fat, as measured by the price of cream, shows that about 27 per cent of the amount paid for milk is paid for food that is contained in the skim-milk. Stated in another way, if the value of the fat is measured by the price of cream, then the fat in a quart of milk is worth 6.5 cents, and the skim-milk sells for 2.5 cents. Or, if the fat in milk is considered to have the same

[1] Prices furnished by the Borden Company and verified from several other sources.

value as the fat in butter, then the fat in a quart of milk is worth 3.5 cents, and the skim-milk sells for 5.5 cents.

QUESTIONS AND PROBLEMS

1. For each of the regions given in Tables 28 and 29 find the feed cost and all other costs and the per cent that the feed cost is of the total cost. Compare the feed costs in the different regions.

2. At the prices of feeds in this region, find the approximate value of the feed required to feed a cow, as given in Table 28.

3. What per cent is the feed of the total cost of raising heifers, as given in Table 30.

4. At prices of feed and milk in this region, find the approximate value of the feed used to raise a heifer, as given in Table 30.

5. Using the weights given on page 298, how many pounds are there in one gallon of milk? In one gallon of 35 per cent cream? How many quarts in 100 pounds of milk? In 100 pounds of 20 per cent cream?

6. In what proportion should milk testing 3.2 per cent fat and milk testing 4.5 per cent fat be mixed to make milk testing 4 per cent?

7. Using figures from page 298, how much dry matter is there in 40 quarts of skim-milk? In 100 pounds?

8. Some animal food is necessary for good success with hens. Meat scrap is often purchased for this purpose at about $3 per hundred pounds. It is also fed to hogs. It contains about 90 per cent dry matter, but the dry matter is not so valuable as that in skim-milk. If the dry matter in skim-milk is worth the same as that in meat scrap, what would 100 pounds of skim-milk be worth? What would it be worth per quart?

9. A farmer is offered 30 cents a pound for butter-fat, or $1.30 per hundred for whole milk. His average test is 3.8 per cent. Which is the higher price? Would the skim-milk be worth the difference as feed for hogs or poultry?

10. What would be received for 100 pounds of 4 per cent milk when sold at each of the following prices:

   a. 3 cents per quart?
   b. $1.50 per 100 pounds?
   c. 35 cents per pound for butter-fat?
   d. 30 cents per pound for butter?

Considering the value of skim-milk and the labor of making butter, which would be the best way to sell?

11. The prices paid for milk by the Borden Company from April, 1915, to March, 1916, were as follows, in the region where the freight to New York is 26 cents per 40-quart can.

Butter-fat	3.0	3.5	4.0	4.5	5.0
April	1.31	1.46	1.61	1.76	1.91
May	1.06	1.21	1.36	1.51	1.66
June	1.00	1.15	1.30	1.45	1.60
July	1.16	1.31	1.46	1.61	1.76
August	1.32	1.47	1.62	1.77	1.92
September	1.41	1.56	1.71	1.86	2.01
October	1.70	1.85	2.00	2.15	2.30
November	1.80	1.95	2.10	2.25	2.40
December	1.80	1.95	2.10	2.25	2.40
January	1.70	1.85	2.00	2.15	2.30
February	1.65	1.80	1.95	2.10	2.25
March	1.60	1.75	1.90	2.05	2.20

The above prices will be paid to dairymen where they maintain, during this contract, conditions scoring not less than 25 per cent on equipment and 43 per cent on methods, according to the New York Department of Health Score Card, as scored by the Company's representatives. Dairymen scoring less than 25 per cent on equipment and 43 per cent on methods, will receive ten cents per 100 pounds less than the above schedule. Milk of intermediate composition was paid for at corresponding prices.

Calculate the average price for the year for milk with each per cent of fat.

What is the average price for fat in 3 per cent milk? What is paid per pound for the additional fat in 4 per cent milk? In 5 per cent milk? What is the price for the additional fat above 3 per cent in all cases?

12. If skim-milk is worth as much as found in problem 8, at what price would butter have to be sold to bring as much as the average price paid by the Borden Company for 3 per cent milk? For 5 per cent milk?

13. Using the average production given on page 42, what would be the value of the milk for one year for a cow of each breed?

14. Find the average price paid at retail in a near-by city for butter, cream with known fat content, and milk. What price is paid for fat in each form?

COLLATERAL READING

Farm Management, G. F. Warren, pp. 440–493.
U. S. Dept. Agr., Bulletin 49.

CHAPTER 13

OTHER IMPORTANT FACTORS FOR SUCCESS IN DAIRY FARMING

G. F. Warren

Ways of Measuring Profits

221. The Most Important Factors for Success. In a dairy region the most important factors have been shown to be the size of the business, the returns per cow, the crop yields, and the diversity of the business.[1] Many other factors have to do with financial success, but on careful examination it will be found that most of them are covered by the above. For instance, nothing is said about the effective use of labor, but the most important single factor controlling such use is the size of the business. The following are some of the many other factors that cause minor variations in profit on many farms and that sometimes become the most important factors. Too much or too little capital may be invested in buildings or stock. Too many or too few men or horses may be kept. The region or farm may not be adapted to dairying. The wrong kind of product for the region may be sold. The barns and fields may be so arranged as to aid in the work, or they may cause a loss of time. Other things being equal, large cows pay better than small ones.

222. Ways of Measuring Profit. Two things are at work on a farm — money and men. To be called a financial suc-

[1] Cornell University Agricultural Experiment Station, Bulletin 349.

cess any business should pay a reasonable rate of interest on the capital invested and, in addition, pay fair wages for the labor used. The best way to measure profits on a farm is first to find the difference between the receipts and the business expenses for a year, including in expenses all labor except the owner's. This difference represents the pay for the use of the capital and for the owner's time. The interest on the money invested in the business calculated at 5 per cent, or at the current rate of interest, should be subtracted from the income from capital and owner's labor to get the amount left to pay for his time. This is called his labor income. The following averages from 73 farms in Illinois show the method of figuring:[1]

Average capital	$51,091
Average receipts	5,042
Average farm expenses	1,866
Income from capital and owner's labor	3,176
Interest on capital at 5 per cent . .	2,555
Owner's labor income	621

Size of Business

223. Size of Business. In order to be most economically managed, a dairy farm should be large enough to provide full use for a reasonable equipment of modern machinery. This does not mean that it should be one of the great costly and money-losing establishments that are often maintained by wealthy men. But it does mean that a farm is working at a disadvantage if it is not large enough to provide work for two or three persons. Just how many acres this will require depends on the richness of the land and on what is done with the milk. A small area of land that will naturally grow two tons of hay and fifty bushels of corn per acre will represent

[1] U. S. Dept. Agr., Bulletin 41, p. 9.

as large a business as many more acres of poor soil. If milk is sold at retail, a smaller area and smaller number of cows may represent an equally large business. But even when milk is sold at retail, it is very desirable to have 15 to 30 cows.

How important a reasonable area of land is to a dairy farmer is shown by the results from 1988 farms in New York as given in Table 33.

TABLE 33. — RELATION OF SIZE OF FARM TO LABOR INCOME. 1988 FARMS, TOMPKINS, LIVINGSTON, AND JEFFERSON COUNTIES, NEW YORK

ACRES	NUMBER OF FARMS	AVERAGE NUMBER OF ACRES PER FARM	AVERAGE ACRES OF CROPS	AVERAGE LABOR INCOME
30 or less	74	22	14	$121
31– 50	141	44	25	252
51–100	616	79	40	402
101–150	572	126	66	568
151–200	304	177	89	776
Over 200	281	281	134	995

These farms are fairly typical of many of the dairy farms from Dakota to New England. About half the farm is devoted to hay, corn, small grain, and other farm crops. The other half is pasture, or woods and waste land. The farms of less than 100 acres are on the average not paying the owner more than interest and hired man's wages. There are of course some small farms that pay well, but, as a rule, the larger farms pay better. Similar results have been obtained in many other states.

224. Relation of Size of Farm to Efficiency in the Use of Labor. In every region where such studies have been made the small farms accomplish much less per man than do the fair-sized farms. Table 34 gives results for one county. The average number of men per farm as given in the table includes all human labor. Work of women and children is expressed in terms of the number of men that would have been required to do the same work. On the smallest farms, very little work was done by any one except the operator. On the farms of over 200 acres, the hired labor and labor by members of the family amounted to the time of one and one-third men, or, counting the time of the farmer, these farms had the equivalent of 2.35 men.

The farms of less than 30 acres had an average of 3.5 animal units per farm besides work horses. Those of over 200 acres had an average of 34.2 animal units besides work horses.

The producing enterprises on most farms are the acres of crops grown and the animals other than horses.

TABLE 34. — RELATION OF SIZE OF FARM TO EFFICIENCY IN THE USE OF LABOR. 670 FARMS, JEFFERSON COUNTY, NEW YORK

ACRES	AVERAGE MAN EQUIVALENT	AVERAGE ACRES OF CROPS	AVERAGE NUMBER OF ANIMAL UNITS EXCEPT WORK HORSES	ACRES OF CROPS PER MAN	ANIMAL UNITS EXCEPT HORSES PER MAN
30 or less . . .	1.04	14	3.5	13	3
31–50 . . .	1.18	25	7.9	21	7
51–100 . . .	1.34	40	13.2	30	10
101–150 . . .	1.61	66	19.4	41	12
151–200 . . .	1.98	89	25.1	45	13
Over 200 . . .	2.35	134	34.2	57	15

The acres of crops grown, the yields of these crops, the number of producing animals, and the production of these animals are a measure of the amount that is being accomplished on a farm. The crop yields and the production of animals are no better on the small farms than on the large farms, hence the acres of crops and the animals kept are a fairly accurate measure of the amount accomplished. The acres of crops raised per man varied from 13 on the small farms to 57 on the largest farms. The number of animal units per man varied from 3 on the small farms to 15 on the largest farms (Table 34).

225. Relation of Size of Farm to Work Done. From cost accounts and other records, we know approximately how much time it takes to do each kind of farm work under normal conditions. The raising of a wheat crop ordinarily takes 15 to 25 hours of man labor and 20 to 40 hours of horse labor per acre. With anything like efficient methods of work, 20 hours of man labor and 30 hours of horse labor per acre is sufficient. Many farmers do better than this. We may therefore say that a wheat crop represents two days of man work and three days of horse work. If much more time than this is spent, the work is not efficiently done. This may be because the fields are too small, because of poor machinery, because the land is unusually hard to work, or for other reasons. It matters not why time is lost. If it is lost, the farm is not efficient.

Similarly the average farmer spends about 150 hours of work per year on a cow. If the barn or pasture is unhandy, or if he has only a half-dozen cows, more time may be required. Some farmers who get good returns spend less time. To care for a cow for a year may be counted as about 15 days' work (see Table 35).

In order to compare farms, all the productive enterprises are similarly expressed in work units. The income of the farm is dependent on the crops raised, the cows and other productive animals kept, the outside work done for pay.

TABLE 35. — UNITS OF PRODUCTIVE WORK

	MAN WORK UNITS	HORSE WORK UNITS
Timothy, alfalfa, clover, per acre per cutting	1	1
Oats, wheat, barley, rye, buckwheat, per acre	2	3
Corn husked from standing stalks, per acre	3	5
Corn husked from shock, per acre	6	6
Corn for silo, per acre	5	6
Field beans, per acre	4	5
Cotton, per acre	12	6
Tobacco, per acre	20	7
Potatoes, cabbage, beets, per acre	10	10
Peas for canning factory, per acre	3	5
Hops, per acre	20	8
Apples, peaches, pears, bearing per acre	15	5
Dairy cow	15	2
10 cattle or colts running loose	20	1
10 brood sows, and raising pigs to weaning	30	5
50 hogs, not brood sows	25	5
100 ewes	50	3
100 hens	15	2
Raising 200 chickens	15	2

TABLE 36. — RELATION OF SIZE OF FARM TO EFFICIENCY IN THE USE OF MEN AND HORSES. 670 FARMS, JEFFERSON COUNTY, NEW YORK

ACRES	UNITS OF PRODUCTIVE WORK PER MAN	UNITS OF PRODUCTIVE WORK PER HORSE
30 or less	102	35
31–50	154	41
51–100	205	57
101–150	245	62
151–200	253	65
Over 200	294	76

Much other work may be done, such as repairing machinery and buildings, taking care of work horses, mowing the lawn, and the like, but it is the productive work that limits the income.

On farms in Jefferson County, New York, the average amount of productive work per man varied from 102 work units on the small farms to 294 on the largest farms. Each man on the largest farms is accomplishing nearly three times as much work as a man on the small farms. It must be remembered also that the crop yields and the returns per cow are as good on the larger farms. Each horse on the large farms is accomplishing twice as much as each horse on the small farms. The farms of less than 100 acres are very wasteful of both man and horse labor.

TABLE 37. — RELATION OF SIZE OF FARM TO EFFICIENCY IN THE USE OF HORSES. 1248 FARMS, JEFFERSON AND LIVINGSTON COUNTIES, NEW YORK

ACRES	NUMBER OF FARMS	ACRES OF CROPS	NUMBER OF HORSES	ACRES OF CROPS PER HORSE
30 or less	42	14.2	1.5	9.5
31– 50	64	28.4	2.3	12.3
51–100	315	46.8	3.1	15.1
101–150	364	73.5	4.2	17.5
151–200	226	98.7	5.0	19.7
Over 200	237	152.8	7.2	21.2

226. Relation of Size of Farm to Efficiency in the Use of Horses. The discussion given above is the best way of comparing horse labor. Another comparison is shown in Table 37. On the large farms, twice as many acres of crops are raised per horse as on the small farms. The average cost of keeping a horse, as shown by cost accounts, is about $100 to

$175 a year in different parts of the United States. This includes feed, labor, depreciation, and all other costs. From this the importance of the efficient use of horses is apparent.

227. Relation of Size of Farm to Efficiency in the Use of Machinery. The small farms are very inadequately equipped with machinery, as is shown in Table 38. Even the

TABLE 38. — RELATION OF SIZE OF FARM TO EFFICIENCY IN THE USE OF MACHINERY. 1248 FARMS, LIVINGSTON AND JEFFERSON COUNTIES, NEW YORK

ACRES	ACRES OF CROPS	VALUE OF MACHINERY	VALUE OF MACHINERY PER ACRE OF CROPS
30 or less	14.2	$141	$9.93
31– 50	28.4	207	7.29
51–100	46.8	426	9.10
101–150	73.5	497	6.76
151–200	98.7	613	6.21
Over 200	152.8	833	5.45

farms of over 200 acres have an investment in machinery of only $833. This represents machinery of all ages. Probably the cost when new would be over twice as much, but even this sum will not provide all the well-established machines, such as a grain-binder and manure-spreader for each farm. But, while the small farms are not well equipped, their machinery cost per acre of crops is almost double that on the larger farms.

228. Relation of Size of Farm to Efficiency in the Use of Capital. The small farm has relatively much more of its capital invested in unproductive ways than does the large farm. No matter how small the farm may be, the owner desires a respectable house. Table 39 shows that the smallest farms have 43 per cent of their capital in houses; the largest farms have somewhat better houses, but have only 9 per cent of their capital thus invested.

TABLE 39. — AREA RELATED TO INVESTMENT IN BUILDINGS. 578 FARMS, LIVINGSTON COUNTY, NEW YORK

Acres	Value of Houses	Per Cent of Total Capital in Houses	Value of Other Buildings	Per Cent of Total Capital in Other Buildings	Value of Other Buildings per Animal Unit
30 or less . . .	$1494	43	$ 655	19	$164
31– 50 . . .	1000	23	681	15	95
51–100 . . .	1236	18	1091	16	87
101–150 . . .	1477	14	1408	13	74
151–200 . . .	1810	13	1900	13	73
Over 200 . . .	2113	9	2552	11	50

The barns on the small farms also take a much larger proportion of the capital. The smallest farms have 19 per cent of their capital thus invested, the largest farms have only 11 per cent thus tied up. A barn for ten head of stock costs much more than half as much as an equally good barn for twenty head of stock. The smallest farms have an investment in barns of $164 per animal unit. The largest farms have only $50 per animal unit. Yet observations lead to the conclusion that the stock on the larger places is better housed. If interest, repairs, depreciation, and insurance on a building amount to 8 per cent of the value, then the housing cost per animal unit will vary from $13 per year on the smallest farms to $4 per year on the largest.

Similar results for the United States are shown in Table 40. These indicate, as for other points in this work, that the results are of general rather than local application. The farms of less than 20 acres have 36 per cent of their capital invested in buildings and machinery. Those of 100 to 174 acres have only 17 per cent of the money thus invested, yet they have much better buildings and more machinery. Money thus employed not only is unproductive, but it is a source of constant cost for repairs. If a farmer had all his money invested in buildings and machinery, his income would, of course, be zero. In fact, he would not be a farmer at all.

TABLE 40. — AREA RELATED TO INVESTMENT IN BUILDINGS AND MACHINERY, FOR UNITED STATES, 1909, FROM THE CENSUS REPORT

ACRES	VALUE OF BUILDINGS PER FARM	PER CENT OF CAPITAL IN BUILDINGS	VALUE OF MACHINERY	PER CENT OF CAPITAL IN MACHINERY
Under 20	$ 605	34	$ 56	2.5
20– 49	474	21	76	2.8
50– 99	848	19	156	3.1
100–174	1182	14	241	2.7
175–499	1734	10	390	2.4
500–999	2174	8	639	2.4
1000 or over	3330	5	1196	1.0

229. Size of the Herd. In regions where very little except dairy products is sold, the number of cows kept is the best measure of the size of the business. Table 41 gives results from such a region in Jefferson County, New York, and shows that farmers who have herds of 20 or more cows are doing very much better than those who have smaller herds. In fact, the size of the herd is as important as the quality of the cows. The usual advice to sell the poorest cows and keep only the best ones should be changed to the more practical advice to replace the poorest cows by good ones, rather than leave half of the barn empty. A cow that is much too poor to keep may yet pay as well as an empty stanchion. Of course, if the farm has too many cows for its area, it will pay to sell the poorest ones and decrease the number. In regions like Jefferson County that are well adapted to dairying and not adapted to many other things, herds of 20 to 30 cows when kept on farms that are large enough for the herd, are usually more profitable than small herds. Of course the number of cows should not be increased out of proportion to the farm. On the other hand extremely large herds are a disadvantage because the farm family is ordinarily not able to do the work and too much labor must be hired.

Table 41. — Relation of Number of Cows and Milk Sold per Cow to Labor Income. 585 Farms, Jefferson County, New York

Milk Sold per Cow	Number of Cows		
	6–10	11–20	Over 20
	Labor Income	*Labor Income*	*Labor Income*
Less than $50	$632	$ 481	$1046
$51–75	447	704	1093
76–100	599	836	1249
Over 100	760	1054	1959

230. Summary of Size of Dairy Farms. Unless a dairy farm keeps four or five horses, it cannot take advantage of the great economy in human labor that comes from the use of four-horse machinery. But each horse ought to raise 20 to 30 acres of crops so that this calls for 80 or more acres of crops. If 25 cows and young stock are kept, there will usually need to be 60 to 100 acres of pasture. This calls for 140 to 200 acres of land, a very common size in most of the dairy regions of the United States. The average size of farms among subscribers to *Hoard's Dairyman* was reported to be 167 acres. In some of the rich irrigated valleys the pastures and alfalfa are so productive that a considerably smaller area provides an equally large business. In some very fertile regions like Lancaster County, Pennsylvania, where very intensive crops are combined with dairying, a farm of 60 to 80 acres represents as large a business as two or three times this area in some regions.

Not every dairyman has money enough to buy a farm of the best size, but there are other ways of obtaining land. The usual steps in becoming a farm owner are: first, to work as a hired man; then to become a tenant; then own a mortgaged farm; and finally pay off the mortgage. Only 36 per cent of the farmers in the United States own free from mortgage all the land that they operate. If one who has too small a farm knows how to farm and how to live economically, he will often find it profitable to go in debt to buy more land. A mortgage is not necessarily a bad thing. The important point to consider is the use to which the borrowed money is put. It may not be wise to mortgage a farm for the purpose of buying an automobile, but it may be good business to mortgage it to buy additional cows or land that is needed. Another way of enlarging the farm is to rent additional land. There are half a million farmers in the United States who own part of the land that they operate, and who rent additional land.

Returns per Cow

231. Reasons for Poor Returns. No single factor is more important than the returns per cow (see Table 41). Low returns may be due to not having a good market for dairy products, or may be due to selling the wrong kind of product; for instance, making butter in a region where there is a good demand for market milk at much better prices. Low returns may be due to keeping the wrong kind of cattle for the region or for the kind of product sold, or to poor production because of poor care or feed, or to having cows that are naturally not good ones. Before one can intelligently change his practice, he must find out to which of these causes his poor returns are due. The preceding chapters have given attention to feeding and to determining which are the cows that are naturally poor, so that nothing more need be said on these most vital points.

Even in regions unfavorable for dairying there are usually some persons who make more money by combining dairying with their other farm work than they would make if they did not keep cows. Everywhere there must be cows enough to supply the fresh milk even if butter is shipped in. But in some regions the prices of products are low compared with feed prices and other costs. In such regions, a farmer who is only a fair dairyman may find that it pays best to keep only a few cows or possibly to keep only enough to supply products for home use.

In some regions milk is sold by the quart at the same price regardless of the percentage of butter-fat. In such a region, herds that give a high test are at so great a disadvantage that they cannot often be made to pay.

Those who keep pure-bred cattle sometimes fail to make a profit because they select a breed that is not desired in the region. The best market for the surplus stock of the small breeder is nearly always in his neighborhood. He should raise the kind that is wanted.

232. Costs and Returns must Both be Considered. No set standard can be given for the receipts that are necessary in order to make a profit, because the costs of feed and labor are so variable in different regions and on different farms in the same region. But many studies of this question have indicated that it is a fairly easy matter to obtain receipts per cow of a half more than the average for the region. Usually the most profitable farms in a region are doing as well as this. But increased costs must also be considered. It is not the return per cow, nor the cost, that is of most importance, but the relation between the two. Sometimes the better returns are obtained at too great cost. On the other hand, a dairy herd that produces less than the average sometimes pays, because the farmer has reduced the cost of feed and labor to a still lower point.

233. For Good Returns the Poor Producers should be Promptly Sold. In one county in New York the farmers who obtained the best production per cow were doing the most buying and selling of cows. Those who obtained poor to fair returns were on the average replacing 1 cow in 23 by purchase, but those who obtained the best returns replaced one-seventh of the herd each year by purchase.

Those who got the lowest production per cow replaced one-seventh of the herd each year by cows purchased or raised. Those who obtained good production replaced one-fifth, and those who got the best production replaced one-fourth each year. They disposed of poor cows and milked good cows whether they were home-raised or purchased. The essential point is not who raised the cow, but how much her milk is worth.

234. Size of Cows. As machines for changing feed into milk, large cows and small cows seem to be about equally effective. But the milk produced for a given amount of barn room and labor is also important. Of two animals that are equally efficient users of food, the larger animal is usually much more profitable. Table 42 gives the value of the milk and value of the feed for 355 cows in Wisconsin.

TABLE 42. — RELATION OF SIZE OF COWS TO VALUE OF PRODUCT ABOVE FOOD COST[1]

WEIGHT OF COWS	AVERAGE WEIGHT	NUMBER OF COWS	POUNDS OF BUTTER-FAT	VALUE OF PRODUCT	VALUE OF FEED	VALUE OF PRODUCT FOR $1 IN FEED	VALUE OF PRODUCT ABOVE FOOD COST
900 and under	847	87	366.2	$114.52	$60.32	$1.90	$54.20
901–1000	952	82	417.8	131.22	69.86	1.88	61.36
1001–1100	1071	53	447.8	142.56	76.28	1.87	66.28
1101–1200	1175	60	477.7	155.02	82.81	1.87	72.21
1201–1300	1276	31	506.2	163.52	91.51	1.79	72.01
1301–1400	1379	26	525.8	171.79	92.15	1.86	79.64
Over 1400	1556	16	566.6	184.61	96.60	1.91	88.01

It takes very little more barn room and very little more labor to care for large cows than it does for small ones. Medicine, veterinary fees, and many other expenses cost about the same for large as for small cows. These costs were found to be $25 per year in Minnesota, and $29 in New York (page 247).

According to the figures in Table 42 a herd of 15 cows averaging 1276 pounds in weight would make more butter than 20 cows averaging 847 pounds. The saving on labor, barn room, and other fixed costs, would be about $125 per year

[1] Data furnished by F. W. Woll, for cows whose records are reported in Wisconsin, Bulletin 226.

by keeping the smaller number of large cows. Where the land is level, and particularly if hay or other roughage is abundant, large cows are usually more profitable. Even if small ones are introduced the farmers usually change to large ones in time. Where the pastures are on steep, rocky hillsides small cows are better able to hold their place. If pastures are very poor, the large cow is at a disadvantage. She needs more feed, but she is not able to walk so far as the small one. In the South where heat and insects are both serious enemies of the dairy business, nearly all of the cows kept are of the small active breeds.

Records of 110 cows kept by the University of Nebraska showed that cows averaging 801 pounds in weight gave an average of 263 pounds of butter-fat, those weighing 1002 pounds gave 278 pounds of fat, and those averaging 1211 pounds produced 346 pounds of butter-fat. The production was in proportion to the size.[1]

Of course the vital point is production per cow. If one is buying a cow with a known record, it is the record that should be considered. A large cow that is a failure is a bigger failure than a small one that is a failure. The best success comes from keeping large cows that are also good for their size.

When large numbers are considered, the production and feed consumption seem to be about in proportion to the size. The advantage of having large animals is in the saving of barn room and labor, just as there is an advantage in using a six-foot mower rather than a four-foot one.

[1] Records of cows reported in Nebraska Agricultural Experiment Station Bulletin 139. Cows sorted by average weights for the years reported, into three groups, 900 pounds or less, 901–1100 pounds, and over 1100 pounds.

Crop Yields

The returns from crops and costs of these crops have as much to do with the success of the farm as a whole as do the returns from the cows. It is not enough that the farmer be a good dairyman, he should be a good dairy farmer. Sometimes the farmer raises crops that are good for feed but cost too much to raise. More frequently the yields are not good enough to be profitable.

235. Soils for the Dairy Farm. Only under exceptional conditions does it pay to choose land that is not naturally productive. The farmer ordinarily raises all the hay and part of the grain for the cows. If he buys grain, he ought to have for sale some product other than milk that will more than pay the feed bill. It is usually difficult for a farmer who has poor land to succeed in competition with those who have good land. Occasionally, but not usually, the poor land is enough cheaper to make up for the difference in quality.

The best dairy soils are loams and clay loams that grow grass well. The great dairy sections of the North are on soils that grow Kentucky blue-grass and white clover for pasture, clover or alfalfa hay, and corn. Dairy farms do not as a rule buy much chemical fertilizer. The farmers who get better crops than their neighbors are as a rule receiving greater profits than the average, but as in the case of good returns per cow, the returns are sometimes obtained by methods that are too costly. Sometimes poor crops are grown by such economical methods that they pay well. Many successful farmers have crops a fifth better than their neighbors grow.

236. The Well-balanced Farm. If a good-sized business, good cows, and good crops are three of the most important factors for success, then a farmer who excels in all three ought to do very well indeed. With rare exceptions this is the case. Table 43 gives the labor incomes on 585 farms.

TABLE 43. — RELATION OF SIZE OF FARM, RECEIPTS PER COW, AND CROP YIELDS, TO LABOR INCOME ON 585 FARMS WITH SIX OR MORE COWS, JEFFERSON COUNTY, NEW YORK

	Acres		
	100 or less	101–150	Over 150
	Labor Income	*Labor Income*	*Labor Income*
Receipts per cow $50 or less			
Crop index 85 per cent or less	$308	$ 273	$ 331
Crop index 86–115 per cent	381	482	424
Crop index over 115 per cent	158	415	413
Receipts per cow $51–$75			
Crop index 85 per cent or less	304	590	669
Crop index 86–115 per cent	437	653	1017
Crop index over 115 per cent	537	636	1161
Receipts per cow over $75			
Crop index 85 per cent or less	594	935	1233
Crop index 86–115 per cent	641	1038	1148
Crop index over 115 per cent	659	1124	1291

They are grouped as small, medium, and good-sized farms; small, medium, and good returns per cow; and small, medium, and good crop yields; so that there are 27 different combinations (crop index compares the crops with average crops as 100 per cent). A study of this table indicates that if the crops are wasted by being fed to cows that give very poor returns, the final result is poor, even with a good-sized farm and good crops. Medium cows and medium crops with a good-sized farm pay very much better than the best cows and crops on a small farm. Improvement in any one of the three points helps, but well-balanced improvement in all is best. A fourth important factor for success in dairy farming is the diversity of the business. It usually pays better to have cash crops or other products combined with the dairy.

Diversified and Specialized Dairy Farms

237. Relation of Cash Crops to Profits. As has previously been mentioned (page 229), farmers who combine cash crops or some other product with dairying, usually make more than do those who sell nothing but dairy products. The poorer the cows, or the lower the price of dairy products, the more important it is that crops be sold. But even with extra good returns per cow, those who sell some crops are usually doing better than those who sell no crops, as is shown in Table 44. The results here given are for a typical region in New York. In the corn-belt the most generally profitable type of dairy farming is to raise corn for sale or for hog feed in addition to raising feed for the cows.

Table 44. — Relation of Receipts per Cow and Cash Crops to Profits on 585 Farms with Six or More Cows. Jefferson County, New York

Per Cent of Receipts from Crops	Receipts per Cow from Milk and its Products		
	$50 or less	$51–$75	Over $75
	Labor Income	*Labor Income*	*Labor Income*
No crops sold	$ 56	$ 571	$ 926
1–20 per cent	311	589	962
21–40	426	947	1183
41–60	554	1366	[1]
Over 60	599	[1]	[2]

[1] Only two farms in this group. [2] No farms in this group.

238. Relation of Capital to Amount of Stock Kept. The amount of capital must also be considered in determining how many cows to keep. Farmers who are short of capital usually keep less stock than do those who have more capital.

TABLE 45. — RELATION OF CAPITAL AND CASH CROPS TO PROFITS. 578 FARMS, LIVINGSTON COUNTY, NEW YORK

PER CENT OF RECEIPTS FROM CROPS	CAPITAL		
	$5000 or less	$5001–$15,000	Over $15,000
	Labor Income	*Labor Income*	*Labor Income*
20 or less	$253	$399	$1000
21–40	181	411	1399
41–70	256	624	1038
71–90	424	623	1194
Over 90	231	497	473

Table 45 shows that with small capital those who depend largely on cash crops make the most, while with larger capital those who derive more of their money from live-stock are doing best. The exact capital groups will vary with different land values, but the principle is universal, that one who is short of capital should keep less stock than one who has more money. This is as one would expect. Live-stock represents added capital after one has bought and equipped his farm. If one is short of money, the absolutely essential things are land, machinery, and horses. One may get along without live-stock, but one cannot farm without land and equipment. The majority of farmers understand this principle. When they get more money, they increase the amount and improve the quality of their live-stock.

For the young man with small capital it often pays to gradually work into pure-bred cattle. One can begin with a few moderate-priced pure-breds and, with a good bull, can gradually develop a good herd. Ordinary pure-breds can be improved just as grade cows can be improved. The advantage of the pure-breds is that after one has them improved, they are in greater demand for breeding purposes because they are recorded.

239. Acres per Animal Unit. Another way of comparing farms is on the basis of the number of acres of crops grown per animal unit kept. Results for one dairy region in New York are given in Table 46. The amount of stock that it pays to keep, of course, depends on the returns that one gets from it. With very poor returns, very little stock should be kept. The better the returns, the more heavily the place should be stocked. With good stock in the region here mentioned, it pays best to have an animal unit other than horses for each 3 to 4 acres of crops. The exact amount that it pays to keep will of course vary with different regions and on different farms, but nearly always it is best to have the place moderately well stocked rather than go to either extreme.

TABLE 46. — RELATION OF ACRES OF CROPS PER ANIMAL AND RECEIPTS PER ANIMAL UNIT TO LABOR INCOME. 670 FARMS, JEFFERSON COUNTY, NEW YORK

ACRES OF CROPS PER ANIMAL UNIT	RECEIPTS FOR EACH ANIMAL UNIT EXCEPT HORSES		
	$50 or less	$51–$75	Over $75
	Labor Income	*Labor Income*	*Labor Income*
1.0–2.0	$210	$649	$ 895
2.1–3.0	264	680	971
3.1–4.0	314	763	1053
Over 4.0	378	824	914

240. Reasons for Larger Profits on Diversified Farms. There are many reasons why it does not pay to go to the extreme either way. Ordinarily a man can raise feed for more cows than he can milk. If each man milks 10 to 15

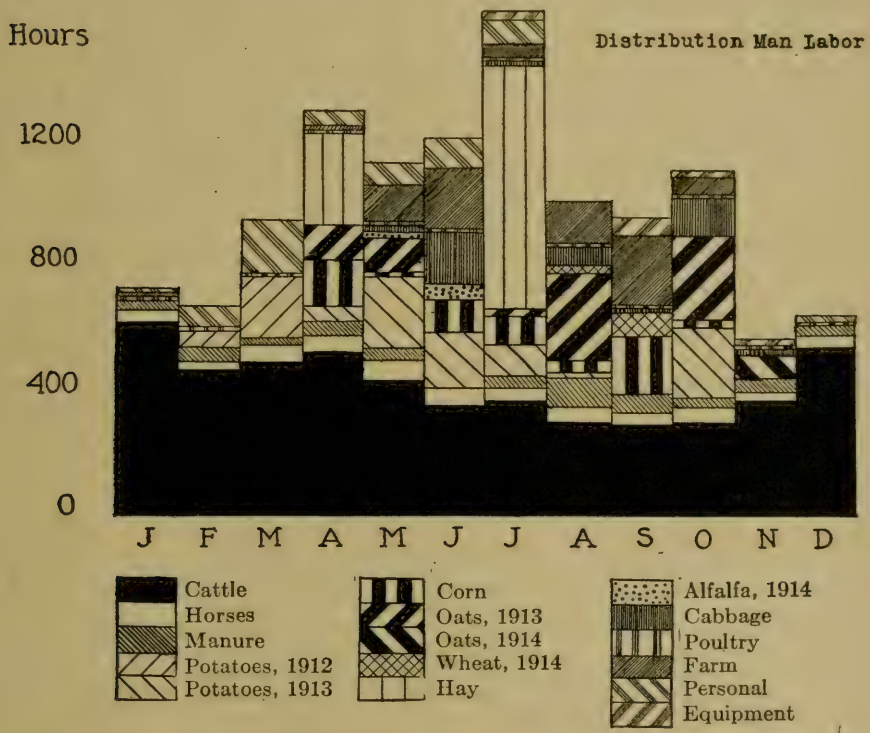

FIG. 78. — Distribution of man labor on a highly successful diversified dairy farm, that kept 42 cows, 1 bull, 10 heifers, and 9 horses. The crops raised were potatoes 11 acres, corn for silo 19 acres, oats 44 acres, hay 102 acres, and cabbage 7 acres, besides starting crops for the next year. The cabbages, potatoes, and some of the hay were sold for more than enough to pay the entire feed and labor bills.

cows, he can raise the hay and silage for these cows and part of the grain, and in addition will have time to raise hay, grain, potatoes, cabbage, or other crops for sale. If the cows are so poor, or prices of the product so low, that the cows do not pay a good price for their feed, it is of vital importance that cash crops be raised. Even if the cows are highly profitable, it may still pay to raise crops for sale, because these crops can be raised at very little additional cost. It might be suggested that more cows be kept to eat the additional crops, but this calls for more men, who in turn can raise additional crops.

In regions where cash crops are not raised, the women usually help with the milking because the farmer can raise feed for more cows than he can milk, and it does not pay to keep a hired man unless there is full work for him. Women can milk and do housework between milkings. If the region is well adapted to crops, it pays better to employ men and have them do farm work between milkings. Figure 78, page 279, shows the distribution of labor on a very successful diversified dairy farm. The owners of this farm have followed the same system for three generations and have always been successful.

If a farm is too heavily stocked, much feed will have to be purchased in a poor year or some of the stock must be sold. In such years feed is likely to be very high and stock cheap, so that whatever one does he is likely to lose.

If a farm is too heavily stocked, the returns per ton of manure used will be low. The value of manure depends on how heavily it is applied. A light application usually gives better returns per ton of manure than does a heavy application, as shown on page 235.

If one goes to the other extreme and keeps no animals or too few animals, he will not have a full year's work. Animals help to provide winter work, they provide work night and morning when the days are too short to allow a full day of field work. Notice how little winter work there would be for the farm shown in figure 78 if there were no cows and no manure hauling.

Most farms have a considerable amount of low-grade hay, mixed hay, and other products that do not have much market value or that are too bulky to pay to sell. At least enough stock should be kept to make use of these low-grade products. On many farms there is some land that will not pay for farming, but that will bring some income as pasture. Farmers who find cash crops very profitable often tend to keep too little live-stock.

The more money one has and the more profitable his animals are, the nearer he should come to exclusive stock farming, but it usually pays to sell at least one cash crop. In the corn-belt, corn marketed through the hog takes the place of a cash crop. When little money is available and when stock pays poorly, one should keep fewer animals, but it usually pays to produce at least one kind of animal or animal product. It is desirable that a farm have two to four important products for sale, and usually at least one should be an animal product, and at least one a cash crop.

Some Successful Dairy Farms

241. A Successful Dairy and Hog Farm in Iowa. One can learn much by a study of successful farms, provided he is sure that the farm he is studying is really successful. A farm is a financial success when it pays interest on the capital invested and pays good wages to the operator. Sometimes unimportant peculiarities of the farm are erroneously considered the cause of success. A systematic study of a number of farms will help to avoid this error. The record here given for an Iowa farm shows one of the best types of dairy farming for the corn-belt. (Data furnished by Professor H. B. Munger, Iowa State College.)

Capital Invested in the Farm Business

	April 1, 1913	April 1, 1914
160 acres land	$32,000	$32,000
Machinery and tools	715	764
18 cows, 4 heifers, 2 calves	2000	
1 bull	175	175
17 cows, 2 heifers, 11 calves		2440
8 horses, 2 colts	1340	
7 horses, 3 colts		1360
5 ewes	35	
18 brood sows, 26 other hogs and pigs	630	
19 brood sows, 40 other hogs and pigs		715
100 chickens	50	50
Feed and supplies	1079	1047
Cash to run farm	100	100
	$38,124	$38,651

Crops Grown 1913

Crop	Acres	Total Yield	Amount Sold	Amount Received
Corn	44	1990 bu.	150	$95
Corn for silo	11	128 tons		
Oats	28	1540 bu.	600	198
Hay	15	19 tons		

In addition, there were 45 acres of rotated pasture and 17 acres of farmstead roads and waste land. Corn is raised for two years, followed by oats in which grass is seeded. The hay is left down two years, part for hay and part for pasture.

Receipts	
3939 lb. butter-fat @ 33¢, skim-milk returned	$1300
12 cattle sold and 6 increase of inventory	755
Eggs	30
85 hogs sold and 15 increase of inventory	1645
Horses sold and increase of inventory	138
150 bushels corn	95
600 bushels oats	198
Outside labor	9
Machine work	30
	$4200

Farm Expenses

1 man 12 months	$ 344
1 man 1 month	40
Machinery and repairs cost above increase value	81
Grain feed	69
Horseshoeing	10
Breeding fees	20
Veterinary	20
Seeds	47
Twine	11
Threshing	31
Machine work hired	13
Fuel for farm use	5
Insurance	25
Taxes	110
Sheep sold for less than inventory value	7
Decrease in feed on hand	32
	$ 865

Summary

Receipts	$ 4200
Expenses	865
Income from capital and operator's labor	$ 3335
Interest on average capital $38,388 at 5%	1919
Labor income	$ 1416

Efficiency Factors

Size

Acres 160
Acres crops 98
Number cows $17\frac{1}{2}$
Number brood sows $18\frac{1}{2}$
Number men $2\frac{1}{12}$
Number work horses $7\frac{1}{2}$
Number of productive man work units 620
Number of productive horse work units 435

Production

Corn 45 bushels per acre
Oats 55 bushels per acre
Hay $1\frac{1}{4}$ tons per acre
Receipts per cow from butter-fat $74
Receipts per cattle unit $88
Pigs raised per sow 5.4

Diversity

Three main sources of income — milk, cattle, and hogs

Efficiency in use of labor
Crop acres per man 47
Crop acres per horse 13
Work units per man 298
Work units per horse 58

Fertility
Acres of crops, including rotated pasture per animal unit 3.6

The farm represents a good-sized business. It provides full work for two men (one besides the owner) and has enough crops to justify the use of four-horse teams and good machinery.

The crop yields are excellent. The returns per cow are very good for milk sold to a creamery. The $74 per cow represents a production of 225 pounds of butter-fat per cow in addition to new milk for home use and for calves. The number of pigs per sow is good.

The farm has three important products, — milk, cattle, and hogs. The corn raised for hog feed takes the place of the cash crops that are raised by the farm described on page 285. The farmer has for five years used a pure-bred bull and now has ten pure-bred cows, so that cattle are a third important source of income.

The acres of crops raised per man and work units per man are very good. The efficiency in the use of horses is only fair. It is possible that the farm might pay a little better if fewer horses were kept.

In short, the farm is a good-sized business, has good crops, good cows, good diversity, and uses man labor efficiently, and the place is carrying enough stock so that there is a good supply of manure.

The farmer had a common school education. He worked as a hired man five years, then as tenant five years, after which he bought this farm and has been operating it four years. The efficiency factors given above when compared with the averages for farms given in preceding tables, show how well the farm is managed.

242. A Successful Diversified Dairy Farm in New York. This farm is typical of the best general type of dairy farming for those portions of the Eastern States where intensive cash crops combine well with dairying.

Capital Invested in the Farm Business

	Beginning of Year	End of Year
211 acres of land	$14000	$14000
Machinery and tools	400	400
31 cows	2480	2480
2 calves	20	
3 calves		30
1 bull	45	80
5 horses	500	500
25 sheep, 38 lambs	365	
28 sheep, 43 lambs		411
75 chickens	50	50
Feed and supplies	350	350
Cash to run farm	200	200
	$18410	$18501

Crops Grown

Crop	Acres	Total Yield	Amount Sold	Amount Received
Corn for silo	10	120 tons		
Wheat	11	330 bu.	310 bu.	$264
Oats	26	1006 bu.		
Timothy and clover hay	55	83 tons	2 tons	25
Potatoes	12	2400 bu.	2025 bu.	1050
Apples	2	40000 lb.	36000 lb.	145
Cabbage	1			

In addition to the above there were 85 acres of permanent pasture and 9 acres of woods, farmstead, waste land, etc.

RECEIPTS

264,837 lb. milk	$3449
Calves sold and increase inventory	290
Sheep, lambs, and wool	204
Eggs	106
310 bu. wheat	264
2 tons hay	25
2025 bu. potatoes	1050
Apples	145
	$5533

FARM EXPENSES

Labor	$1100
Feed	511
Fertilizer	100
Seeds	53
Other expenses	260
	$2024

SUMMARY

Receipts	$5533
Expenses	2024
Income from capital and operator's labor	3509
Interest on average capital $18,455 @ 5%	923
Labor income	2586

EFFICIENCY FACTORS

Size

Acres 211
Acres of crops 117
Number of cows 31
Number of men $3\frac{2}{3}$
Number of work horses 5
Number units productive man work 835
Number units productive horse work 431

Production

Corn 12 tons
Potatoes 200 bu.
Oats 41 bu.
Wheat 30 bu.
Milk sold per cow 8543 lb.
Receipt per cow from milk $111
Receipt per cattle unit $112
Lambs raised per ewe 1.5
Receipts per ewe $8.16

Diversity

Two main sources of income — milk and potatoes — several other important things.

Efficiency in use of labor

Crop acres per man	32
Crop acres per horse	23
Work units per man	228
Work units per horse	86

Fertility

Acres of crops per animal unit	2.6
Fertilizers produced per acre of crops	$.85

Although this farm is a long distance from the preceding one, its success has been due to the same factors. The farm is a good-sized business, the cows and crops are good, the farm combines dairying with cash crops. The only difference is that the Iowa farm marketed its corn crop through hogs, while the New York farm raised a human food crop for direct sale. Instead of keeping hogs to eat up extra grain, the New York farm depends to a large extent on purchased grain. Each farm followed the best type of farming for its conditions. Because of the size and diversity of the business each man is accomplishing a large amount. The production per cow on this farm is unusually good. The farmer has been in the dairy business for many years and now has a herd of high grade and pure-bred Holsteins. The farmer began as a tenant and worked this farm many years on shares. Because of his good-sized diversified business, with good production, he was able to save money and buy the farm.

QUESTIONS AND PROBLEMS

1. What is the labor income for a farm on which the expenses amounted to $1028, the receipts $2524, and on which the capital was $20,247?

2. For a dairy farm in your region find the total area, area in each crop, number of each kind of animals, and number of men employed. Calculate the units of productive man and horse work. Calculate the area of crops and units of productive work per man and per horse. Compare with farms of the same area in Tables 33–40. If each student bases his report on a different farm, the results may be compared.

3. To how many animal units is the stock on the above farm equal? (See p. 218.) How many acres of crops per animal unit? About what proportion of the manure is produced in the barn. How many tons would this probably make per year if it is all saved? If the manure is well cared for, and if eight tons are applied per acre, how many years would it take to cover the entire farm?

4. What is the value of the barns on the above farm? How much is this per animal unit? Compare with Table 39.

5. Are conditions in your region naturally favorable for large or for small breeds of dairy cattle?

6. What things aside from dairy products are commonly sold from dairy farms in your region?

7. As an average for the beginning and end of the year, how many animal units are there on the farm described on page 281? How many on the farm on page 285?

8. Compare the farms on pages 242 and 244 as to size of business, crop yields, returns per cow, work units per man and horse, and in other ways.

9. Compare each of the above farms as to efficiency in the use of men and horses with farms of the same area in Table 36.

LABORATORY EXERCISES

36. Record of a Year's Business on a Farm. Arrange with some dairy farmer to allow the class to go to his farm and study his methods and obtain a record of his business for the past year, using Farmer's Bulletin 661 for taking the record. Later calculate the labor income and work, the efficiency factors, and compare with the farms described on pages 281 and 285. What are the strong points and what are the weak points of the farm?

Each student should make a similar record and study of the farm on which he lives.

COLLATERAL READING

A Method of Analyzing the Farm Business, U. S. Dept. Agr., Farmers' Bulletin 661.

Farm Management, G. F. Warren, pp. 535–565.

APPENDIX

ADDRESSES OF CATTLE BREEDERS' ASSOCIATIONS

American Aberdeen-Angus Breeders' Association, Charles Gray, Sec., Chicago, Ill.

Ayrshire Breeders' Association, C. M. Winslow, Sec., Brandon, Vt.

Brown Swiss Cattle Breeders' Association, Ira Inman, Sec., Beloit, Wis.

Dutch Belted Cattle Association of America, E. J. Kirby, Sec., Covert, Mich.

American Galloway Breeders' Association, R. W. Brown, Sec., Carrollton, Mo.

The American Guernsey Cattle Club, William H. Caldwell, Sec., Peterboro, N.H.

American Hereford Cattle Breeders' Association, R. J. Kinzer Sec., Kansas City, Mo.

The Holstein-Friesian Association of America, F. L. Houghton, Sec., Brattleboro, Vt.

The American Jersey Cattle Club, R. M. Gow, Sec., 324 West 23d St., New York City.

Red Polled Cattle Club of America, H. A. Martin, Sec., Gotham, Wis.

American Shorthorn Breeders' Association, F. W. Harding, Sec., Chicago, Ill.

The Polled Durham Breeders' Association, J. H. Martz, Sec., Greenville, O.

SCALE OF POINTS FOR JERSEY COW

Adopted by the American Jersey Cattle Club, 1913

Dairy Temperament and Constitution

Head, 7.	
A. Medium size, lean; face dished; broad between eyes; horns medium size, incurving	3
B. Eyes full and placid; ears medium size, fine, carried alert; muzzle broad, with wide open nostrils and muscular lips, jaw strong	4
Neck, 4.	
Thin, rather long, with clean throat, neatly joined to head and shoulders	4
Body, 37.	
A. Shoulders light, good distance through from point to point, but thin at withers; chest deep and full between and just back of fore legs	5
B. Ribs amply sprung and wide apart, giving wedge shape, with deep, large abdomen, firmly held up, with strong muscular development	10
C. Back straight and strong, with prominent spinal processes; loins broad and strong	5
D. Rump long to tail-setting, and level from hip bones to rump bones	6
E. Hip-bones high and wide apart	3
F. Thighs flat and wide apart, giving ample room for udder	3
G. Legs proportionate to size and of fine quality, well apart, with good feet, and not to weave or cross in walking	2
H. Hide loose and mellow	2
I. Tail thin, long, with good switch, not coarse at setting-on	1
Udder, 26.	
A. Large size, flexible, and not fleshy	6
B. Broad, level or spherical, not deeply cut between teats	4
C. Fore udder full and well rounded, running well forward of front teats	10
Carry forward	68

Brought forward	68
D. Rear udder well rounded, and well out and up behind	6
Teats, 8.	
Of good and uniform length and size, regularly placed	8
Milk-Veins, 4.	
Large, long, tortuous, and elastic, entering large and numerous orifices	4
Size, 4.	
Mature cows, 800 to 1000 pounds	4
General Appearance, 10.	
A symmetrical balancing of all the parts, and a proportioning of parts to each other, depending on size of animal, with the general appearance of a high-class animal, with capacity for food and productiveness at pail	10
	100

SCALE OF POINTS FOR AYRSHIRE COW

Adopted by Ayrshire Breeders' Association, 1906

Head, 10.	
Forehead — Broad and clearly defined	1
Horns — Wide set on and inclining upward	1
Face — Of medium length, slightly dished, clean-cut, showing veins	2
Muzzle — Broad and strong without coarseness, nostrils large	1
Jaws — Wide at the base and strong	1
Eyes — Full and bright with placid expression	3
Ears — Of medium size and fine, carried alert	1
Neck, 3.	
Fine throughout, throat clean, neatly joined to head and shoulders, of good length, moderately thin, nearly free from loose skin, elegant in bearing	3
Fore Quarters, 10.	
Shoulders — Light, good distance through from point to point, but sharp at withers, smoothly blending into body	2
Chest — Low, deep, and full between and back of fore-legs	6
Carry forward	21

Brought forward	21
Brisket — Light	1
Legs and Feet — Legs straight and short, well apart, shanks fine and smooth, joints firm; feet medium size, round, solid, and deep	1
Body, 13.	
Back — Strong and straight, chine lean, sharp, and open jointed	4
Loin — Broad, strong, and level	2
Ribs — Long, broad, wide apart, and well sprung . .	3
Abdomen — Capacious, deep, firmly held up with strong muscular development	3
Flank — Thin and arching	1
Hind Quarters, 11.	
Rump — Wide, level, and long from hooks to pin bones, a reasonable pelvic arch allowed	3
Hooks — Wide apart and not projecting above back nor unduly overlaid with fat	2
Pin Bones — High and wide apart	1
Thighs — Thin, long, and wide apart	2
Tail — Long, fine, set on a level with the back	1
Legs and Feet — Legs strong, short, straight when viewed from behind and set well apart; shanks fine and smooth, joints firm; feet medium size, round, solid, and deep	2
Udder, 22.	
Long, wide, deep, but not pendulous, nor fleshy; firmly attached to the body, extending well up behind and far forward; quarters even; sole nearly level and not indented between teats, udder veins well developed and plainly visible	22
Teats, 8.	
Evenly placed, distance apart from side to side equal to half the breadth of udder, from back to front equal to one-third the length; length $2\frac{1}{2}$ to $3\frac{1}{2}$ inches, thickness in keeping with length, hanging perpendicular, and not tapering	8
Mammary Veins, 5.	
Large, long, tortuous, branching, and entering large orifices	5
Carry forward	82

Brought forward	82
Escutcheon, 2.	
Distinctly defined, spreading over thighs and extending well upward	2
Color, 2.	
Red of any shade, brown, or these with white; mahogany and white, or white; each color distinctly defined. (Brindle markings allowed, but not desirable)	2
Covering, 6.	
Skin — Of medium thickness, mellow, and elastic . . .	3
Hair — Soft and fine	2
Secretions — Oily, of rich brown or yellow color . . .	1
Style, 4.	
Alert, vigorous, showing strong character, temperament inclined to nervousness, but still docile	4
Weight, 4.	
Weight at maturity not less than one thousand pounds	4
Total	100

SCALE OF POINTS FOR GUERNSEY COW

Adopted by Guernsey Cattle Club

Dairy Temperament Constitution, 38.	
Clean-cut, lean face; strong, sinewy jaw; wide muzzle with wide-open nostrils; full, bright eye with quiet and gentle expression; forehead long and broad. . .	5
Long, thin neck with strong juncture to head; clean throat. Backbone rising well between shoulder blades; large rugged spinal processes, indicating good development of the spinal cord	5
Pelvis arching and wide; rump long; wide, strong structure of spine at setting on of tail. Long, thin tail with good switch. Thin, incurving thighs	5
Ribs amply and fully sprung and wide apart, giving an open, relaxed conformation; thin arching flanks . .	5
Abdomen large and deep, with strong muscular and navel development, indicative of capacity and vitality . .	15
Hide firm yet loose, with an oily feeling and texture, but not thick	3
Carry forward	38

Brought forward	38
Milking Marks Denoting Quantity of Flow, 10.	
Escutcheon wide on thighs; high and broad, with thighs oval	2
Milk veins long, crooked, branching, and prominent, with large or deep wells	8
Udder Formation, 26.	
Udder full in front	8
Udder full and well up behind	8
Udder of large size and capacity	4
Teats well apart, squarely placed, and of good and even size	6
Indicating Color of Milk, 15.	
Skin deep yellow in ear, on end of bone of tail, at base of horns, on udder, teats, and body generally. Hoof, amber-colored	15
Milking Marks Denoting Quality of Flow, 6.	
Udder showing plenty of substance, but not too meaty	6
Symmetry and Size, 5.	
Color of hair, a shade of fawn, with white markings. Cream-colored nose. Horns amber-colored, small, curved, and not coarse	3
Size for the breed: mature cows, four years old or over about 1050 pounds	2
	100

SCALE OF POINTS FOR HOLSTEIN-FRIESIAN COW

Adopted by Holstein-Friesian Association

Head — Decidedly feminine in appearance; fine in contour	2
Forehead — Broad between the eyes; dishing	2
Face — Of medium length; clean and trim especially under the eyes, showing facial veins; the bridge of the nose straight	2
Muzzle — Broad with strong lips	1
Ears — Of medium size; of fine texture; the hair plentiful and soft; the secretion oily and abundant	1
Eyes — Large; full; mild; bright	2
Horns — Small; tapering finely towards the tips; set moderaately narrow at base; oval; inclining forward; well bent inward; of fine texture; in appearance waxy	1
Carry forward	11

Brought forward	11
Neck — Long; fine and clean at juncture with the head; free from dewlap; evenly and smoothly joined to shoulders	4
Shoulders — Slightly lower than hips; fine and even over tops; moderately broad and full at sides	3
Chest — Of moderate depth and lowness; smooth and moderately full in the brisket, full in the fore flanks (or through the heart)	6
Crops — Moderately full	2
Chine — Straight; strong; broadly developed, with open vertebræ	6
Barrel — Long; of wedge shape; well rounded; with a large abdomen, trimly held up (in judging the last item age must be considered)	7
Loin and Hips — Broad; level or nearly level between the hook bones; level and strong laterally; spreading from chine broadly and nearly level; hook bones fairly prominent	6
Rump — Long; high; broad with roomy pelvis; nearly level laterally; comparatively full above the thurl; carried out straight to dropping of tail	6
Thurl — High, broad	3
Quarters — Deep; straight behind; twist filled with development of udder; wide and moderately full at the sides	4
Flanks — Deep; comparatively full	2
Legs — Comparatively short; clean and nearly straight; wide apart; firmly and squarely set under the body; feet of medium size, round, solid, and deep	4
Tail — Large at base, the setting well back; tapering finely to switch; the end of the bone reaching to hocks or below; the switch full	2
Hair and Handling — Hair healthful in appearance; fine, soft, and furry; the skin of medium thickness and loose; mellow under the hand; the secretions oily, abundant, and of a rich brown or yellow color	8
Mammary Veins — Very large; very crooked (age must be taken into consideration in judging of size and crookedness); entering very large or numerous orifices; double extension; with special developments, such as branches, connections, etc.	10
Carry forward	4

Brought forward	84
Udder and Teats — Very capacious; very flexible; quarters even; nearly filling the space in the rear below the twist, extending well forward in front; broad and well held up	12
Teats — Well formed; wide apart, plump, and of convenient size	2
Escutcheon — Largest; finest	2
	100

TABLE 47. — IMPORTS AND EXPORTS OF DAIRY PRODUCTS

	YEAR ENDING JUNE 30, 1912		YEAR ENDING JUNE 30, 1913		YEAR ENDING JUNE 30, 1914	
	Amount	Value	Amount	Value	Amount	Value
Imports						
Butter, pounds .	1,025,668	$237,154	1,162,253	$304,094	7,842,022	$1,753,461
Cheese, pounds	46,542,007	8,807,249	49,387,944	9,185,184	63,784,313	11,010,693
Cream, gallons .	1,120,427	923,779	1,247,083	1,068,109	1,773,152	1,549,549
Milk		61,671		135,724		1,089,440
Total . . .		10,029,853		10,693,107		15,403,143
Exports						
Butter, pounds .	6,092,235	1,468,432	3,585,600	872,804	3,693,597	877,453
Cheese, pounds	6,337,560	898,035	2,599,058	441,186	2,427,577	414,124
Condensed milk, pounds . . .	20,642,738	1,651,879	16,525,918	1,432,848	16,209,082	1,341,140
Other milk and cream . . .		244,913		474,055		333,217
Total . . .		4,263,259		3,220,893		2,965,934

NOTES FOR TABLE 48, ON PAGE 297

[1] U. S. Dept. Agr., Yearbook, 1913, p. 487.
[2] No state standards.
[3] Federal rulings adopted.
[4] Percentage of fat based on total solids.
[5] Fat, 7.8 per cent; total solids plus fat, 34.3 per cent.
[6] For butter making, 25 per cent fat.
[7] This standard for sweetened condensed milk: "Evaporated milk," solids, 24 per cent; fat, 7.8 per cent.
[8] No report; 1910 standard given.
[9] By weight.
[10] Not more than 0.2 per cent "filler."
[11] Must correspond to 11.5 per cent solids in crude milk.
[12] If artifically colored.
[13] Must correspond to 12 per cent solids in crude milk.
[14] 23–24 per cent solids, 7.9 per cent fat; 24–25 per cent solids, 7.8 per cent fat; 25–26 per cent solids, 7.7 per cent fat; 26 per cent solids, 7.6 per cent fat.
[15] In May and June, solids 12 per cent.
[16] Fat, 27.5 per cent of total solids.

Table 48. — Legal Standards for Dairy Products[1]

State	Milk: Total Solids	Milk: Solids not Fat	Milk: Fat	Skim-milk: Total Solids	Cream: Fat	Butter: Fat	Whole Milk Cheese: Fat	Condensed Milk: Total Solids	Condensed Milk: Fat	Ice Cream (Plain): Fat	Ice Cream (Fruit and Nut): Fat
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Alabama[2]											
Arizona[2]											
Arkansas[3]											
California	11.5	8.5	3.0	8.8	18.0	80.0	50[4]	([5])	([5])	12	
Colorado			3.0		16.0[6]	80.0	50[4]			14	12
Connecticut	11.75	8.5	3.25		16.0						
Delaware[2]											
District of Columbia	12.5	9.0	3.5	9.3	20.0	83.0					
Florida	11.75	8.5	3.25	9.25	18.0	82.5	50[4]	28.0[7]	7.7[7]	12	
Georgia	11.75	8.5	3.25	9.25	18.0	82.5	50[4]	28.0	27.66[4]	14	12
Hawaii[8]	11.5	8.5	3.0					28.0	7.7		
Idaho	11.2	8.0	3.2	9.3	18.0	82.5	30	([5])	([5])	14	12
Illinois	11.5	8.5	3.0	9.25	18.0	82.5	50[4]	([5])	([5])	8	
Indiana		8.5	3.25	9.25	18.0	82.5	50[4]	28.0	27.5[4]	8	
Iowa	12.0		3.0		16.0	80.0[9]				12	
Kansas	11.75	8.5	3.25	9.25	18.0[6]	80.0	50[4]	([5])	([5])	14	12
Kentucky	12.5	8.5	3.25	9.25	18.0	82.5	50[4]	28.0	27.66[4]	14	12
Louisiana		8.5	3.5	8.0	18.0			([5])	([5])		
Maine	11.75	8.5	3.25		18.0						
Maryland	12.5		3.5	9.25	18.0			([5])	([5])	4	6
Massachusetts	12.15		3.35	9.3	15.0						
Michigan	12.5		3.0							12	
Minnesota	13.0	9.75	3.25		20.0		45[4]	([5])	([5])	12	
Mississippi[2]											
Missouri	12.0	8.75	3.25	9.25	18.0	82.5	50[4]	28.0	7.76	14	
Montana	11.75	8.5	3.25		20.0	82.5	50[4]			14	
Nebraska			3.0		18.0					14	12
New Hampshire	12.0			8.5	18.0	80.0				14[10]	
New Jersey	11.5		3.0		16.0						
New Mexico[2]											
New York	11.5		3.0		18.0			([11])	25.0[4]		
Nevada	11.75	8.5	3.25	9.25	18.0	82.5	50[4]	26.5	7.8	14	
North Carolina	11.5	8.5	3.25	9.25	18.0	82.5	50[4]	28.0	27.5[4]	14	12
North Dakota	12.0	9.0	3.0		15.0					14	
Ohio	12.0		3.0			80.0[12]		([13])	25.0[4]		
Oklahoma	12.51	9.5	3.0		18.0	81.5				14	
Oregon		9.0	3.2		20.0		30	([14])	([14])	12	
Pennsylvania	12.0		3.25		18.0		32			8	6
Porto Rico	12.0	9.0	3.0								
Rhode Island	12.0		2.5								
South Carolina[2]											
South Dakota		8.5	3.25	9.25	18.0	80.0	50[4]	28.0	27.5[4]	14	12
Tennessee		8.5	3.50								
Texas		8.5	3.25								
Utah	12.0	9.0	3.2	9.0	18.0	80.0	50[4]	([5])	([5])	14	12
Vermont	12.5[15]	9.25									
Virginia	11.75	8.5	3.25	9.25	18.0	82.5		([5])	([5])	8	
Washington	12.0	8.75	3.25	9.3	18.0		30				
West Virginia[2]											
Wisconsin		8.5	3.0	9.0	18.0	82.5	50[4]	28.0	8.0	14	
Wyoming		8.5	3.25	9.25	18.0	82.5	50[4]	28.0	([16])	14	12

Table 49. — Average Composition of Milk and its Products

	Water	Ash	Protein	Sugar	Fat
Skim-milk, gravity	89.88	.77	3.54	4.91	0.90
Skim-milk, separator	90.60	.78	3.57	4.95	0.10
Buttermilk	91.24	.70	3.50	4.00	0.56
Whey	93.04	.42	0.84	5.34	0.36

Table 50. — Average Weights

Product	Weight in Pounds per Quart[1]
Average milk	2.15
20 per cent cream	2.10
25 per cent cream	2.09
30 per cent cream	2.08
40 per cent cream	2.01
50 per cent cream	1.97

The Haecker Feeding Standard

The feeding standard formulated by Prof. T. L. Haecker of the Minnesota Experiment Station[2] has found considerable favor especially in the Middle West. This standard is based upon a long series of investigations concerning the requirements for maintenance and for the production of milk of varying richness. This standard has recently been modified by Savage in the direction of simplicity in form and some increase in the nutrients.

This standard makes use of the total digestible nutrients and does not exclude the amide nitrogen as is done by Armsby.

[1] Calculated from the specific gravity of cream as given by Farrington and Woll, Testing Milk and its Products, 20th edition, p. 77.

[2] Minnesota Agricultural Experiment Station, Bulletins 69, 79, 130, 140.

This accounts mostly for the difference in protein requirement and the larger amount of protein in the various feedstuffs as shown in the table.

This standard as modified by Savage is expressed in terms of digestible protein and total nutriment. The term "total nutriment" is applied to the sum of the digestible protein, the digestible carbohydrates, and the fat. The latter is multiplied by 2.25 to convert into its carbohydrate equivalent. The maintenance requirement is stated for each 100 pounds live weight, and the amount necessary for the animal in question is then found by calculation, taking the weight of the animal into account.

MAINTENANCE REQUIREMENT

	DIGESTIBLE PROTEIN POUNDS	TOTAL DIGESTIBLE NUTRIMENT, POUNDS
Per 100 lb. live weight	.070	.79

For One Pound of Milk

PER CENT FAT	DIGESTIBLE PROTEIN POUNDS	TOTAL DIGESTIBLE NUTRIMENT, POUNDS
3.0	.057	.29
3.5	.061	.32
4.0	.065	.35
4.5	.069	.38
5.0	.073	.41
5.5	.077	.43
6.0	.081	.46
6.5	.085	.49

In using this standard the same plan of calculation is followed as explained for the Armsby standard. The maintenance requirement is first calculated, taking into account the size of the animal. To this is added the amount necessary to produce the milk, taking into account the amount and richness. For example, let it be assumed the problem is to calculate the ration for a 1150-pound cow producing 30 pounds of 4.5 per cent milk daily. According to the preceding statements the requirements would be as follows:

	Digestible Protein Pounds		Total Nutriment	
Maintenance 1150 lb.	(.070 × 11.5)	.81	(.79 × 11.5)	9.09
30 lb. 4.5% milk . .	(30 × .069)	2.07	(30 × 38)	11.40
Total		2.88		20.49

The ration to be fed will then be selected and calculated using the average composition of feeds as given in Table 51, making such changes and modifications as are seen to be necessary in order to bring the composition of the ration reasonably close to the standard.

Table 51. — Dry Matter, Digestible Protein and Total Nutriment per 100 Pounds [1]

	Total Dry Matter	Digestible Protein	Total Nutriment
Concentrates.			
Corn	89.4	7.8	84.3
Sweet Corn	91.2	8.8	88.3
Corn-and-cob Meal . .	84.9	4.4	70.9
Gluten Feed	90.8	21.3	80.6
Gluten Meal	90.5	29.7	85.9
Hominy Feed (chops) .	90.4	6.8	83.9
Germ Oil Meal	91.4	15.8	78.8

[1] This table is adapted from Henry's "Feeds and Feeding," 10th edition, p. 582.

	Total Dry Matter	Digestible Protein	Total Nutriment
Corn Bran	90.6	6.	69.2
Wheat	89.5	8.8	79.7
Red-dog Flour	90.1	16.2	80.8
Wheat Middlings	88.8	13.	68.8
Wheat Bran	88.1	11.9	59.5
Rye	91.3	9.5	81.6
Rye Middlings	88.2	11.	69.7
Rye Bran	88.4	11.2	62.0
Barley	89.2	8.4	77.3
Oats	89.6	10.7	69.5
Oatmeal	92.1	11.9	92.0
Oat Middlings	91.2	13.1	85.4
Oat Hulls	92.6	1.3	41.2
Buckwheat	86.6	8.1	61.7
Buckwheat Middlings	87.2	22.7	73.7
Buckwheat Hulls	86.8	1.2	30.9
Rice	87.6	6.4	86.5
Canada Field Pea	85.0	19.7	69.9
Cowpea	85.4	16.8	74.2
Soybean	88.3	29.1	85.2
Kafir Corn	90.1	5.2	52.6
Linseed Meal	90.2	30.2	77.7
Cottonseed	89.7	12.5	81.4
Cottonseed Meal	93.0	37.6	80.6
Cottonseed Hulls	88.9	.3	37.3
Factory By-products.			
Dried Brewers' Grains	91.3	20.0	65.7
Wet Brewers' Grains	23.	4.9	16.3
Malt Sprouts	90.5	20.3	69.4
Dried Distillers' Grain	92.4	22.8	88.6
Wet Beet Pulp	10.2	.5	8.2
Dried Beet Pulp	91.6	4.1	69.0
Sugar-beet Molasses	79.2	4.7	58.8
Silage.			
Corn	26.4	1.4	17.2
Sorghum	23.9	0.1	14.1
Red Clover	28.0	1.5	11.8
Soybean	25.8	2.7	15.2
Cowpea Vine	20.7	1.5	12.1

	Total Dry Matter	Digestible Protein	Total Nutriment
Dried Roughage.			
Fodder Corn with Ears	57.8	2.5	39.8
Corn Stover, Ears removed	59.5	1.4	34.2
Timothy	86.8	2.8	48.1
Orchard Grass	90.1	4.9	50.4
Redtop	91.1	4.8	53.9
Kentucky Bluegrass	86.0	4.4	46.2
Bermuda Grass	92.9	6.4	54.9
Johnson Grass	89.8	2.9	50.3
Barley	85.0	5.7	51.6
Oat	86.0	4.7	45.2
Hungarian Grass	86.0	5.0	54.4
Prairie Grass	90.8	3.0	49.5
Buffalo Grass	85.0	3.0	48.6
Hay from Legumes and Mixed Legumes and Grasses.			
Red Clover	84.7	7.1	48.9
Alsike Clover	90.3	8.4	50.6
Crimson Clover	90.4	10.5	48.1
Sweet Clover	92.1	11.9	49.7
Soybean	88.2	10.6	54.2
Cowpea	89.5	13.1	49.1
Alfalfa (western U. S.)	93.2	11.1	51.5
Hairy (winter) Vetch	88.7	11.9	56.2
Peanut Vine	92.4	6.7	55.6
Oat and Pea	89.5	7.6	52.4
Mixed Grasses and Clover	87.1	5.8	50.5
Straw and Chaff.			
Wheat	90.4	.8	36.9
Rye	92.9	.7	41.2
Oat	90.8	1.3	42.6
Barley	85.8	.9	42.3
Buckwheat	90.1	1.2	39.7
Fresh Green Roughage.			
Green Corn and Sorghum-forage.			

	Total Dry Matter	Digestible Protein	Total Nutriment
Fodder, Corn, all Varieties	20.7	1.0	13.8
Sweet Varieties	20.9	1.2	14.7
Fresh Green Grasses			
Pasture Grass	20.	2.5	13.7
Kentucky Blue-grass	34.9	2.8	24.2
Timothy	38.4	1.5	22.7
Orchard Grass	27.0	1.2	15.7
Redtop in bloom	34.7	1.9	24.3
Wheat Forage	22.7	1.7	14.6
Rye Forage	23.4	2.1	17.1
Oat Forage, in Milk	37.8	2.5	22.9
Barley Forage	21.0	1.9	12.9
Johnson Grass	25.0	.6	14.7
Bermuda Grass	28.3	1.3	15.6
Common Millet	20.0	0.8	12.3
Fresh Green Legumes, Grasses and Legumes Combined.			
Red Clover	29.2	2.9	19.3
Alsike Clover	25.2	2.6	15.1
Crimson Clover	19.1	2.4	12.6
Sweet Clover	20.0	2.5	11.8
Alfalfa	28.2	3.6	16.6
Cowpea	16.4	1.8	11.0
Soybean	24.9	3.1	15.2
Canada Field-pea	15.3	1.8	9.4
Roots and Tubers.			
Potatoes	20.9	1.1	17.0
Common Beet	11.5	1.2	9.3
Mangel	9.1	1.0	7.0
Sugar Beet	13.5	1.3	11.3
Flat Turnip	9.9	.9	7.5
Carrot	11.4	.8	9.2
Rutabaga	11.4	1.0	9.5
Miscellaneous.			
Dwarf Essex Rape	14.3	2.0	10.6
Cabbage	10.0	2.3	8.4
Field Pumpkins	9.1	1.0	7.3

Wing's Method of Balancing Rations

A short method of balancing rations devised by H. H. Wing is practical and convenient.

He divides the ordniary grains into three groups: low protein (less than 12 per cent); medium protein (12 to 25 per cent); high protein (over 25 per cent). The figures given in the table are for the total and not the digestible protein.

Table 52.—Wing's Method of Balancing Rations

Low Protein Group Total Protein 12% or less		Medium Protein Group Total Protein 12% to 25%		High Protein Group Total Protein 25% or more	
Corn	10.3	Wheat bran	15.4	Malt sprouts	26.3
Oats	11.4	Mixed wheat feed	16.3	Linseed oil meal	33.9
Wheat	11.9	Wheat middlings	16.9	Cottonseed meal	45.3
Rye	11.3	Cottonseed feed	20.0	Gluten feed	25.0
Barley	12.0	Buckwheat feed	18.3	Brewers' dried grains	25.0
Buckwheat	10.8	Pea meal	20.2	Distillers' dried grains (corn)	31.2
Hominy chop	10.5	Cull beans	21.6	Buckwheat middlings	26.7
Dried beet pulp	8.1				
Corn-and-cob meal	8.5				

Mixed hay, corn silage, and corn fodder are very similar in composition as far as the relation between the protein and carbohydrates is concerned. When roughage of this class is used, a grain mixture made by mixing equal parts by weight of one from each of the three groups will make a well-balanced ration. A dairy cow in full flow of milk should receive all the hay and silage she will eat and the grain mixture at the rate of one pound for each 3 or 3½ pounds of milk that she produces, if this milk be about the average composition of 4. percent. If the milk contains 3 to 3.5 percent fat, 1 pound grain to 4 pounds of milk is sufficient. If alfalfa hay is used the high protein feed is not necessary.

Table 53. — Average Weights of Different Feeding-Stuffs [1]

Feeding Stuff	One Quart Weighs	One Pound Measures
	Pounds	*Quarts*
Barley meal	1.1	0.9
Barley, whole	1.5	0.7
Brewers' dried grains	0.6	1.7
Corn-and-cob meal	1.4	0.7
Corn-and-oat feed	0.7	1.4
Corn bran	0.5	2.0
Corn meal	1.5	0.7
Corn, whole	1.7	0.6
Cottonseed meal	1.5	0.7
Distillers' grains, dried	0.5–0.7	1.0–1.4
Germ oil meal	1.4	0.7
Gluten feed	1.3	0.8
Gluten meal	1.7	0.6
Hominy meal	1.1	0.9
Linseed meal, new process	0.9	1.1
Linseed meal, old process	1.1	0.9
Malt sprouts	0.6	1.7
Oats, ground	0.7	1.4
Oats, whole	1.0	1.0
Rye bran	0.6	1.8
Rye meal	1.5	0.7
Rye, whole	1.7	0.6
Wheat bran	0.5	2.0
Wheat, ground	1.7	0.6
Wheat middlings (flour)	1.2	0.8
Wheat middlings (standard)	0.8	1.3
Wheat, whole	2.0	0.5

Rules for Measuring Feed

Measuring Grain. A bushel of grain contains approximately $\frac{5}{4}$ cubic feet. To find the capacity of a bin, find the number of cubic feet and multiply by $\frac{4}{5}$, or multiply by 8 and divide by 10.

Measuring Ear Corn. Two bushels of ears are ordinarily required to make one bushel of grain. To find the capacity

[1] U. S. Dept. Agr., Farmers' Bulletin 222.

of a crib, find the number of cubic feet and multiply by $\frac{2}{5}$, or multiply by 4 and divide by 10. Seventy pounds of ear corn is ordinarily called a bushel.

Measuring Straw. Few weights of straw have been reported. The writer measured and weighed two barns full of settled wheat straw. The mows were 14 feet deep, 1200 cubic feet were required for one ton.

Measuring Hay. Some kinds of hay are heavier than others. The deeper the mow or stack and the longer it has stood, the heavier the hay is per cubic foot. Of course the bottom of a mow is much heavier than the top. Usually about 500 cubic feet of settled hay are counted as one ton.

A barn 30 × 60 feet and 16 feet from floor to top of the plate, and having the peak 9 feet above the plate, was filled as full as possible with timothy hay and refilled after a few days. This hay was baled by the writer about five months later. It weighed 51½ tons. On another year it weighed 51 tons. A barn 30 × 42 feet and 16 feet from floor to top of plate, with peak 9 feet above the plate, was similarly filled, and baled out 32.75 tons.

Capacity of Silos. King gives the weight of a cubic foot of silage at different depths two days after filling, as follows:[1]

Depth	Weight per Cubic Foot	Average Weight to this Depth
Feet	*Pounds*	*Pounds*
1	19	19
10	33	26
20	46	33
30	56	40
36	61	43

[1] Wisconsin Agricultural Experiment Station, Bulletin 59.

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In the five parts into which the book is divided the author treats of horses, cattle, sheep, swine, and poultry, and each is discussed with reference to breeds, judging the animal, feeding, and care and management. There is also a chapter on the general principles of feeding. Practical questions and numerous laboratory exercises supplement the text and compel the student to think through each subject as he proceeds. The book is extensively illustrated. Designed for use as a textbook, it is also well suited for use as a reference book in schools in which time limitations make it impossible to use it as a text.

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