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The Milk Industry of Nebraska

Walter Kollmorgen
University of Nebraska-Lincoln

THE MILK INDUSTRY OF NEBRASKA

BY
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Research Assistant
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The Milk Industry of Nebraska

HISTORY OF THE MILK INDUSTRY IN NEBRASKA

The first cattle were brought to Nebraska in about 1820, crossing the Missouri River near the present site of Omaha. These cattle were purchased in St. Louis and were driven to Fort Atkinson, located at the present site of Fort Calhoun, for the use of the 600 men, women and children of the garrison. General Atkinson and Benjamin O'Fallon had previously made a treaty with the Indians for the purchase of a plot of land 15 miles square to be used for the fort and had assured the Indians that the game of the area would not be disturbed. The cattle, including some milk cows, were purchased to provide a meat supply for the garrison. Although we do not know how many cattle were in the first herd, the November 2, 1823 report of the Sixth Infantry stationed at the fort, listed among other things the following cattle:[1]

2	English bulls
2	common bulls
121	cows
112	calves
96	yearlings
43	young cattle
6	steers
Total 382	

Fort Atkinson was abandoned in 1827 and we may assume that there were no milk cows in the territory now comprising Nebraska during the succeeding ten to fifteen years.

In the early 1840's there were migrations to the humid Pacific Northwest—the Oregon country. In 1847 the Mormon migration through Nebraska took place and the discovery of gold in California caused a rush to that region in 1849. Many of the caravan travelers to these western regions brought cattle with them. Cows accompanying the pioneers were frequently milked to vary and supplement the diet of travelers, particularly the diet of children. Indian raids, inclement weather, and the length of the journey caused partial or complete failure of many attempts to drive cattle to the western regions.

In 1854 the Territory of Nebraska was opened for settlement, and the pioneer fringe began creeping to the west of the Missouri River. The domesticated cattle of the East, descendants of stock brought over from

[1] Hughes, Hayden Deforest, *The Beginnings of Formal Education in Nebraska*, M. A. Thesis, Department of School Administration, University of Nebraska, June 1934, p. 69.

England and related to the Devon, Hereford, and Shorthorn breeds, came with the pioneers. These were triple-purpose breeds; they were used as beasts of burden, they were milked, and they furnished meat. A table compiled from a duplicate census record gives us an estimate of the cattle and dairy situation in some of the southeastern counties of Nebraska in 1860 (Table 1). In that year 641 farmers in the counties listed kept 4,541 cattle, an average herd of about seven. The average number of cows milked per farmer was about 2.5. The farmer obtained about 50 pounds of butter a year from each cow.

TABLE 1.—*Dairy statistics of 1860 for five counties in the Territory of Nebraska* *

	Pawnee County	Gage County	Clay County**	Johnson County	Nemaha County	Total
Farmers reporting milk cows	108	27	32	89	385	641
Number of cows milked	298	66	75	224	963	1,626
Work oxen	183	78	56	139	657	1,113
Other cattle	403	88	85	171	1,055	1,802
Pounds of butter produced	17,241	3,700	4,205	12,700	44,541	82,387
Farmers making cheese	12	1	1	2	6	22
Pounds of cheese made	1,309	60	50	150	468	2,037

* Original copies of census of 1860 filed with State Historical Library. Census information apparently recorded on duplicate copies.

** Represents what is now the southern one-third of Lancaster County and the northern one-third of Gage County.

The cattle industry became important on the grazing land of central and western Nebraska in the 1860's and 1870's moving northward from Texas. The range cattle that moved northward, commonly known as Texas Longhorns, were the descendants of the Spanish Longhorns, introduced into Mexico from the West Indies in 1521.[2] These Texas Longhorns were small, lean, sinewy animals with immense horns. They were fair beef animals but were of no value as milk animals. Texas Longhorns made no direct imprint on the dairy activities of the state although these animals played a rather important part in the beef industry up to about 1885. Crossing the Texas Longhorns with the more domesticated cattle from the East improved neither beef- nor milk-producing qualities. As a result, Texas Longhorns were replaced by the close of the nineteenth century.

The mixed breed cattle of early Nebraska represented poor milking stock. Milk production per cow was very low and milking was largely of a seasonal nature being limited to the spring and summer months when grass was abundant.[3] Cows usually went dry during cold weather and few animals were milked in winter. The supply of dairy foods, with the exception of cheese and stored butter, was limited to the brief milking season.

[2] Sanders, A. H., *National Geographic Magazine*, December 1925, p. 627.

[3] *Yearbook of Agriculture*, 1899, p. 382.

The seasonal production of dairy products was in a measure the result of the indifferent care which the animals received. Except during the pasture season, cows were underfed and poorly housed. Frequently they died during the winter because of undernourishment and exposure. Emaciated and weakened cattle frequently required special assistance to get on their feet in spring. The enthusiasm registered by isolated dairymen, creamery men, and promoters did not sweep over the state and convert Nebraska farmers to a dairy program. The extensive pairie lands were considered more appropriate for grain production and the raising of meat stock. As a result, improvement in cattle was usually directed at the beef qualities of the animals rather than at increased milk production.

As might be expected, average milk production per cow was in keeping with the general care the animal received. Up to the Civil War the production record per animal was not materially improved by selective breeding and herd culling. It is of interest to know that as late as 1865 a New England dairyman advertised to pay $100 for any cow that would yield 50 pounds of milk a day, for two or three consecutive days.[4] Although the price proffered was practically three times as great as the average value of ordinary milk cows, no animal was offered to the advertiser. Today dairy cows producing between 20,000 and 30,000 pounds of milk a year are not considered a curiosity. This means a daily average of between 75 and 100 pounds of milk during a lactation period lasting about 10 months. In terms of butterfat production, the improvement is parallel and equally striking. If a cow during and prior to the days of the Civil War produced a pound of butter a day for two or three months, her record was considered excellent. Today a good dairy cow is expected to produce at least 300 pounds of butterfat a year.

NEBRASKA'S POSITION IN THE NATIONAL DAIRY INDUSTRY

Rank of Nebraska in Total Number of Cows Milked, 1929

In 1929 about 650,000 milk cows were credited to Nebraska by the census enumeration. As a state it ranked thirteenth in number of cows milked (Fig. 1). Since Nebraska is larger in size than most states, its rank does not signify a high concentration of milk cows. Wisconsin, Minnesota, Iowa, New York, and Illinois rank as the foremost dairying states. Texas assumes a prominent position in number of milk cows merely by virtue of its great size.

Figure 1 also shows the relative number of cows of dual-purpose and those of other breeds. Only Iowa exceeds Nebraska in the total number of milk cows that are of dual-purpose breeds. The number of unspecialized

[4] *Ibid.*, p. 392.

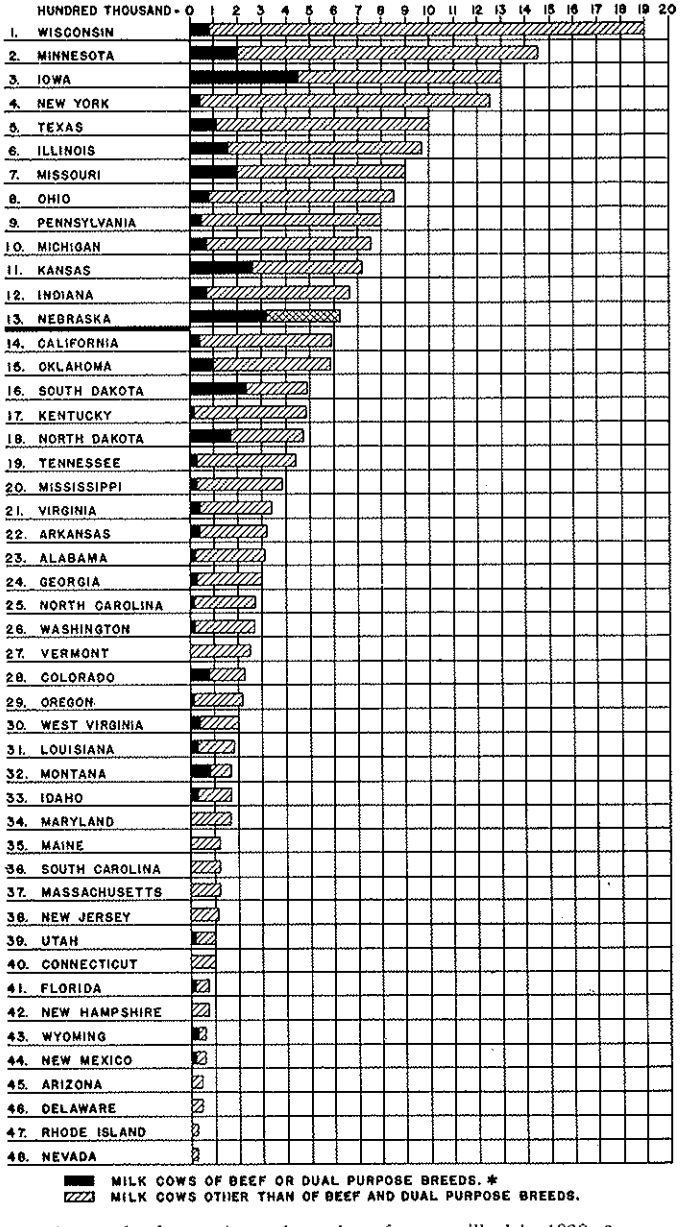

FIG. 1.—Rank of states in total number of cows milked in 1929. Source: *Statistical Supplement Number 9* to *Milk Production Trends*, U. S. Dept. of Agriculture, Washington, 1934.

* States having less than 10,000 of beef or dual-purpose breed milk cows do not show color differential in bar.

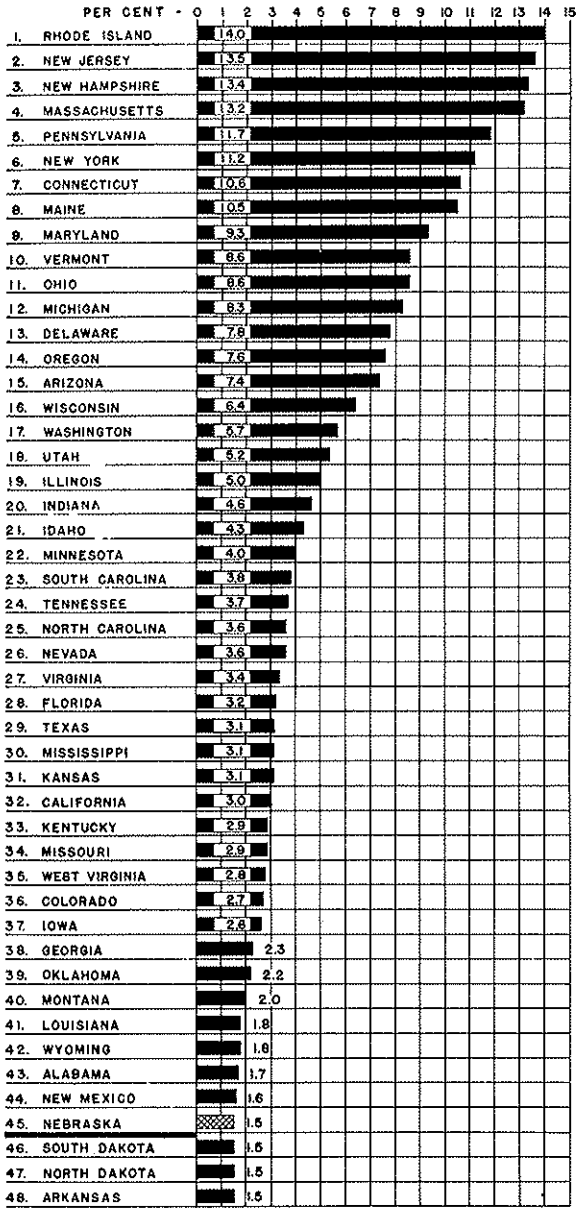

FIG. 2.—Rank of states in percentage of purebred milk cows in 1929.* Source: *Statistical Supplement No. 8* to *Milk Production Trends*, U. S. Dept. of Agriculture, Washington, 1933.

* Calculated from census enumeration of "Registered cows, heifers, and heifer calves" reported as of specified dairy breeds; does not include milking Shorthorns.

milk cows is relatively small in such dairy states as New York, Wisconsin, Illinois, Ohio, Pennsylvania, and California, and unspecialized cattle disappear entirely in New England and in certain other seaboard states.

Rank of States in Percentage of Purebred Milk Cows, 1929

The seriousness with which dairying is pursued in any one state is in part reflected by the percentage of milk cows that are purebred, Nebraska ranking among the four lowest states in this respect (Fig. 2). The high-ranking states are located in the more thickly populated sections of northeastern United States where the ready and usually profitable market for milk products in the large cities encourages a concentrated and highly specialized form of dairy farming.

The number of registered purebred milk cows in Nebraska is limited (Table 2). The registry of an animal exacts some time and expense; hence not all purebred animals are registered. However, the number in Nebraska is relatively small, particularly so when compared with figures from other states.

TABLE 2.—*Number of Registered Dairy Animals in Nebraska, 1929* *

Breed	Farmers Reporting Male Animals	Total Number of Male Animals	Farmers Reporting Female Animals	Total Number of Female Animals	Total Number of Registered Animals
Ayrshire	45	77	42	343	420
Brown Swiss	31	34	20	112	146
Dutch Belted	2	3	2	9	12
Guernseys	259	356	214	884	1,240
Holstein	1,187	1,657	1,170	6,208	7,865
Jerseys	241	341	401	1,909	2,250

*Census of 1930.

Rank of States in Percentage of Milk Cows of Dual-Purpose Breeding, 1929

The nature of the dairy enterprise in any state is well reflected by the types of milk cows prevailing in the milking herds. In states in which dairying is highly specialized, milk cows of the better milking strains predominate, whereas in the states in which dairying is unspecialized indifferent milking strains are likely to be more or less common. The percentage of unspecialized milk cows milked in 1929 is shown in Figure 3. Only Wyoming exceeds Nebraska in percentage of dual-purpose cows milked. In Nebraska every second cow is of a type that will do well as a beef animal and only fairly well as a milk cow. Consequently a modest average production of milk per cow must be anticipated in this state.

It is also of interest to note the states in which but a small or negligible percentage of the milk cows is of the dual-purpose type. A strikingly

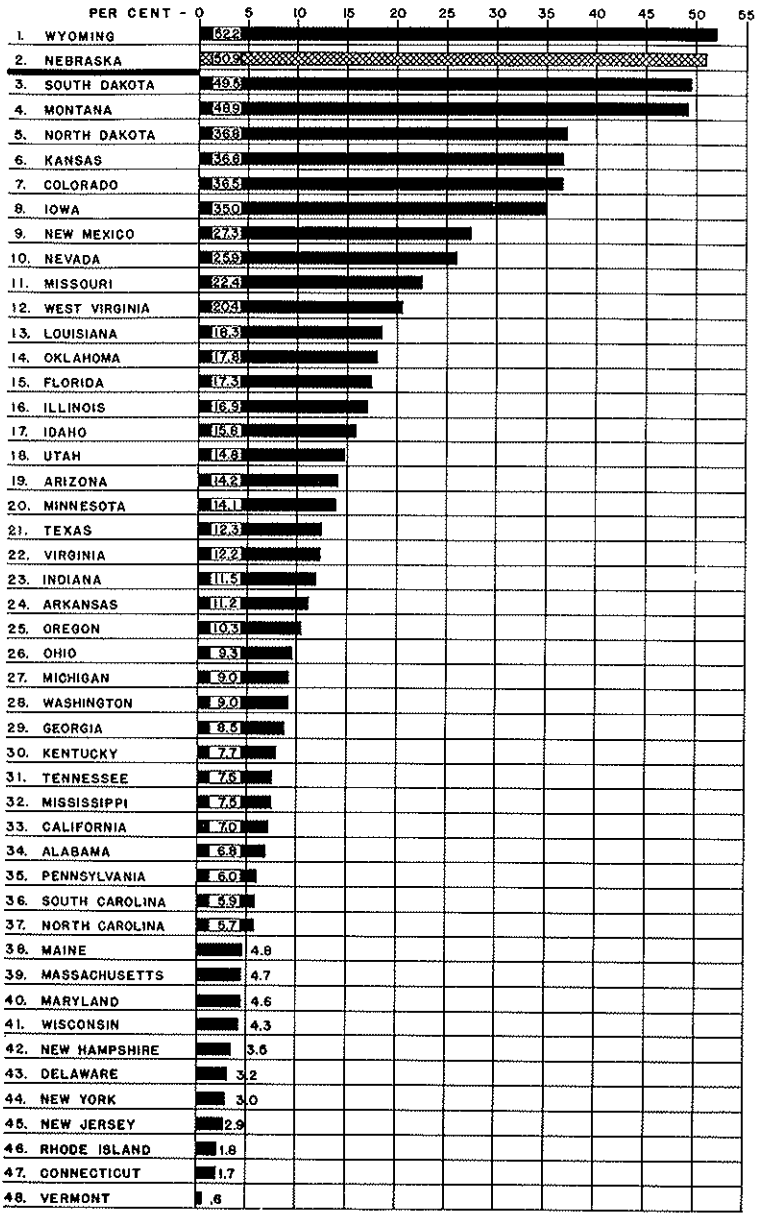

FIG. 3.—Rank of states in percentage of milk cows of dual-purpose breeding in 1929.* Source: *Statistical Supplement No. 8* to *Milk Production Trends*, U. S. Dept. of Agriculture, Washington, 1933.

* Calculated from the census enumeration of cows milked during 1929 and the number of those that were reported as mainly of beef or dual-purpose breeding. Classification is not exact because no classification of cattle of mixed breeding can be completely accurate.

small percentage of such cows is found in the New England states and in New York, Wisconsin, and certain other prominent dairying states that rank high in average milk production per cow (Fig. 3).

Distribution of Beef Cattle and Milk Cattle in the United States, 1930

Figures 4 and 5 show the distribution of milk cows and heifers and of cows and heifers kept mainly for beef production in the United States in 1930. The distribution of the cow population follows in a measure the distribution of human population. The greatest concentration of milk cows is in the Great Lakes district. The relation of cow population to human population is disproportionate in Iowa, Minnesota, and particularly in Wisconsin. Iowa and Minnesota produce vast surpluses of butter, whereas Wisconsin produces great surpluses of cheese and butter and some fresh fluid cream. The tier of states including Nebraska and those north and south of it represents the transition zone from the more thickly milk-cow-populated East to the less thickly milk-cow-populated plains and mountains country. This distribution parallels in a measure the human population.

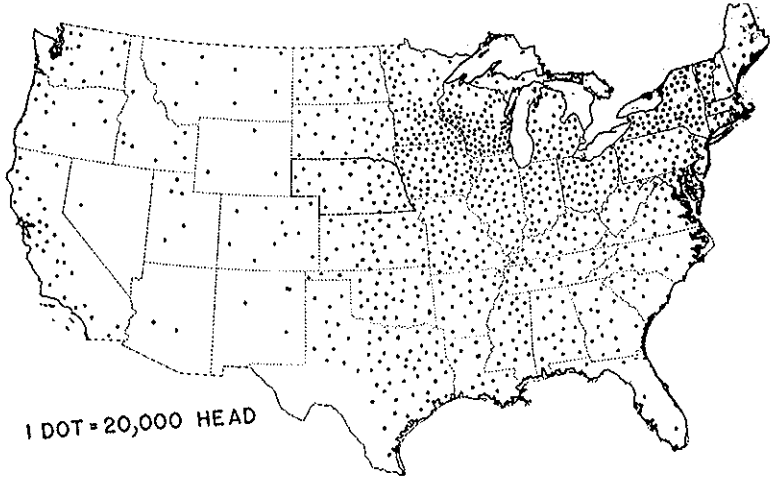

FIG. 4.—Cows and heifers kept for milk. Number on farms April 1930. Source: Census of 1930.

Figure 5 shows the distribution of cows and heifers kept mainly for beef production in the United States in 1930. In this instance, Nebraska lies in a transition zone from the more heavily beef-cow-populated plains and mountains country to the more thickly milk-cow-populated eastern part of the United States. In a measure, these two types of cattle overlap in the plains country, from Kansas northward. It is for this reason that a

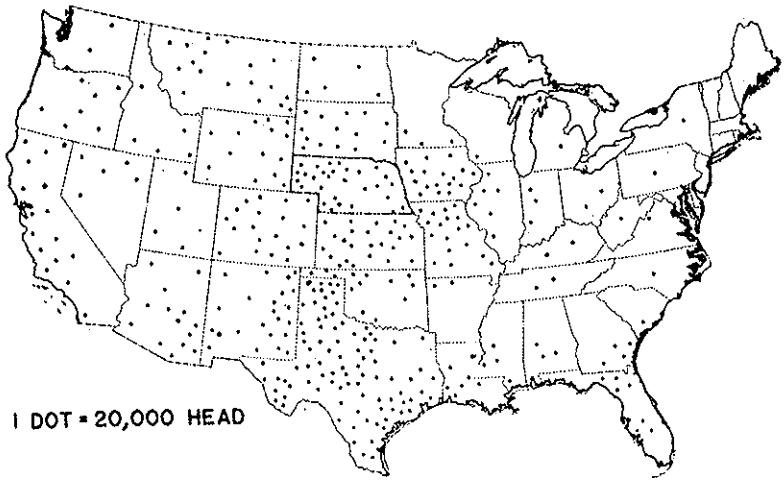

FIG. 5.—Cows and heifers kept mainly for beef production. Number on farms April 1, 1930. Source: Census of 1930.

high percentage of milk cows in this section of the country are of dual-purpose types and consequently have low milk production records. People in this transition zone milk largely to supply their own tables with certain dairy products. Only small surpluses of accumulated cream are marketed at convenient intervals.

Rank of Nebraska in Average Annual Milk Production per Cow, 1929

The haphazard mixture of milk cows in Nebraska results in a low average production of milk per cow. In 1929, Nebraska ranked thirtieth among the states in average milk production per cow. California, which ranked first in this respect, reported an average milk production of 6,493 pounds per cow; Nebraska cows averaged merely 4,050 pounds. Figure 6 shows this in more generalized form.

The production of milk per cow depends initially upon the breed and quality of animals and secondly upon the care these cattle receive. In areas in which dairying is prominent much dairy-herd improvement work has been done and cows are tested, selected, retained, and sold largely on the basis of individual production records. The extent to which this practice improves the producing capacity per herd is amazing. States ranking low in milk production per cow are found largely in the Gulf, South Atlantic and Great Plains areas (Fig. 6). Dairying plays an unimportant part in the scheme of farming in these areas and milk cows do not receive much care or concern. Hence small milk yields result. The low average production of milk in the Gulf-South Atlantic section, how

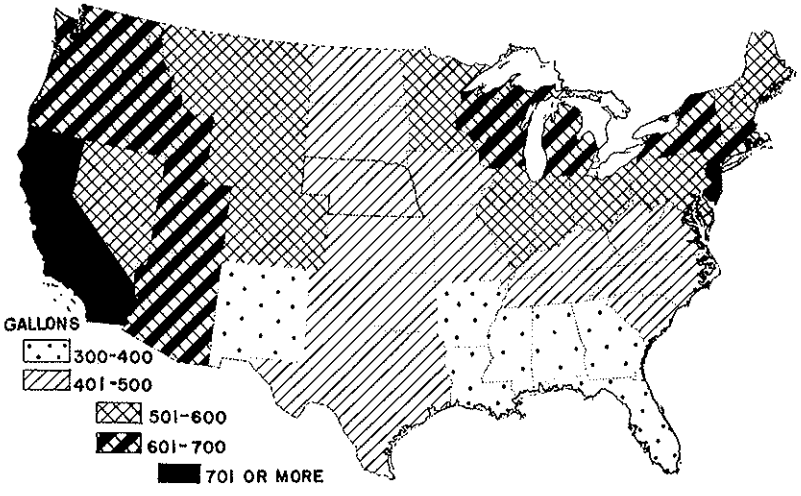

FIG. 6.—Average amount of milk produced per cow in the various states during 1929. Source: Census of 1930.

ever, is in part attributable to the fact that Jersey cows, which produce a relatively small quantity of exceedingly rich milk, predominate.

Average Milk Production per Cow in Nebraska and in the United States, 1890-1935

The various census reports of the United States up to 1880 contained no satisfactory data for the computation of the average milk production per cow in the various states and the country as a whole. The census of 1890 and following censuses, however, contain such data. The figures in these reports apply to the full year immediately preceding the census year. These records show that in 1889 the average production of milk per cow in Nebraska was about 2,400 pounds; for the United States it was about 2,700 pounds (Fig. 7). It will be noted that on Figure 7 the production curve per cow rises up to 1910, drops somewhat for 1920, and then rises rather precipitously for 1930. In 1929 the average production of milk per cow in Nebraska was about 4,200 pounds whereas the average for the whole country was about 4,500 pounds.

A gradual decline of milk production per cow is noted for Nebraska and the country as a whole since 1929. This decline cannot be wholly attributed to the poor pastures resulting from the drouth; there was also a decline in many states not affected by drouth. The explanation seems to lie in the greatly increased milking activities that have taken place in the last few years. Financial stress compelled many farmers to milk cows that in more normal times would not have been milked. Poorer milk

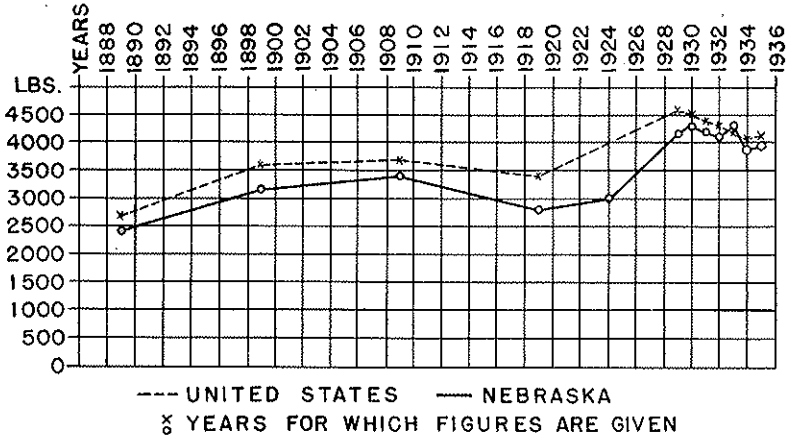

FIG. 7.—Average annual milk production per cow for Nebraska and the United States, 1898-1935. Source: Data for 1898 to 1924 from *Statistical Supplement No. 6* to *Milk Production Trends*, U. S. Dept. of Agriculture, 1932; 1929 to 1935 from *Yearbooks of Agriculture*.

cows were thus added to the milking herd, and the average production of milk per cow declined.

Trends in Number and Value of Milk Cows in the United States and in Nebraska

Dairying and the commercial production of dairy products in the United States date back roughly to the middle of the nineteenth century. The census of 1850 reports 6,000,000 milk cows in this country. The number of these animals then increased very rapidly and by 1880 had reached a total of 12,000,000, an increase of 100 per cent. In 1930 there were about 21,000,000 milk cows on the farms in this country; this represents an increase of about 250 per cent since the middle of the nineteenth century.

From 1930 to 1934 the number of cows milked in the United States increased phenomenally. In these four years there were 5,000,000 more milk cows on the farms, an increase of about 24 per cent. This additional milking may largely be attributed to the depression. Although scarcely any farming activities in this period could be termed profitable, milking possessed the virtue of providing a sustained form of income. Dairy products did not fall quite so low in price, proportionally, as many other farm commodities.

From 1850 to 1930 the population of the United States increased at an equally rapid or an even more rapid rate than the cow population. In 1850 the population was about 23,000,000, or approximately four people to each milk cow in the country. By 1880 our population was slightly over

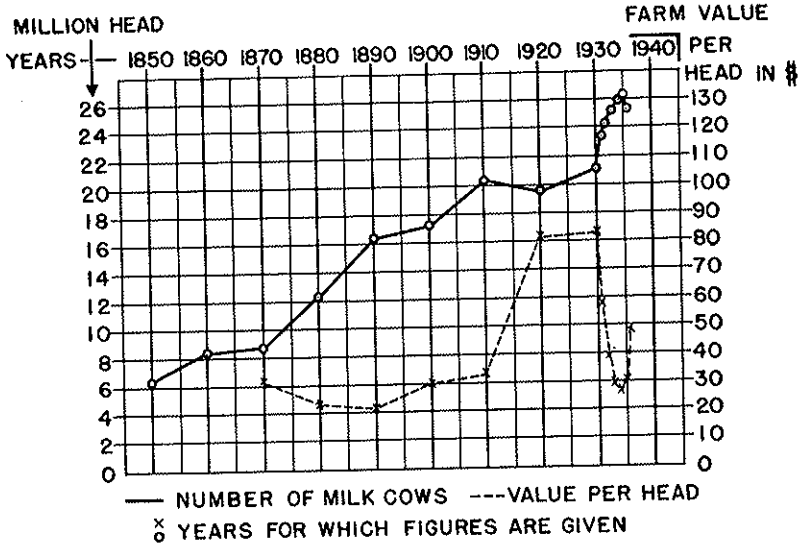

FIG. 8.—Number and farm value of milk cows in the United States, 1850-1936. Source: Number of milk cows for 1850 to 1930 from census reports; for 1931 to 1936 from *Yearbooks of Agriculture*; value per head from 1870 to 1936 from *Yearbooks of Agriculture*.

50,000,000, slightly over four people per milk cow. In 1930 the census recorded a national population of almost 123,000,000 and approximately 21,000,000 milk cows, a ratio of about six people per milk cow. This change in ratio of human population to milk-cow population does not signify a corresponding change in the production and consumption of dairy products.

The classification of milk cows has changed considerably as census enumeration practices have been perfected. Since 1920 finer distinctions between milk cows and beef cows have been made. This has served to exclude many cows in the recent census which under previous practices were included under "milk cows." The significance of this change in enumeration is reflected more clearly in the census figures on cow population in Nebraska. The Federal census credits Nebraska with the following cow population in the stated years:

Census Classification	*Year*	*Number*
Milk cows	1870	28,940
Milk cows	1880	161,187
Milk cows	1890	505,045
Dairy cows, 2 years old and over	1900	512,544
Dairy cows, 2 years old and over	1910	613,952
Cows and heifers 2 years and over (kept for milking)	1920	438,459
Cows and heifers 2 years and over (kept for milking)	1930	575,639

It is obvious that these figures are more inclusive with reference to milk cows or dairy cows during the earlier periods than during the later periods. Available evidence indicates that the milk-cow population of the state has increased somewhat constantly with each succeeding census and has not fluctuated in the manner shown by these figures. A truer indication of the increased dairying activities in this state is shown by the butter production record in each succeeding census. The increased production of butter, the main product of Nebraska dairying activity, can be explained only in the light of a constantly increasing cow population, the increased production records per cow notwithstanding.

Figure 9 shows the total number of cattle, other than milk cows, and milk cows credited to Nebraska in the *Yearbook of Agriculture* from 1896 to 1934, except in 1901 and 1902. The figures on the total number of cattle may be taken as reasonably accurate; no problem of classification enters into the mere ascertainment of total numbers. The line representing milk cows, however, again reveals peculiarities. According to these figures Nebraska had nearly 900,000 milk cows from 1908 to 1910, figures exceedingly high in the light of total amount of butter produced at that time.

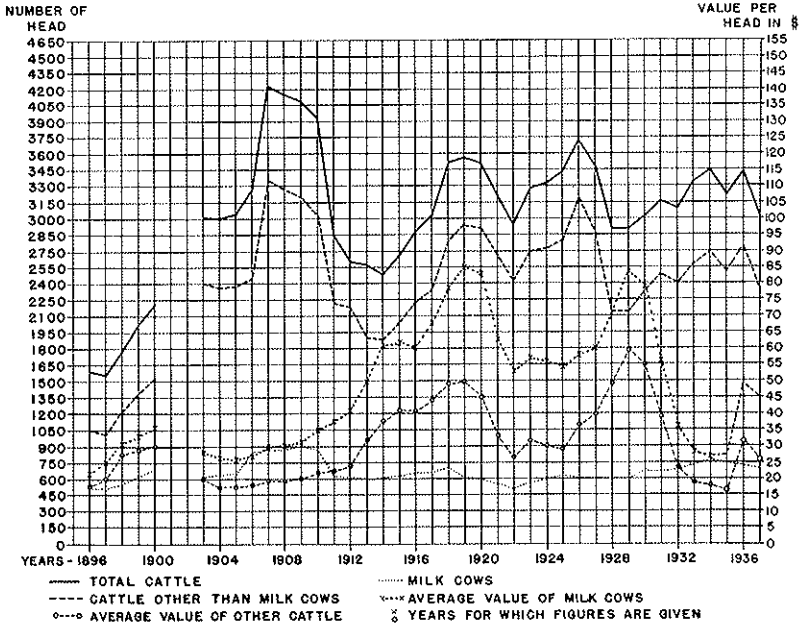

FIG. 9.—Number of milk cows, other cattle, and total number of cattle in Nebraska, 1896-1937, together with average value of milk cows and other cattle. Figures for 1937 are preliminary. Source: *Yearbooks of Agriculture* from 1896 to 1934 and State-Federal Division of Agricultural Statistics, Lincoln, for more recent years.

The mixed type of cattle milked in this state accounts in a large measure for the difficulty of classifying them as milk cows or otherwise.

Figure 9 shows also the average value of milk cows and of other cattle. The mature nature of all milk cows explains in part their relatively higher value. The common practice of seeking out the better, larger, and healthier animals for milking also contributes to the higher value of the milk cow.

Since 1910 the value of milk cows in Nebraska has reached two exceedingly high points. In 1919 the average milk cow sold for about $85. By 1922 the figure had dropped to $53, only to rise again to $84 by 1929. From this high price the average value descended precipitously to $27 per cow in 1934. These periods correlate roughly with the World War period, the deflation period following the war, the stock market boom of the middle and later twenties, and the severe depression of the early thirties. These radical fluctuations in value of milk cows suggest that the prosperity of the dairy industry depends on a multitude of factors, connected both immediately and remotely with this activity.

Rank of States in Percentage of Gross Farm Income Derived from Dairy Products, 1929-32

The role that dairying plays in the farming scheme of the various states is in part reflected by the percentage of gross income that farmers receive from this form of activity. The average percentage of gross farm income from 1929 to 1932 derived from the sale of dairy products ranged from 9.1 per cent in Florida to 60.4 per cent in Vermont. Nebraska ranked next to Florida, the lowest state, in average percentage of income derived from the sale of dairy products. From 1929 to 1932 Nebraska farmers received 11.6 per cent of their total income from what the milk cow produced (Fig. 10).

The low rank of Nebraska in percentage of income from dairy activities is not attributable to a small quantity of dairy products produced. Nebraska ranks fourth in the production of creamery butter and also produces considerable quantities of other dairy commodities. The explanation lies in the high degree of diversification common to Nebraska farming and the emphasis given to forms of specialized farming other than dairying. The relative success with which Nebraska farmers produce other products dwarfs the percentage of income obtained from dairy products. It is clear from these figures that the milk cow provides a relatively incidental form of income to our rural people. In time of stress, this income, however small, plays an important part in the family budget. During stringent times many essentials of food and clothing are purchased with the cream check.

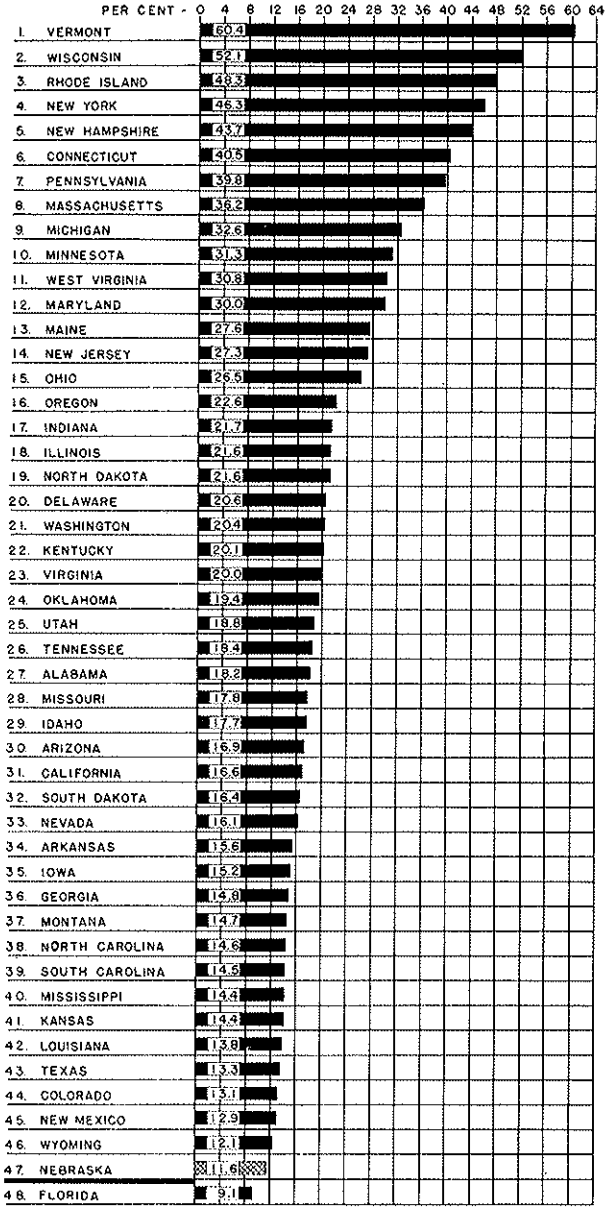

FIG. 10.—Rank of states in percentage of gross farm income derived from dairy products, 1929-32 average. Source: *Statistical Supplement No. 8* to *Milk Production Trends*, U. S. Dept. of Agriculture, 1933.

Size of Dairy Herds in Selected States, 1929

The significance of milking and dairying in an area is indicated in part by the average size of milk-cow herds. In 1929 the average herd of milk cows in Nebraska consisted of about five and one-half animals. In this same year the average herd in Kansas was five, in Iowa six and one-half, in Minnesota eight and one-half, and in Wisconsin eleven animals

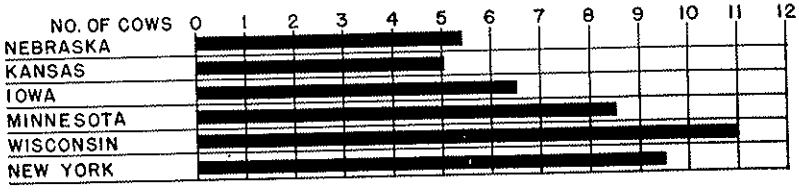

FIG. 11.—Average-sized herd of milk cows in selected states in 1929. Source: *Statistical Supplement No. 9* to *Milk Production Trends*, U. S. Dept. of Agriculture, Washington, 1934.

(Fig. 11). The size of the herd alone does not reveal the amount of milk and butterfat produced. The type and quality of animals predominating must also be considered. Hence, although the average herd of milk cows is only half as large in Nebraska as in Wisconsin, Nebraska herds produce considerably less than half as much milk because of the popularity of the dual-purpose cow, so common in the state.

DAIRY CONDITIONS IN VARIOUS COUNTIES AND TOWNSHIPS OF NEBRASKA

The climatic transition from the more humid eastern part of Nebraska to the less humid or semiarid western part gives rise to many differences in agricultural practices. Different physiographic conditions and soil patterns control the varying farm activities. Surface or sub-surface irrigations further distort a normal transition of farming activity from one part of the state to another. Lastly, the farming habits of different nationalities as they established themselves in this state determined to some extent the choice of farm activity. For example, the German, Scandinavian, and Bohemian pioneers, because of their constant association with dairying activity in their native country, were more likely than certain other nationalities to obtain a dairy herd. In contrast with these nationalities the native American pioneers, coming from eastern states, were not noted for their preference for the dairy cow. Moreover, the Irish settlers were not particularly fond of milking. The presence or absence of considerable milking activities in certain sections suggests a possible and probable predominance of certain nationalities or offspring from such nationalities. Varying farming practices must, therefore, be looked upon from a number

of different viewpoints; in part, such conditions may reflect partial adaptation to natural conditions; in part, they may reflect customary hangovers.

Average Size of Farms

The average size of farms in different counties of Nebraska suggests much with reference to the type of agricultural activities in the various counties. Those with large average-sized farms usually engage more or less extensively in grazing (Fig. 12). On the level to rolling tablelands of western Nebraska wheat raising also plays an important part. On the smaller farm units in the eastern part of the state more intensive farming becomes prominent because of the greater amount of rainfall.

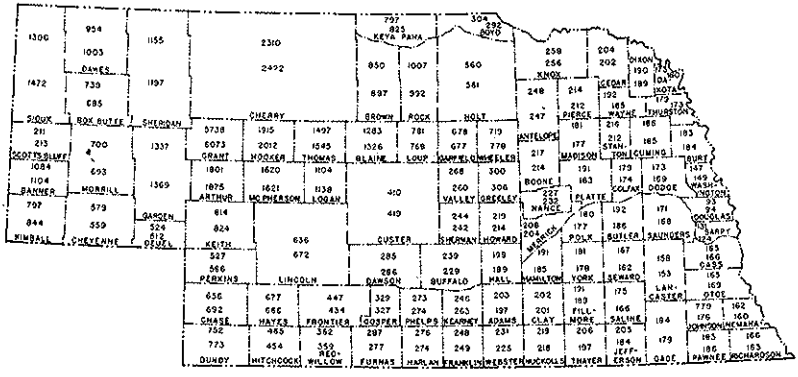

FIG. 12.—Average size of farms in acres in the counties of Nebraska, 1930 (upper figure) and 1935 (lower figure). Source: *Census of Agriculture, 1935.*

It will be noted that the smaller farms extend farther westward in southern than in northern Nebraska. These smaller farm units indicate a more intensified form of farming. Soil texture is largely responsible for this difference in the westward extension of farm operation. In the northern part of the state the sandier soils prevail farther eastward and the tendency of these soils to blow inclines farmers to plow them less extensively. Hence grazing must continue to be one of the major activities on the native grass lands. In southern Nebraska the fine, silty soil, largely formed on loess, may be plowed with less danger from wind and water erosion. Therefore cereal culture, particularly wheat, extends uninterruptedly farther westward in this part of the state. On these smaller-sized farms more dairying may also be noted. The sandhills, because of their sandy soil, are used almost exclusively for grazing, which is a large-scale enterprise.

Average Number of Cows Milked per Square Mile, 1930 and 1934

Figure 13 shows the average number of milk cows per square mile in the counties of Nebraska in 1929 and in 1934. This cow population is heaviest around urban centers, such as Omaha, Lincoln, Fremont, Norfolk, Grand Island, and Hastings because of proximity to fluid-milk markets.

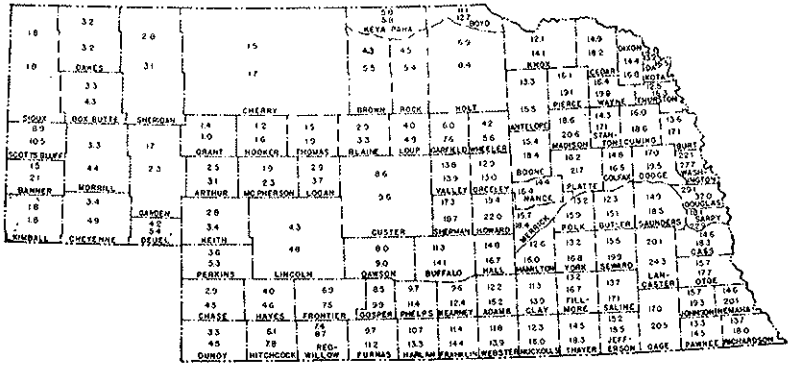

FIG. 13.—Average number of cows milked per square mile during all or any part of 1929 (upper figure) and 1934 (lower figure). Source: Computed from data in *U. S. Census of Agriculture, 1935.*

Aside from the heavier cow population around the urban centers, other areas may be noted where milking receives considerable emphasis. In Figure 13 it may be noted that there is a heavier milk-cow population extending westward along the Republican River than there is in the second tier of counties from the south. The broad flood plain of the Republican River with its underground irrigation makes good pastures, haylands, and cereal crops possible. Equally important, however, is the fact that great numbers of tributary valleys extend from the lowlands of this stream into the plains country flanking it. These rather flat-bottomed valleys with steep walls make for considerable relief. As a result, much land is left in pasture and milking brings in a necessary income on these comparatively undersized farm units. On the level loess plain to the north of this dissected land we find considerably more cereal culture, particularly wheat, and hence somewhat less dairying.

The heavier milk-cow population in eastern Nebraska is merely a concomitant of the heavier human population. The herds of cows are no larger, nor do they play a more important part in the economy of these farmers than in that of the farmers farther west.

Dairying, with the objective of producing cream for butterfat and some milk for cheese, plays a relatively important part in east-central Nebraska north of the Platte River, comprising the territory drained by the middle

and lower courses of the Loup rivers. Some representative counties in this area are Howard, Sherman, Valley, Greeley, Boone, Nance, and Merrick. A number of factors combine to make this a rather popular dairying section. Much land in these counties which is not in flood plains is heavily dissected by long, deep, and fairly steep-sloping headwaters. The relief of much of the country and the texture of the soil favor excessive erosion when the land is broken. This danger counsels the retaining of much pasture land. The farm units are not large enough to allow specialization in the raising of beef animals. Milking brings a greater net return per acre than does stock raising and is practiced rather generally. The numerous streams in the area with subirrigated flood plains provide good pasture, hay, alfalfa, and crop lands. Much feed is raised for the benefit of milk cows. Another contributary factor may be found in the relatively high percentage of Germans, Scandinavians, and Bohemians in the area. The background of these people inclines them favorably towards the dairy cow.

In western Nebraska the number of milk cows per square mile becomes less. This does not mean that the ratio of cows to man becomes smaller; it remains about the same. Milking continues to play a part in other specialized or unspecialized forms of farming.

Average Number of Milk Cows per Square Mile in the Various Townships of Nebraska in 1928 and 1933

Figure 13, which shows the average number of milk cows per square mile in the counties of Nebraska, indicates where most of the milking is carried on in the state. In recent years State and Federal crop statisticians have made available additional data which can be used to make a finer distinction with reference to the distribution of milk cows in this state. Figures 14 and 15 reflect this distinction for 1928 and 1933.

Figure 14 gives an approximation of the number of milk cows per square mile found in the various townships in 1928. It will be noted that the greatest concentration of milk cows is found in the area adjacent to Omaha. Outside of the Omaha milk shed, only one township—and that was in Madison County—showed more than 25 milk cows per square mile in 1928. For this same year concentration of dairying activities is also shown in the southern part of Lancaster County and in Platte and Howard counties. The more westward extension of more concentrated dairying activities in southern Nebraska is also well shown.

Figure 15 shows the approximate distribution of milk cows for Nebraska by townships in 1933. Comparison of Figures 14 and 15 reveals that the concentration of milk cows has been accentuated considerably in certain townships as well as in larger areas. Considerable extension of the Omaha milk shed may be noted, and a striking increase of milk

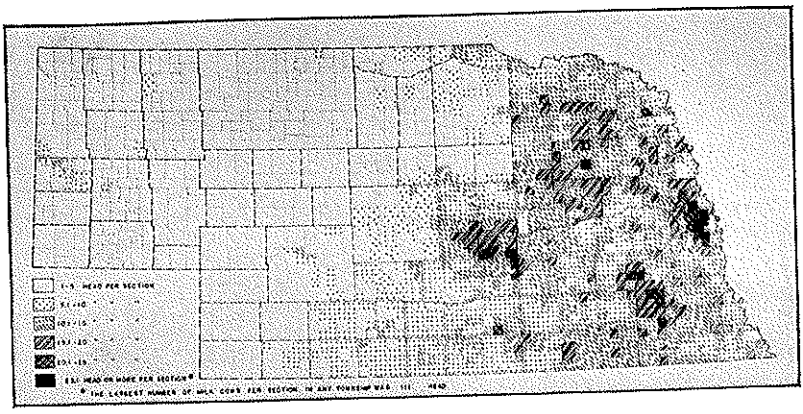

FIG. 14.—Number of milk cows per square mile in the various townships of Nebraska in 1928. Source: State-Federal Division of Agricultural Statistics, Lincoln.

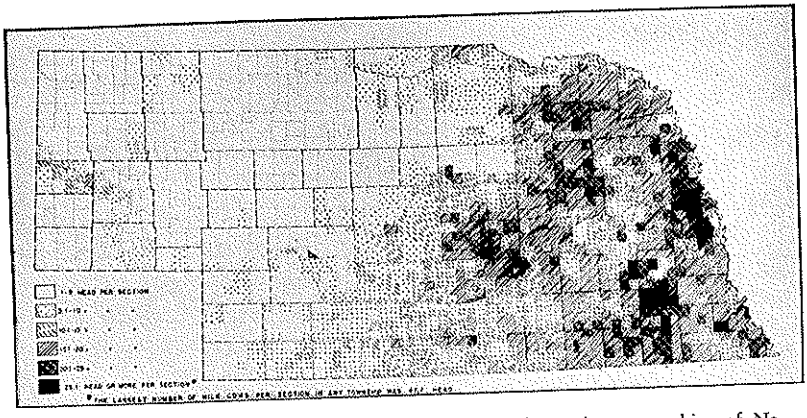

FIG. 15.—Number of milk cows per square mile in the various townships of Nebraska in 1933. Source: State-Federal Division of Agricultural Statistics, Lincoln.

cows has taken place in the Lincoln milk shed. Only one township outside of the Omaha milk shed had a cow population of 25 milk cows or more per square mile in 1928, but 25 townships outside of the Omaha milk shed reported more than that proportion in 1933. A striking increase is also noted in the other cow-population groups listed, particularly in the eastern part of the state. The increased popularity of the milk cow is largely traceable to the depression. Although dairying does not always and necessarily bring a profitable income, it does assure a sustained one. This means much to the farmer when other forms of income are meager and inadequate.

Percentage of Increase or Decrease in Number of Milk Cows from 1920 to 1929 and from 1929 to 1934

The production of creamery butter in Nebraska increased from 58,000,000 pounds in 1920 to about 97,000,000 pounds in 1929. This phenomenal increase in butter production must be based in a large measure on increased milking activities and also to some extent on the increased production of milk per cow. The great increase in milking activities in the state during the twenties must be ascribed to a number of factors, important among which are the economic disturbances following the war. With the resumption of agricultural production in Europe, a highly profitable outlet for many farm products disappeared. This, in part, caused a great drop in farm prices. Deflationary practices aggravated rapidly sinking prices. Of the various farm commodity prices, that of butterfat remained relatively high. This price advantage attracted attention to the milk cow. Equally important was the fact that farmers, like nearly every other class of citizens, had contracted a heavy debt burden. Distressingly low grain and stock prices did not net a satisfactory return to meet financial obligations; consequently family incomes were bolstered up by more milking. In the meantime the increased activities of the Dairy Husbandry Department in the University of Nebraska and other organizations had done much to popularize more and better dairy cows.

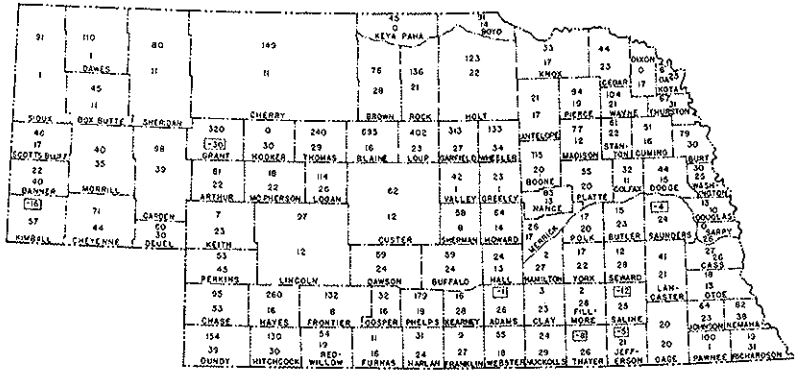

FIG. 16.—Percentage of increase or decrease in number of milk cows in the counties of Nebraska from 1920 to 1929 (upper figure) and from 1929 to 1934 (lower figure). Source: Census of 1920 and *Census of Agriculture, 1935.*

The change in cow-population in the various counties from 1920 to 1929 ranged from a decrease of 30 per cent in Hooker County to an increase of 695 per cent in Blaine County. The milk-cow population of the sandhill counties has always been small, and variation in number may easily appear exaggerated when converted into per cent. The changes in

number of cows milked in these counties do not signify radical changes in the program of the farmers, since in most instances merely a few beef cows are added to or dropped from the milking herd. It is significant to note, however, that the percentage of increase in milk cows is most striking in the sandhills and in certain sections of southwestern Nebraska.

The decrease in number of milk cows in Saline, Thayer, and Jefferson counties is of more than passing interest. This loss in milk-cow population may in part be explained as a concomitant loss or decrease in all cattle population. During the twenties each of these counties except Jefferson suffered a decline in number of cattle per square mile. Previous to the twenties, war-time prices had served to over-stimulate cattle raising in these as well as in many other counties. The low prices of cattle after the war served in part to reduce the cattle population in certain sections of Nebraska. In many sections the drouth years in the latter twenties also compelled a reduction in grazing animals per acre of pasture. As a result, we find that a number of counties had fewer cattle in 1929 than in 1920. However, the striking increase in milk cows in most of the counties during this same period serves as a significant indication of changing farming methods.

Figure 16 also shows a general increase in cow population of Nebraska from 1929 to 1934. Nearly 20 per cent more cows were milked in the latter year though the total milk production in the state was only 9 per cent greater in the same year. This indicates decreased milk production per cow in the drought year of 1934 (see Fig. 16). Although total milk production did increase during the five year period, butter production actually decreased about 6 per cent (97 million pounds to 91 million pounds). It seems probable that more milk and milk products were consumed on the farm during the recent trying drought and depression years. It is not likely that all recent changes with respect to dairying in this state are indicative of more permanent trends.

Average Size of Dairy Herds, 1929 and 1934

Figure 17 shows that milk-cow herds are generally larger in the sandhills than in the remainder of the state and that the average herds in many of the eastern counties are smaller than those found in many of the western counties of Nebraska. The type of cows milked and the length of lactation periods modify these differences to some extent. On the whole, better milk-producing cows are found in eastern than in western Nebraska. The milk cows in the sandhills and in the grazing sections of the state are more consistently of the beef type than are the cows in the eastern part of the state. In parts of the sandhill region natural conditions encourage seasonal milking activity. Grasses usually provide

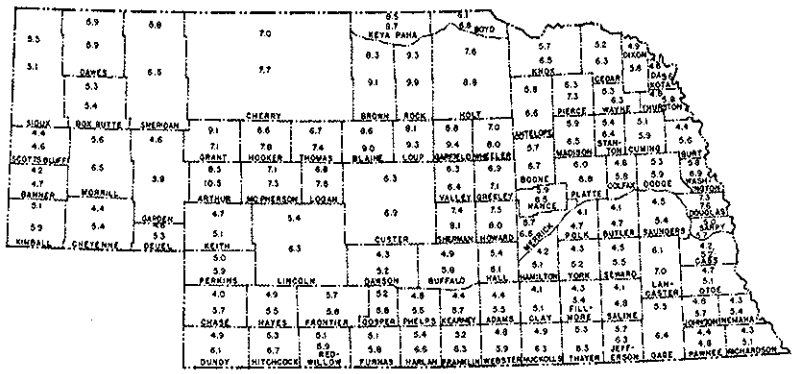

FIG. 17.—Average-sized herds of milk cows in the counties of Nebraska, 1929 (upper figure) and 1934 (lower figure). Source: Computed from data in *U. S. Census of Agriculture, 1935.*

abundant feed for fresh cows in the summer. Milking a number of the better cows and the cows whose calves were lost provides a substantial income which may be had by the application of effort. During hard times more cattle are milked than during prosperous times.

A distinction in the milking activities in the sandhills may be made with reference to the size of ranch or farm units. Ranchers in fairly prosperous circumstances are more loath to undertake milking on a commercial scale than those operating smaller, less prosperous units. Obviously, a greater return per acre may be attained by milking a number of cows. Owners of smaller ranches, as a general rule, milk a considerable number of cows and attempt to extend the milking period over as many months as possible. The cream check is an important sustaining factor to these people, largely because of the limited number of sources of income.

Percentage of Farm Income Derived from the Sale of Dairy Products, 1929

The census of 1930 contains data on the various forms of farm income in the various counties of the United States. Among other things, it lists the amount of income derived from the sale of dairy products, *viz.*, milk, butterfat, and farm butter. Figures on the total income of farmers are also given. That these figures are not fully correct may readily be granted. A moment's reflection on the task of census enumeration will suggest reasons for many variations. It may, however, be argued that these figures possess considerable relative value, even if their absolute value is in a measure unreliable. It is with these factors in mind that Figure 18 is presented.

The relative income from the sale of dairy products in 1929 ranged from 2.1 per cent in Keith County to 15.2 per cent in Rock County. These

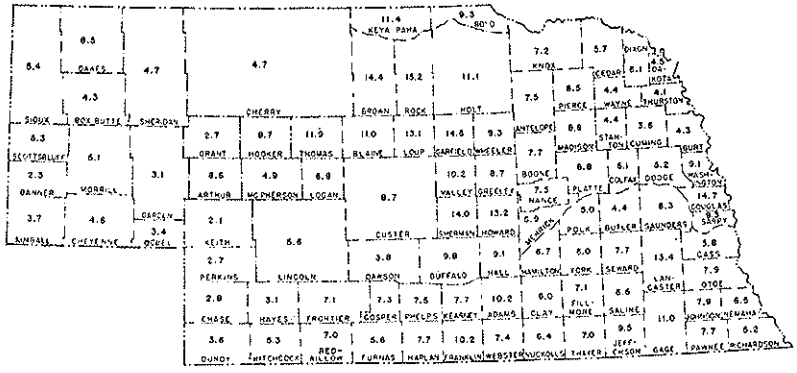

FIG. 18.—Percentage of farm income derived from the sale of dairy products in the various counties of Nebraska, 1929. Source: Census of 1930.

figures do not indicate the total proportion of income derived from dairy products; they show merely the relative importance that milking plays in the farming schemes in the various counties. Income from sources other than dairy products are greater in some counties than in others, and hence the relative income from dairying will be dwarfed to varying degrees. The fluid milk sheds of Omaha and Lincoln account for a relatively high income from the sale of dairy products in Douglas and Lancaster counties. Dairying is more highly concentrated around these cities than in any other section of the state. The relative income from dairy products is even higher in certain other counties where dairying is not so highly specialized. It is obvious that the highly productive nature of the land in Douglas and Lancaster counties encourages the production of other crops which net a considerable portion of the farmer's income. The apparently small income from dairy products in Cuming County does not necessarily indicate less milking in that county than in adjoining ones; it suggests, on the contrary, a greater income from the fattening of stock and the raising of cereals. Consequently, the dairy income is dwarfed.

It is interesting to note the prominent part that milking plays in the eastern part of the sandhills and in the marginal land flanking these hills to the east. In much of this area farm units are too small for extensive grazing activities. Grain production is discouraged in much of this region because of the drouth hazard, and also because of wind and water erosion. Milking is therefore carried on to supplement the income which is largely derived from the raising of beef cattle.

The percentage of farm income derived from the sale of dairy products in Dakota and adjoining counties is small when their proximity to Sioux City is considered. Up to 1930 very few milk routes from Sioux City

penetrated these counties. The percentage of income shown, therefore, largely reflects income derived from the sale of butterfat. Since 1930 a few milk routes have penetrated this section, and the sale of fluid milk in recent years will augment these percentages.

Average Milk Production per Cow in Different Crop Sections of the State, 1932-33

Agricultural activities in different parts of Nebraska vary greatly because of differences in soil, relief, and climatic conditions, and because of other factors. The varying agricultural practices brought about by these differences would suggest that the average production of milk per cow may also vary in different parts of the state. The State Satistician in Lincoln receives about a thousand crop reports from farmers located in all parts of the state. These reports contain, among other things, figures on daily milk production. The results of summarizing these figures are shown in Figure 19. A considerable difference in daily production of milk is to be noted in the various crop districts of the state. The highest average daily production of milk, 22.7 pounds, is found in the east-central crop district of the state, and the lowest daily production, 16.68 pounds, is found in the north-central district, of which the sandhills form the greater part.

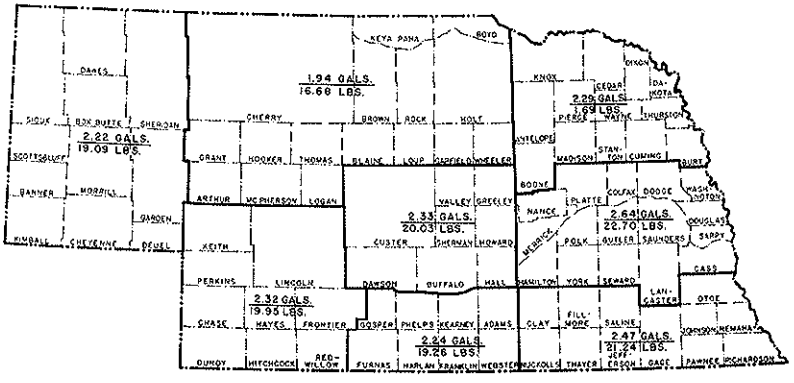

FIG. 19.—Average daily production of milk by cows kept by crop correspondents in Nebraska, 1932, 1933. Source: State-Federal Division of Agricultural Statistics, Lincoln.

The difference in daily milk production reflected in Figure 19 must be ascribed mainly to differences in types of milk cows predominating in the milking herds. The greatest number of better milking cows in Nebraska are found in the east-central crop district, the district which contains Omaha, Lincoln, Fremont, Columbus, and several other prominent towns of the state. Much of the milk produced in this district is sold for immedi-

ate city consumption. Hay and grains are produced in abundance, and many dairymen in this area find it to their interest to increase the milk flow by liberal and good feeding.

A lower daily production record is found in the other districts because of a greater admixture of beef-type cows. It is for this reason that the daily production of milk is lowest in the sandhill region. Other important factors reducing the average milk production in the counties to the westward are poorer pastures, except in the subirrigated lowlands, and in some areas less abundant grain and legume hays.

Percentage of Dairy Income Derived from the Sale of Whole Milk, 1929

A considerable income is derived from the sale of whole milk in many sections of the state, although butter is the main commercial product of Nebraska dairying. The sale of whole milk becomes particularly important in areas adjacent to urban centers. Milk sheds are frequently not so restricted in Nebraska as they might be if dairying were more specialized. As a result we frequently find that milk routes are long and scattered.

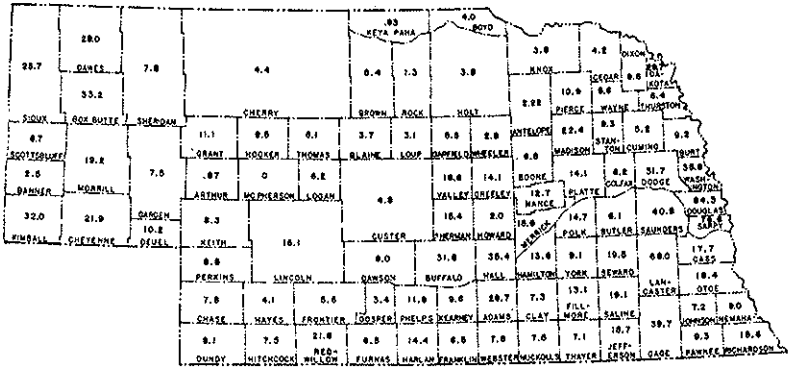

FIG. 20.—Percentage of dairy income derived from the sale of whole milk in the counties of Nebraska, 1929. Source: Census of 1930.

Figure 20 shows the percentage of dairy income derived from the sale of whole milk in 1929 in the various counties of Nebraska. It will be noted that the greatest percentage of income from the sale of milk is derived in areas adjacent to cities. The Omaha milk shed is largely restricted to Douglas, Sarpy, Saunders, Dodge, and Washington counties. The Lincoln milk shed is confined largely to Lancaster County. Beatrice in Gage County affords a considerable fluid-milk market. In the northwestern part of the state, Chadron, Crawford, and Alliance bolster up the income derived from the sale of fresh milk. Scottsbluff similarly provides a city market for a considerable amount of milk.

FLUID MILK IN NEBRASKA

Milking Practices

Practices to be Observed. The dangers that lurk in unapproved methods of milking are quite generally known. In order to provide wholesome milk the following regulations should be observed:

1. Milk must come from healthy cows. All cows should be tested for tuberculosis, have no diseased udders, and show a healthy constitution.

2. The udder and adjoining parts of the body should be clipped at intervals to prevent, as much as possible, the accumulation of dirt and bacteria.

3. The udder should be cleansed by washing or wiping with a wet rag before milking.

4. Feeds with strong and obnoxious odors should not be used. Those which impart unfavorable tastes and odors to milk should not be fed to cows for several hours before milking.

5. Cows should have access only to wholesome water. Stagnant water should not be accessible to the animals for drinking purposes, nor should they be allowed to stand in it. Dangerous bacteria may lurk in such water and may find their way into the milk produced.

6. For fifteen days before a cow calves and for five days after, the cow's milk, as a rule, should not be used as human food.

7. Since milk is an ideal medium for the multiplication of bacteria, it is essential that no disease-producing germs enter it. This is assured in part if the milker is free from infections and performs the milking operation only with well washed hands.

8. Only the small-top milk pail should be used for milking. This greatly reduces the amount of foreign matter charged with bacteria that may fall into the bucket. After use, the utensils should be rinsed and then scalded, steamed, or treated with chlorine solution. Failing such treatment, they should be scrubbed with hot water to which alkali or soda-ash washing powder has been added, and afterwards rinsed. They should then be stored in a clean, well-ventilated place, preferably in the sunlight.

9. Promptly after milking, the milk should be strained through a mesh strainer containing 80 to 100 meshes to the inch.

10. After straining, milk should be cooled immediately to a temperature of 60° to 50° F. or even less. These lower temperatures arrest the growth of bacteria and sustain the wholesomeness of milk for a relatively long period.

11. Cows should be milked in clean and relatively dustless and odorless stables. Stables should be cleaned daily and have plenty of clean, soft bedding.

Necessity for Sanitary Milking Measures. The readily available nutrients in milk provide excellent food for all forms of bacteria. These are not of such dimensions that we can see them with our naked eye; we are constantly surrounded by millions of tiny living forms known as bacteria, which promptly multiply in alarming numbers once they find a proper

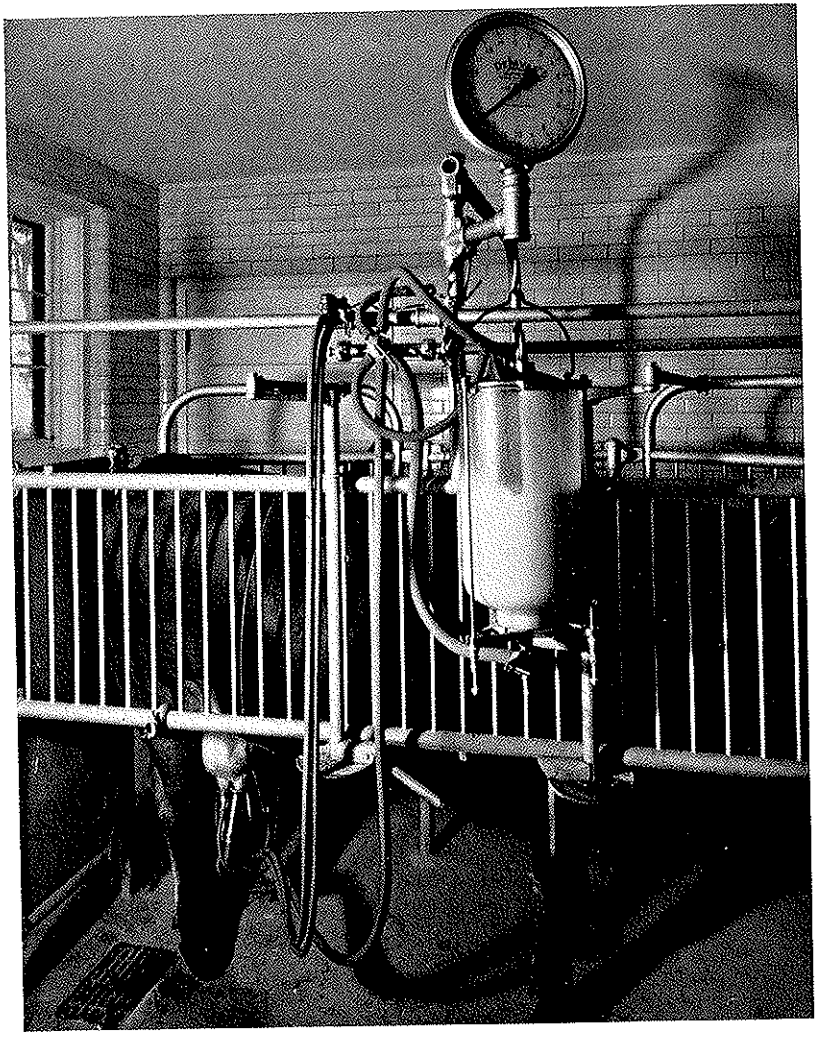

FIG. 21.—Milking machine with automatic milk weighing device. Note the immaculate condition of the lactorium (Picture taken on the Dan Stephen farm near Fremont, Nebraska).

medium. Milk, upon exposure, immediately becomes the host of a great number of these minute bacteria which multiply quickly unless checked by unfavorable temperatures.

The sources of bacteria that get into fresh milk are many. Samples of fresh manure in a stable have been found to contain nearly 50,000,000 bacteria per gram.[1] This stupendous number takes on staggering proportions when we remember that there are 453.6 grams in a pound. Portions of manure, particularly when dry, may readily fall into the milk pail, and immediately the bacteria begin to multiply. Hence, foreign matter of every nature must zealously be kept out of the milk.

Improperly cleaned cows are a ready source of bacteria in milk. This is particularly true when milking is done by hand, as agitation of the udder shakes many fine bacteria-laden particles from the udder into the pail.

The difference in bacteria count between milk obtained from clean cows and that from dirty cows shows the significance of clipping and washing the udder. In tests made by the Bureau of Dairy Industry it was found that fresh milk from dirty cows had an average bacterial count of 55,208 per cubic centimeter, whereas that from clean cows with udders and teats washed averaged only 4,947 per cubic centimeter. A cubic centimeter represents only about 16 drops. Thoroughly cleaned open-top milk pails were used in this test.[2]

The difference in bacteria count between milk drawn into open-top pails and that drawn into small-top pails is equally striking. It was found in 30 samples that milk drawn into the former type of vessel averaged 87,380 bacteria per cubic centimeter, whereas milk drawn into the latter type of vessel contained only 39,263 bacteria in the same volume.[3]

Proper cleaning of milking vessels is equally important from the standpoint of producing wholesome milk. Milk buckets should be rinsed and scalded, steamed, or treated with a chlorine solution after each use. The significance of this precaution is shown by another experiment in which it was shown that milk drawn into pails that had been thoroughly steamed had an average of only 6,306 bacteria per cubic centimeter, whereas samples from pails that had not been steamed averaged 73,308. Equally important are the other precaution measures listed above. Failure to observe these measures may result in diseases, epidemics, and death. A germ

[1] Kelly, Ernest, "Production of Clean Milk," *Farmer's Bulletin No. 602,* U. S. Dept. of Agriculture, p. 7, 1932.
[2] *Ibid.,* p. 7.
[3] *Ibid.,* p. 8.

may be small and invisible, but it is just as real as the sickness and deaths it so frequently brings about.[4]

Necessity for Cooling Milk Promptly. Even with the best of care a goodly number of bacteria will find their way into milk shortly after it leaves the cow. These bacteria are of many kinds, each producing a different effect upon the milk. Some bacteria change either the flavor or the appearance of milk, others change both the flavor and the appearance. The latter class includes the bacteria that sour milk by converting milk sugar into lactic acid and those that cause the formation of curd. Other bacteria decompose the casein and albumin in the milk and hence bring about putrefaction and undesirable odors. To preserve the quality of milk, therefore, it is desirable to maintain the bacteria count at a minimum.

The rapidity with which bacteria multiply in warm milk makes it necessary to cool it immediately after milking. Some types of bacteria are able to divide once every 2 minutes if conditions are favorable. At this rate, a single cell would produce nearly 69 billion cells in 12 hours if all cells lived and divided on schedule. Warm, infected milk would soon reach such a point of contamination as to be unfit for consumption as fresh milk. The rapidity with which bacteria multiply in milk depends more on the temperature of the milk than upon any other factor. Bacteria multiply very slowly if milk is held at 50° F. or lower; temperatures from 70° to 100° F. are highly favorable for the growth of the organisms.

It is clearly apparent that to keep milk wholesome, it must be kept in sanitary containers and be cooled properly. The manner in which it may so be cooled should receive some consideration.

A Cheap and Efficient Method of Cooling Milk. Nebraska farmers producing milk for home use cannot afford to go to much expense or trouble to cool the small amount of milk used in the home. Commonly such milk is stored in the cellar, in the cave, in wells, or in a device which sinks it at shallow depths into the cool earth. Milk kept by these methods will be cooled more promptly and effectively if it is first placed in cool, fresh water. Heat in milk transfers very slowly from the liquid to the air but transfers rather readily from milk to water, particularly agitated water. Once the milk is cooled, it can be stored in the customary places.

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[4] To assure that milk consumed is of satisfactory standard, the state and its many communities would do well to adopt legislation and ordinances advocated by the United States Public Health Service and the Bureau of Dairy Industry of the United States Department of Agriculture. The "safety" measures advocated by these departments may be obtained by a written request to them. Cities and villages are particularly urged to adopt ordinances advocated by these departments. Only in this manner will the health of the citizens of these communities and of the state be properly safeguarded as far as their milk supply is concerned.

Dairymen and farmers producing milk for urban consumption or for cheese or other processing plants should have an efficient method of cooling milk. An economical method that may be recommended in Nebraska is the concrete cooling tank. As the name suggests, this is merely a concrete enclosure having the depth of a ten-gallon milk can. Into this tank the can with the warm milk is set, and fresh, cool water is pumped into the tank. Most Nebraska well water has a temperature of about 52° F., and this provides a very satisfactory cooling medium. It is advisable to connect the cooling tank with the stock tank and to permit fresh water to circulate through the cooling tank during the entire cooling period. Well agitated or circulating water should cool the milk in a ten-gallon can in about one hour.

The Uses of Nebraska Milk

The cows brought to Nebraska during pioneer times served a triple purpose, *viz.*, to perpetuate a beef herd, to supply oxen to be used in the field, and to supply fresh dairy products for the home table. Commercial dairying was restricted or absent in many parts of the state. During the seventies and eighties a number of creameries and a few cheese factories were built in Nebraska, and the farmer supplied a local demand for cream. With the growth of villages, towns, and cities, the practice of delivering milk developed gradually. It is only within the present century, however, that commercial dairying has become prominent in Nebraska.

Estimates have been made in recent years of the ways in which milk is used in the various states. Figure 22, which gives these estimates for Nebraska for 1932, shows that Nebraska farmers produced nearly 2,800,000,000 pounds of milk in that year. Of this amount 1,620,000,000 pounds were separated to produce creamery butter and 328,000,000 were separated to make farm butter. This means that about 71 per cent of the milk

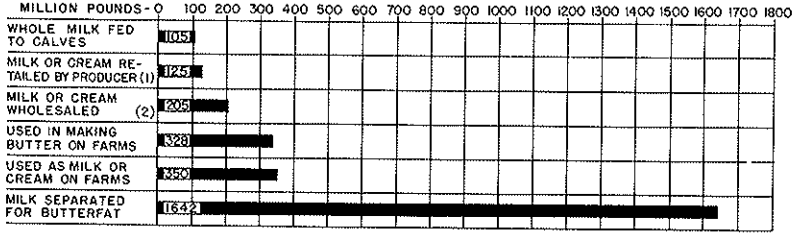

FIG. 22.—Uses of Nebraska milk in 1932.

[1] Approximations based chiefly on population in small towns and rural areas where most families purchase their milk supply directly from local farmers. Estimate includes milk equivalent of cream.

[2] Estimate includes milk delivered to creameries, condenseries, cheese factories, and market milk receiving stations, but excludes market milk sold to other farmers for local delivery. Source: *Statistical Supplement No. 8* to *Milk Production Trends*, U. S. Dept. of Agriculture, Washington, 1933.

produced in the state was used for the production of butter (about 12 per cent for farm butter and 59 per cent for creamery butter). About 13 per cent, or 350,000,000 pounds, was used as milk or cream on farms. Nearly 12 per cent was retailed by the producers or sold wholesale. This represents the bottle milk sold fresh in towns and cities as well as milk which was condensed, powdered, or converted into cheese. A small amount of milk, about 3½ per cent, was fed as whole milk to calves. From the standpoint of milk use, butter is clearly the main commercial end product of Nebraska dairying.

Urban Milk Supply in Nebraska

The present method of distributing milk to village and city folks is a relatively new development. Half a century ago it was still the common practice of residents to keep one or several cows on small plots of ground in and about the city or village. These cows produced well in summer but poorly, if at all, in winter. Butter was made with great effort from small accumulations of cream. This simple and direct system of milk procurement resulted naturally from existing conditions. Improved milking stock was still scarce in those early days. Little effort was made by proper feeding and calving to extend milk production through the winter. Refrigerator systems were limited to large plants, and the use of ice boxes was not very widespread. The absence of the automobile and of improved roads further served to maintain the simple system of that day.

Today the efficient procurement of milk and cream from widespread areas has served to displace the cow almost entirely from cities. Only in small towns and villages are family cows still numerous, and even in these places milk delivery is constantly becoming more popular.

Milk Supply of Villages. Supplying milk to the villages and towns of Nebraska is, on the whole, not a highly specialized activity. The absence of rigid restrictions and regulations regarding the local milk supply lays the field open to any number of competitors. Since very few farmers know the cost of producing milk and other dairy products, discouraging competition results. Prices are cut to such a point that the best facilities or even necessary facilities for the production of good milk are frequently omitted.

A reasonable price must be obtained if the producer of milk is to maintain necessary facilities and standards. In the absence of village regulations, almost any kind of milk may be marketed. Milk may be produced by those who maintain no standards whatever with respect to cleanliness and fitness of animals milked. Many small producers are not aware of their production costs and sometimes set the price of milk at a dangerously low level. Other dairies must also lower their prices or lose customers. The small income resulting from operation under these conditions may bankrupt one or several of the milk producers. These conditions

bring about an unsatisfactory standard for much of the milk sold in many of our villages and towns.

The Problem of Pasteurization in Villages and Towns. The small market for milk in villages discourages the practice of pasteurizing the milk. In the absence of pasteurization rigid standards should be adopted with regard to testing dairy herds for tuberculosis and other infectious diseases, as well as to maintaining sanitary milking measures and satisfactory methods of storing and distributing milk. Unfortunately such standards are not maintained in all dairies. Prior to the present program of tuberculosis eradication, considerable milk from untested cows was marketed.

Pasteurizing plants are more common in cities with a population approaching a thousand people or more. The need of such plants in all towns is unquestioned. In general, however, such plants have a difficult time to maintain themselves because of the additional processing cost of pasteurizing. Purveyors of pasteurized milk cannot compete with others not required to pasteurize or to maintain desirable standards. As a result we find many pasteurizing plants in the state operating at a loss or not at all.

Milk Supply of Large Cities. Providing milk for large urban centers has developed into one of the major industries of the land. To make the development possible, modern mechanical devices have played an important part. So technical has the processing of milk and its products become that large agricultural colleges give four-year courses in dairy husbandry.

Large dairy plants carry on the processing of milk in a scientific manner. To describe all these processes would be impossible in the scope of this bulletin; however, a generalized picture of methods of processing milk and milk products in these plants will be presented.

Milk Procurement. The first step in the operation of a large milk plant is that of milk procurement. In Nebraska nearly all the milk is gathered by trucks along milk routes and is then delivered to the plant. The length of such routes varies considerably. Milk producers live as far as 30 and 40 miles from the city in which the milk is sold and in some instances even greater distances. This means that some trucks must travel at least twice this distance every day on their milk-gathering trips. The amount the farmer pays for having his milk hauled is usually determined by the distance he lives from the dairy. Transportation costs in the Lincoln milk shed vary from 10 to 25 cents per hundred pounds. A graduated hauling charge is desirable in order that farmers living close to the plant do not have to pay part of the hauling charge of those located at greater distances. The cost of hauling milk is either directly or indirectly paid by the farmer.

Milk gathering trucks are expected to cover their routes in the early and middle forenoon. At the dairy, the milk cans are unloaded at the receiving platform on rolling conveyors (Fig. 23) and brought before the milk inspector. Here the milk is graded by smell or taste, or both. The quality of the milk determines its immediate disposition. If the milk is poor, it should be returned to the producer. If the milk has slight off-flavors, it will be used for purposes other than bottle milk.

FIG. 23.—Milk gatherers unloading a day's haul at the dairy plant (Picture taken at the Roberts Dairy Company plant, Lincoln).

After the milk is graded, samples are taken for the butterfat test. At intervals the better dairies also make acidity tests, bacteria tests, and sediment tests of each patron's milk. These tests reveal the quality of the milk with reference to freshness and content of foreign matter. The information gained by these tests may then be used to compel milk producers to take essential sanitary precautions as well as to cool the milk properly before disposing of it to the milk hauler.

The graded and weighed milk is usually put into a preheater and heated to about 90° F. Then it is filtered or clarified to remove a considerable amount of the foreign matter.

Pasteurization. Pasteurization of milk consists of heating it to a temperature of not less than 142° F. for 30 minutes and then promptly cooling it to 38° or 40° F. or somewhat lower. It is highly essential that all of the milk be heated to a temperature of 142° but not more than 143° F., unless the flash system of pasteurizing is used. If the milk is heated to temperatures above 143° F. and held at such high temperatures, the cream layer is injured; if it is not all heated to 142° F., all of the disease-producing bacteria will not be killed or rendered innocuous. The flash system of pasteurizing consists of heating the milk instantaneously to about 180° F. Because of the limited time at which the milk is held at this higher temperature, no pronounced deterioration results in the milk and cream processed.

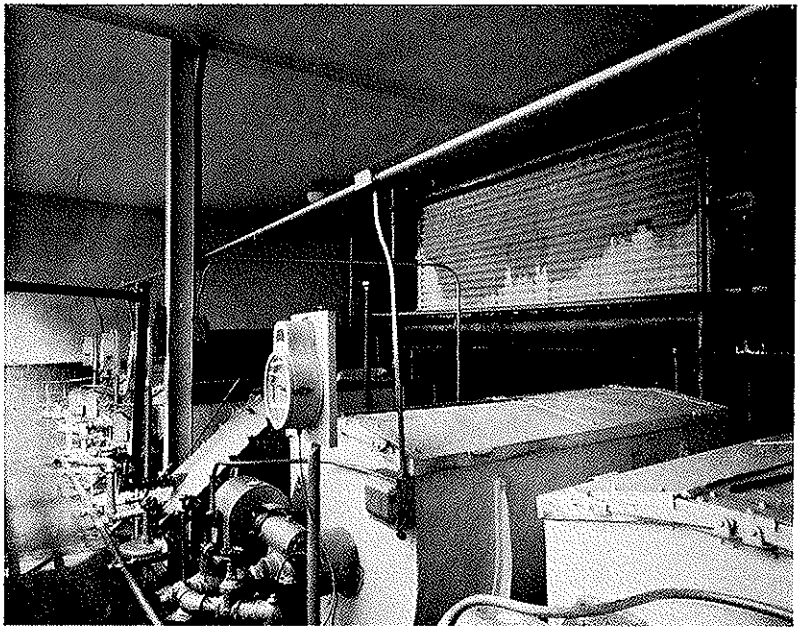

FIG. 24.—A series of milk pasteurizers and a milk cooler (upper background) (Picture taken in the Beatrice Creamery Company plant, Lincoln).

Cooling of milk after pasteurizing is accomplished by running it over pipes, some of which contain cool water or some other cooling agent. After being cooled, the milk is ready to be bottled. In larger dairies the milk is bottled and the bottles are capped by automatic machinery (Fig. 25). The bottled milk is then placed in refrigeration rooms until it is delivered to homes or to retailers.

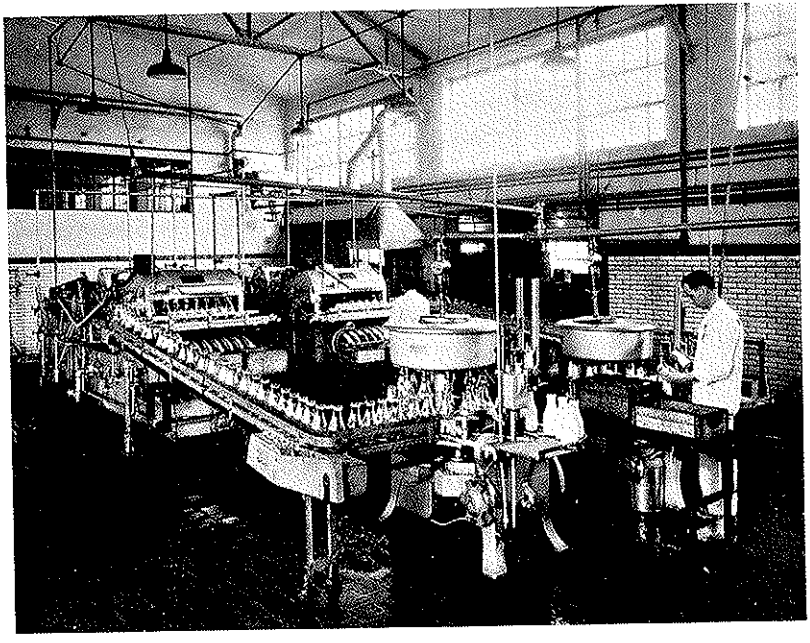

FIG. 25.—Automatic milk bottle washer and filler (Picture taken in the Roberts Dairy Company plant, Lincoln).

Some Uses of Surplus Milk

The daily demand for bottled milk is variable. A large dairy, however, cannot afford to place a minimum milk supply on the market and thus frequently fall short of meeting demands. To avoid such predicaments a safe margin of surplus milk is bottled daily. Some of this milk is returned with the delivery wagon or truck. Other milk is returned after remaining in the hands of retailers for about 24 hours. This milk must be utilized profitably and is variously used by dairies. Some plants separate it and convert the skimmilk into cottage cheese. On the whole, this method is unapproved and is not used by plants equipped to dispose of returned milk profitably by other methods. In some instances it is merely skimmed and sold back to the farmer as feed, a none too profitable method of disposition. Plants equipped with a vacuum pan find it profitable to manufacture the skimmilk into a condensed product, such as condensed skimmilk. One of the large dairy plants in Nebraska converts much of it into a skimmilk powder. Both of these products are in great demand by ice cream manufacturers, bakeries, candy manufacturers, and slaughter houses.

The cream may be used to manufacture ice cream, butter, or may be disposed of in other ways.

Some of the larger dairy plants of the state not only sell bottled milk, but many of them, as has been indicated, also produce cottage cheese and butter. In addition, some of them manufacture one or several of the following products: ice cream, cheddar cheese, various forms of condensed milk, powdered milk, spray-processed milk, and flaked buttermilk. The processing of various forms of skimmilk products[5] will be described briefly in this study.

Sweetened Condensed Skimmilk. Sweetened condensed skimmilk has in recent years become a popular ingredient of bakery bread and candy. Not only does the addition of some form of condensed milk improve the texture, appearance, and taste of these products, but its use in varying quantities also enables the baker or manufacturer to advertise the fact that his candy, bread, or other product contains wholesome milk. If milk is added to these products in sufficient amounts, such advertising is perfectly justifiable.

As its name indicates, sweetened condensed skimmilk is a separated milk, and the condensed product will contain very little fat. It is condensed at the ratio of 2⅓ to 2¾ parts of fresh milk to one part of condensed milk. The amount of sugar added varies, but normal variations range from fourteen to twenty pounds of sugar per one hundred pounds of fresh milk.[6] The addition of sugar adds considerably to the keeping qualities of the finished product. Condensed skimmilk will keep for many months but is more satisfactory when used fresh.

Milk to be condensed is first heated almost to the boiling point. This is done to destroy part of the bacteria and ferments, to aid in the solution of the added sugar, and to prevent the milk from burning when it is run into the vacuum pan. The milk is heated either by running steam directly into it or by turning steam into the jacket of the large milk container. If this latter method is used, the milk must be agitated to keep it from burning.

From the heater the milk is drawn into the vacuum pan (Fig. 26) where it is condensed under a partial vacuum, usually under a pressure of 25 to 26 inches. Under this reduced pressure milk will boil at a temperature of about 140° F. Condensing the milk under a partial vacuum is advisable because a lowering of the air pressure results in boiling at a lower temperature. Boiling at this lower temperature, in turn, serves to preserve the original flavor of the milk; in other words, under this treatment milk does not acquire the boiled taste.

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[5] At present no sweetened condensed milk, evaporated milk, or plain condensed milk—all whole-milk products—are produced in Nebraska.

[6] Hunziker, Otto F., *Condensed Milk and Milk Powder* (5th edition), p. 68.

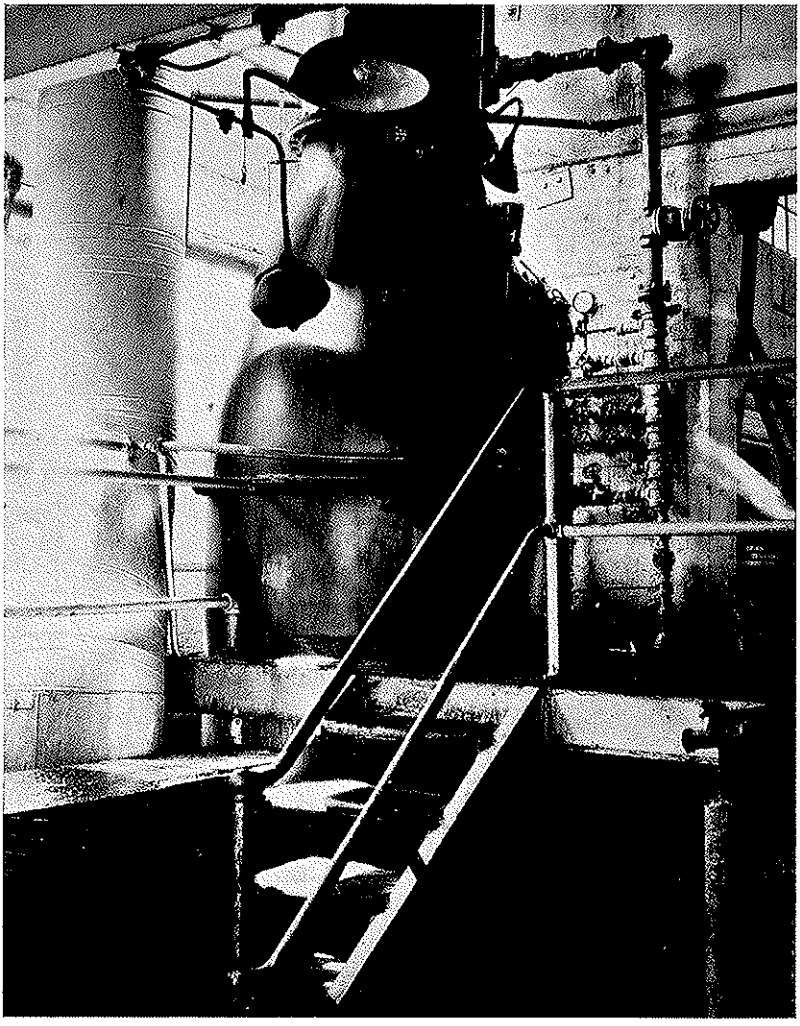

FIG. 26.—A vacuum pan used to condense whole milk, skimmilk, or buttermilk. In this device the product to be condensed is heated under a partial vacuum, thus reducing its boiling temperature (Picture taken in the Roberts Dairy Company plant, Lincoln).

The vacuum pan is constructed of copper or stainless steel and is attached to a condenser and a vacuum pump. The condenser serves to condense the vapors rising from the milk pan, and the vacuum pump serves to reduce the pressure in the pan.

When the milk in the pan has been condensed to a ratio of about 2.5 parts of fresh milk to 1 part of condensed product, it is ready to be drawn and cooled. When the condensed milk is drawn, it must be cooled very promptly to prevent superheating. To accomplish this the milk is drawn into coolers that are mechanically agitated like ice cream freezers. Following this operation the condensed milk is placed in barrels or other containers and sealed.

Fresh, Unsweetened Condensed Skimmilk. Fresh, unsweetened condensed skimmilk is a product used extensively today by ice cream manufacturers and to some extent by bakers. In its condensed form it may also be sent to skimmilk powder plants where it is further concentrated into powder form. The addition of this substance to mix serves to build up the solids in ice cream. This is necessary to give the ice cream a proper and smooth body. Unsweetened condensed skimmik is sold in 10-gallon cans or in barrels. Since the product is not sterile, nor preserved by sugar, its keeping quality is about equal to that of common pasteurized milk and it must be used promptly.

Unsweetened condensed skimmilk is made by a process similar to that used in making sweetened condensed skimmilk. As the name indicates, sugar is not added to this product. The milk is preheated before it is run into the vacuum pan. In the pan it is condensed to the ratio of from three to four parts fresh skimmilk to one part of condensed milk. When the condensation process is nearly completed, the milk may be superheated for a period varying from 25 to 30 minutes. This is accomplished by blowing steam directly into the milk while the condenser and vacuum pump are shut off. The inflowing stream serves to swell and thicken the milk to a desirable consistency, commonly spoken of as "proper liver." Following this operation normal pressure is established in the pan. The milk is then drawn off into the marketing containers.

Spray-Process Skimmilk Powder. At the present time, only one plant in Nebraska is manufacturing spray-process skimmilk powder. This plant is located at Waterloo and receives its raw product from both the Omaha and the Lincoln milk sheds. Spray-process skimmilk powder is becoming increasingly popular for baking, candy making, and for preparing various forms of meat products. The powder ordinarily retails at 7 to 8½ cents a pound; this is slightly higher than the price of roller-process skimmilk powder which ordinarily sells for 6½ to 7¼ cents a pound. The absence of fat in skimmilk powder enhances its keeping qualities. It is advisable, however, to use the product before it is many months old.

Milk arriving at the Waterloo plant is handled similarly to milk brought to other milk plants. It is graded, dumped, sampled, weighed, and pasteurized. Then it is separated. The cream is cooled and sent to Omaha where it is disposed of as bottle-cream or is used by various plants in the making of ice cream. The remaining skimmilk is preheated to 185° F., held at this temperature for 30 minutes, and then condensed to 30 per cent milk solids. This concentrated skimmilk is run through a series of heated chambers, after which it is sprayed into a drying chamber where it is reduced to powder form. The powdered milk is packed and sold in 200-pound barrels and 100-pound drums.

Roller-Process Skimmilk Powder. Roller-process skimmilk powder is a product similar to spray-process skimmilk powder although its texture is not quite so smooth, nor is its color necessarily so consistently white. The variation in color is due to non-uniform heating of the drying cylinder often resulting in partial burning of the milk in the drying process. This condition may also result in imparting a burned flavor to the processed milk. Roller-process skimmilk powder is used principally by meat packers in the making of sausage and by feed mills in the preparation of stock feeds.

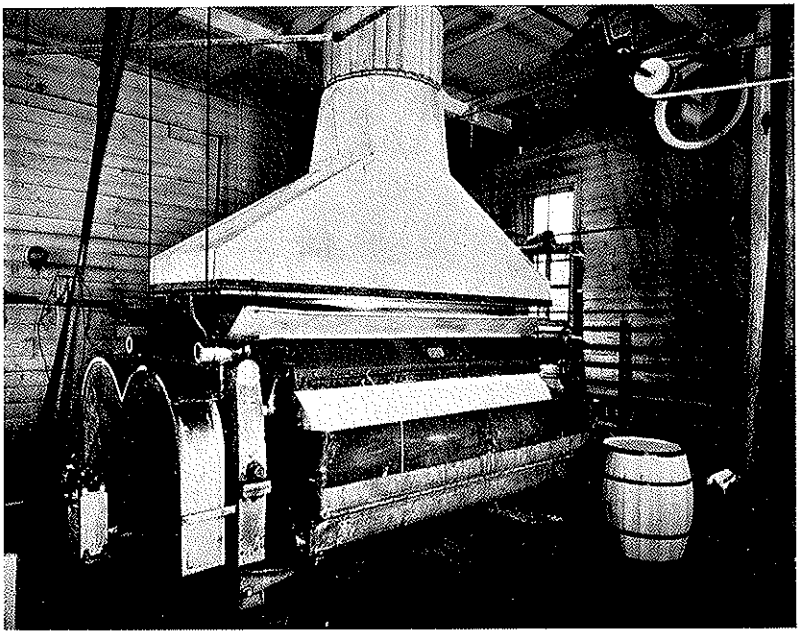

FIG. 27.—Machine used in making dried milk and buttermilk by the roller process (Picture taken in the Roberts Dairy Company plant, Lincoln).

Roller-process skimmilk powder is made from skimmilk that cannot be used profitably for other purposes. Before it is fed to the heated roller it may be condensed, so that the milk has a high percentage of solids. It is then passed over a steam-heated, revolving roller which makes several revolutions per minute. The skimmilk forms a dried film on the roller which is automatically removed by a sharp knife. The flaked milk is then conveyed by screw conveyors to a sifter or breaker to create flakes of uniform size. The product is sold in 200-pound barrels or 100-pound sacks. The output of roller-process skimmilk powder or flaked milk is increasing, particularly to supply feed demands.

Various Bases of Milk Prices for Producers

Many different methods of determining milk prices for producers prevail in Nebraska. The simplest method is that in which the producer distributes his own bottled milk and charges the price that will bring or hold a desired number of customers. The cost of production cannot be lost sight of under this method, at least not for a sustained period of time. Competition in places where this system of milk distribution is common may be severe and disheartening, particularly to the better milk producers.

Butterfat-Content Plan. A more common method of determining the amount paid to milk producers for their product takes into account the butterfat content of milk. This plan usually bears some relationship to local butterfat prices. According to this plan, for example, the farmer may be offered 30c per pound for the butterfat and also an additional consideration for the milk. An example may serve to clarify this. If the milk price of a dairy is 30c for butterfat and 6c for skimmilk, milk containing 4% butterfat would bring the following price:

30c x 4 = $1.20
6c x 4 = .24

$1.44 per hundred weight.

Lincoln "Classification" or "Use" Price Plan. As previously stated, the larger dairies in this state may and do process more than bottled milk. This means that more milk is purchased than is used for bottling purposes. The varying demand for bottled milk dictates the purchase of a safe margin of fluid milk. Since the production of milk by various milk producers fluctuates seasonally, dairies must arrange to purchase milk from enough producers to assure an adequate supply at all times. This means that the milk shed of a large city such as Lincoln or Omaha comprehends more milk producers than the normal consumption of bottled milk requires. Since a varying amount of milk may be bottled from day

to day, or varying amounts may be processed into other products, it is inadvisable and impracticable to pay each and every farmer according to the way his particular milk is used. Under the "classification" plan, therefore, the milk is pooled, and all producers are paid according to the percentage of milk allocated to classes I, II, and III, as shown below.

The Lincoln "classification" or "use" price plan represents a milk marketing arrangement between the Lincoln Non-Stock Cooperative Milk Producers Association and the prominent dairy plants in Lincoln. The price arrangement may be changed at any time by mutual agreement of the contracting parties, and frequent changes occur. The present plan (May 26, 1937) is presented merely to indicate the rather complicated nature of price arrangements that have been developed.

The current plan groups the milk of the association's members into classes I, II, and III for differential payment. Class I represents bottle milk, class II represents bottle cream or bulk, fresh table cream, and class III represents milk used for all other purposes. The prices offered for these classes at present are:

Class I. Fifty-three (53) cents per pound of butterfat.

Class II. The average price per pound of 90-score butter "centralized carlots" in the Chicago market as reported by the Department of Agriculture for the delivery period during which such milk is purchased, plus twenty (20) per cent thereof, plus four (4) cents.

Class III. The average price per pound of 90-score butter "centralized carlots" in the Chicago market as reported by the Department of Agriculture for the delivery period during which such milk is purchased, plus or minus at the rate of one-fourth cent (¼c) for each one cent (1c) that such price is above or below twenty cents (20c), plus four cents (4c).

It will be noted that the Lincoln "classification" or "use" plan does not encourage an even production of milk the year round by the various producers of milk. An increased flow of milk by all producers in the spring will result in lower individual returns, since more milk falls into classes II and III. This, in turn, penalizes the dairymen who attempt to sustain an even flow the year round by calving cows at stipulated times and by proper feeding. It seems desirable that such efforts should be rewarded by a more consistent base pay for each producer for a given amount of milk.

Omaha Combination of the "Classification" or "Use" Plan and the Basic-Surplus Plan. The Omaha plan of determining the price for the milk producer is similar to the Lincoln plan but has the added feature of compensating the producer for producing a uniform volume of milk throughout the year. It is called the basic-surplus plan. A basic quantity is established by each producer, for which the distributor pays the class I or market-milk price. The price of No. 1 milk is determined previously at

a meeting held by representatives of the producers and distributors. Usually the fall months of October, November, and December are taken as the base period to determine the producer's basic production because it is during these months that the production of milk most nearly approximates the consumption of fluid milk. All milk above the agreed amount is considered surplus milk and brings a lower price.

Milk Marketing Associations of Omaha and Lincoln

The milk market offered by Omaha and Lincoln is of such magnitude that a number of large dairy plants have developed in these cities. These dairy plants have much money invested in intricate processing machinery and distributing facilities. They are also manned by dairy-product specialists who can process milk well and to the best advantage. Such large-scale operation naturally leads to a degree of efficiency and economy that cannot easily be matched by a host of smaller producers. For this reason most of the milk marketed in these large cities passes through the hands of the large dairy plants.

The large dairy plants determine to a great extent the price which the milk producer receives for his product. Within limits, the dairy plant desires to purchase its milk supply at rather modest prices. The milk producer hopes to receive an adequate, or shall we say maximum, return for his milk. The consumer in the city wants to purchase milk as reasonably as possible. Milk consumption varies greatly with the price of this food. The milk distributor would like to increase consumption to a maximum at a reasonable price. Obviously conflicting interests clash on this matter of price determination.

The majority of the milk producers in the Omaha and Lincoln milk sheds are organized for the purpose of collective bargaining. Although the purpose of these organizations is more comprehensive than merely price bargaining, this objective nevertheless plays a highly important part in their program.

The Nebraska-Iowa Non-Stock Co-operative Milk Producers Association. Membership in the Nebraska-Iowa Non-Stock Co-operative Milk Producers Association is open, upon the payment of a membership fee of $10.00, to all persons owning or controlling dairy cows in the Omaha milk territory. The main objective of the organization is to obtain the best possible marketing agreement for its members. Should the organization feel that it cannot obtain what it considers a fair price, it is empowered, by the articles of incorporation, to engage in the processing and distribution of milk products. This potential threat is used, it seems, merely to strengthen the bargaining ability of the organization. The association is also empowered to engage in other activities designed to help the milk producers. Information relative to the breeding of cattle is gathered and distributed. It may

engage in advertising to popularize the consumption of dairy products. It may obtain state or Federal loans or loans from other sources to be used for promoting the interest of members individually or collectively.

The Lincoln Non-Stock Co-operative Milk Producers Association. A producer may acquire membership in the Lincoln Non-Stock Co-operative Milk Producers Association by paying a fee of 25c per cow owned or in his control when he signs the membership agreement. Members further agree to surrender 5 per cent of their daily milk return or check to the organization.

The Lincoln Non-Stock Co-operative Milk Producers Association is also primarily incorporated to bargain for favorable milk prices. To further its bargaining ability it is also empowered, by the articles of incorporation, to engage in the processing and distribution of milk. The 5 per cent of the producer's check which it collects is presumably accumulated to make feasible an execution of this threat.

Milk Producers' Organizations and Quality of Milk Sold. As has been stated, the Nebraska-Iowa Non-Stock Co-operative Milk Producers Association and the Lincoln Non-Stock Co-operative Milk Producers Association of the Omaha and Lincoln milk sheds are primarily bargaining associations which serve the interest of the milk producers. Such organizations are numerous throughout the land and serve a definite function in the intricate industrial system of today. Although these organizations are empowered to enter a wider field of service for the producers, this power has been utilized but little. The interposition of the milk producers' organization between the producers and the processors of milk has complicated the problem of setting standards of quality for milk which is purchased by the city dairies. The absence of a direct relationship between the milk processor and the milk producer has served, in the case of these two cities, to forestall the payment of a graduated price based on the quality of milk. Obviously, quality milk merits a higher price than milk improperly cooled and containing considerable filth. There are farmers in these milk sheds who spare themselves no time and expense in producing excellent milk. Under the present system they are not rewarded for their superior product. Additional farmers are, no doubt, willing to produce better milk if their efforts will be rewarded as they should be. Under the present system a great majority produce milk of mediocre and poor quality and profit as much by this enterprise as do the best producers.

The responsibility of improving the quality of milk sold in urban centers belongs definitely to the city governments, more particularly to the city health departments. With the adoption of stringent city ordinances with respect to the quality of milk that may be sold and the appointment of nonpolitical expert inspectors, the conditions in Nebraska's major urban

milk sheds would lend themselves to material improvement. In addition, methods ought to be devised which properly reward the producer of quality-milk.

Quality of Milk in the Lincoln Milk Shed

In 1932 Professor P. A. Downs of the Department of Dairy Husbandry, University of Nebraska, published a bulletin entitled "A Seven-Year Study of an Eastern Nebraska Milk Supply."[7] This publication reports the quality of the milk delivered to a Lincoln market over a seven-year period by a representative group of milk producers in eastern Nebraska. We may assume that the Omaha and the Lincoln milk supply as well as the milk supply of many other urban centers of this state is comparable to the milk studied for this report. The publication reveals much of interest.

Barns and Method of Stabling. According to the report, 81.5 per cent of the farmers housed and milked their cows in combination barns. In this form of barn, the milk cows are stabled in a building in which horses and other farm animals are also kept. This form of barn is very unsatisfactory from the standpoint of creating off-flavors in milk, because of odors in the barn and also because of a high percentage of dust and dirt particles in the air which contaminate the milk and cause a high bacteria count.

It was also found that the majority of the barns were not equipped with sufficient windows. Twenty-two per cent of the barns had no windows in the cow stables, and 39 per cent had only one or two windows. A minimum standard requirement for dairy barns is at least three square feet of window for each stanchion. The absence of sufficient light indicates very strongly the absence of proper hygienic conditions under which milk for human consumption should be produced. The study of floors and gutters also showed unsatisfactory standards for a high percentage of the farms.[8]

Milk Houses and Cooling Equipment. The most satisfactory method of handling fresh milk is to remove it to a separate building, and there strain it and cool it in sanitary utensils. Of the 92 farms studied, only 6.5 per cent had milkhouses in such repair that they could be kept sanitary. In the majority of places the milk was handled in the barn or in the open. Either method is highly unsatisfactory.

Cooling the milk was in most instances also accomplished by unsatisfactory methods. On 56 per cent of the farms, livestock watering tanks were used to cool the milk. Unless completely filled with freshly pumped water, such tanks do not sufficiently cool the milk to check the growth of bacteria properly. Small, shaded tanks, which may readily be filled with

[7] *Bulletin 270*, University of Nebraska, College of Agriculture Experiment Station, Lincoln.

[8] *Ibid.*, p. 9.

fresh water, are much more satisfactory for this purpose. Only 28 of the milk producers studied had such small cooling tanks.

Quality Determination. The quality of the milk produced by the 92 producers was determined by running the sediment test and bacterial counts once a week. The sediment test consisted of filtering one part of milk through a cotton filter, which was then rated. The percentage of farmers falling into the various rating groups is shown in Table 3. The rating of farmers by bacterial count of milk is also shown in this table.

TABLE 3.—*Percentage Distribution of Milk Producers near Lincoln by Quality of Milk Produced*

*Quality determined by sediment score, bacterial count, and both, as reported in a Nebraska study**

Basis of Grade and Grade	1924	1925	1926	1927	1928	1929	1930
Sediment score							
Excellent to good, 7 or above	10.1	20.4	33.5	45.3	84.6	91.2	88.1
Fair to poor, 3 to 7	20.8	65.0	53.7	50.2	14.7	8.6	11.8
Unsatisfactory, below 3	69.1	14.6	13.8	4.5	0.7	0.2	0.1
Bacterial count							
Excellent to good, under 100,000 per c.c.	52.5	63.8	34.3	48.2	51.4	63.9	65.3
Fair to poor, 100,000 to 1,000,000 per c.c.	16.7	17.3	29.8	23.8	20.2	14.8	19.2
Unsatisfactory, above 1,000,000 per c.c.	30.8	18.9	35.9	28.0	28.4	21.3	15.5
Sediment score and bacterial count							
Excellent to good	5.2	13.4	14.2	25.4	44.9	58.8	57.9
Fair to poor	64.0	67.8	48.9	46.6	26.8	19.9	26.4
Unsatisfactory	30.8	18.8	36.9	23.0	28.3	21.3	15.7
Total number of samples	984	1236	1534	1885	2630	3288	3355

* From P. A. Downs, "A Seven-Year Study of a Milk Supply," *Bulletin 270*, University of Nebraska, College of Agriculture Experiment Station, Lincoln, 1932.

Attempts Made to Improve Quality of Milk. During the first three years covered by Professor Downs' study of the milk supply no reports were sent to the producers as to the quality of the milk they produced. Several meetings were held, however, at which the quality of the milk was revealed and discussed. Methods of improving the milk supply were also discussed. Beginning in March 1927, each producer of milk was informed as to the quality of his milk, and this practice was continued during the remainder of the period. In July 1928, a further stimulus for production of quality milk was added in the form of a bonus of three cents per pound of butterfat to those who delivered milk with a sediment score of seven or above and a bacterial count of less than 100,000 per cubic centimeter. In March 1930, the payment plan was further modified by deducting five cents per pound of butterfat from the regular price for all milk that showed a bacteria count of over one million per cubic centimeter.

The results of Professor Downs' study with regard to milk improvement are significant (Table 3). It was found that reports to patrons on sediment and bacterial count brought about only slight improvement in the quality of the milk. Once the system of bonuses and deductions based upon milk quality was adopted, improvement in milk quality was rapid.

The moral of Professor Downs' study is clear. Farmers producing bottle milk in the state should frequently have their milk tested as to sediment, bacteria, and even acidity, particularly during the warm periods of the year. Such tests should be made by a disinterested dairy specialist. The results of these tests should be brought to the attention of the milk producer. The tests should be accompanied by a payment plan of bonuses and deductions that properly rewards or punishes the producers of milk of various qualities. Milk below a minimum standard should be condemned and not be processed for human consumption. Health authorities should be qualified and authorized to cooperate fully with such a milk-quality program. A system of authentic information and proper rewards would soon lead to better dairy equipment and methods.

IMPROVING THE NEBRASKA MILK COW

In 1933 the average milk production per cow in Nebraska was 4,200 pounds.[1] During the same year the average milk production per cow in Rhode Island was 6,300 pounds, and in Louisiana it was 2,070 pounds. The latter two states represent the extremes in annual milk production recorded for 1933. For the United States the average production per cow was 4,178 pounds, slightly less than of Nebraska. Up to 1933 the annual average milk production per cow in Nebraska was less than the average for the United States. That the state has exceeded this record of late is gratifying, for it indicates a degree of improvement in dairy stock which surpasses that of many other states. Of equal interest to Nebraska is the average amount of butterfat produced per cow in the state as well as in certain other states. It is estimated that in 1933 the average cow in this state produced 160 pounds of butterfat.[2] For Rhode Island and Louisiana respectively the estimated production was 243 and 91 pounds. These two states also represent the extremes for the United States in the production of this dairy product.

A cow that produces 12,000 pounds of milk a year does not eat three times as much as a cow that produces 4,000 pounds; hence, other things being equal, the former cow will net proportionately more than three times as much profit as the latter cow. A considerable number of studies that have been made indicate the relationship that exists between milk and butterfat production per cow and the income from such animals over feed

[1] *Yearbook of Agriculture*, 1934, p. 628.
[2] *Ibid.*, p. 629.

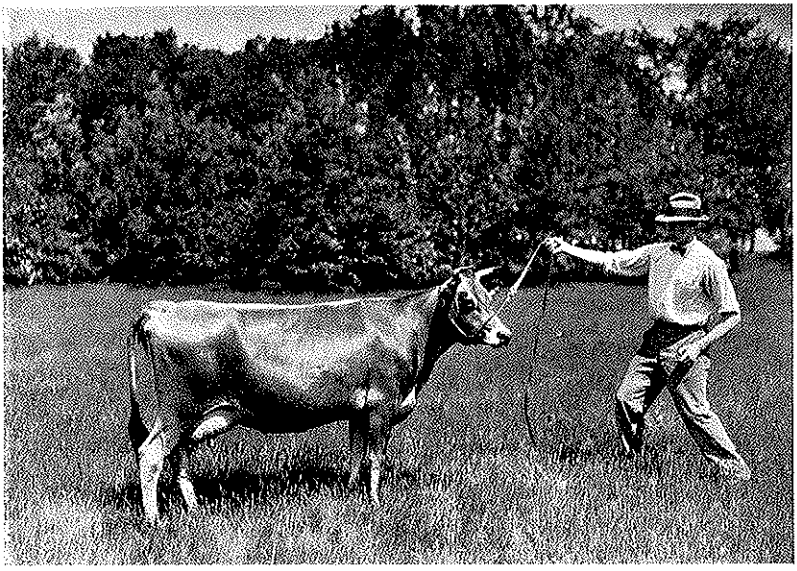

FIG. 28.—A good type Jersey female (Courtesy, Department of Dairy Husbandry, University of Nebraska).

costs. Since it is generally estimated that one-third of the dairy cows in the United States are kept at a loss, that about one-third return little or no profit, and that only about one-third yield large profits,[3] it should be of interest to know what relationship exists between production record per cow and profitableness, and also how the production per cow may be increased to reasonable and expected standards.

Relation of Milk and Butterfat Production to Feed Cost. Table 4 shows the relation of milk production to feed cost for four groups of cows producing from 4,000 to 16,000 pounds of milk annually. This relationship was determined in 1930 by the various dairy herd-improvement associations in the United States keeping individual records of 233,200 cows.[4] It will be noticed that the profits per cow from the lowest to the highest milk-producing group increased at a more rapid rate than did milk production. The average feed cost per 100 pounds of milk was practically cut in half as production increased from 4,000 pounds to 16,000 pounds of milk per cow. In the compilation of these cost figures no allowance was made for labor cost and overhead expenses, but these cost figures would not vary materially between the various producing groups.

[3] Parker, J. B., *Improving Dairy Herds,* Leaflet No. 19, U. S. Dept. of Agriculture, Washington, 1931.

[4] *Yearbook of Agriculture,* 1932, p. 163.

TABLE 4.—*Relation of Milk Production to Feed Cost* *

Milk production per cow (pounds)	Feed cost per 100 pounds of milk	Yearly feed cost per cow	Yearly income over feed cost per cow	Return per dollar spent for feed
4,000	$1.47	$ 60.00	$ 55.00	$1.92
8,000	.99	79.00	115.00	2.46
12,000	.84	101.00	167.00	2.65
16,000	.83	132.00	239.00	2.81

* *Ibid.*, p. 163.

It will be noticed that while the feed cost per 100 pounds of milk decreased, the total annual feed cost per cow increased for the higher producers. The better producing cows consume more feed than poorer producers, but their increased production much more than offsets the cost of the additional food consumed.

The column on "Yearly income over feed cost per cow" in Table 4 should be of particular interest to dairymen. It is usually considered that the keeping cost of the average cow is about equal to the cost of labor and overhead. Then it may be assumed that the cows producing 4,000 pounds of milk merely paid for the feed, labor, and overhead cost required for their maintenance.[5] Since the average cow in Nebraska produced 4,200 pounds of milk in 1933, it follows that a large percentage of milk cows in this state are milked at a loss or at a negligible profit.

It is estimated that about 70 per cent of the milk produced in Nebraska is separated for the purpose of making country or creamery butter.[6] This pronounced emphasis on butter production invites a consideration of the ratio of feed cost to butterfat production per cow. Table 5 shows the rate at which the ratio of income over feed cost advances as butterfat production per cow increases if it is assumed that butterfat has a market value of 30 cents per pound.

TABLE 5.—*Rate at Which Income over Feed Cost Advances as Butterfat Production per Cow Increases* *

Average butterfat production per cow (pounds)	Value of product	Feed cost per cow	Income over feed cost, per cow
100	$ 30	$ 34	$ −4
150	45	37	8
200	60	41	19
250	75	46	29
300	90	52	38
350	105	56	49
400	120	60	60
450	135	64	71
500	150	68	82

* *Yearbook of Agriculture*, 1933, p. 288.

[5] *Ibid.*, p. 164.

[6] Statistical Supplement to "Milk Production Trends," No. 8, U. S. Dept. of Agriculture, 1933, p. 33.

Table 5 shows clearly that a milk cow becomes progressively more profitable as butterfat production increases, notwithstanding the higher feed costs associated with the better cows.

Importance of Selective Breeding

Selected breeding is fundamental in maintaining and improving good milking herds. By efficient testing, the production records of cows may be readily established, and the perpetuation of the herd should be confined to proved animals. Male animals also should be proved before they are fully adopted into a dairy herd. Such proving consists of checking the milk production record of the daughters of male animals against their dams. If the production record of the dams is very high, no improvement in the offspring is necessary to establish the merit of the sire. On the other hand, no material decrease in production record of the daughter should occur. If the dams are poor or only fair milk and butterfat producers, a good bull should always improve the record of the daughters over that of the dams.

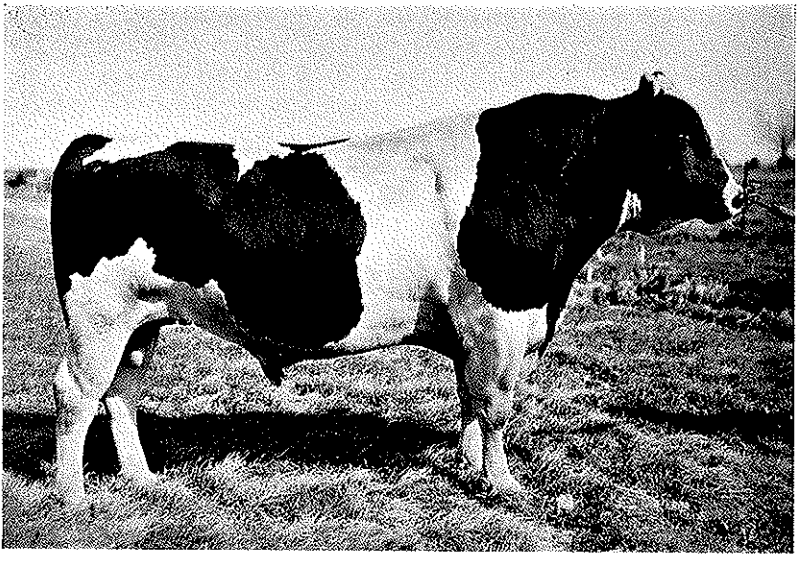

FIG. 29.—A good type Holstein-Friesian male (Courtesy, Department of Dairy Husbandry, University of Nebraska).

The significance of the bull in sustaining and improving the production record of dairy herds has been demonstrated in numerous experiments. One of the most noted experiments of this kind was conducted in recent years by the Agricultural Experiment Station of the Iowa State College of

Agriculture and Mechanic Arts, at Ames.[7] The foundation animals used in this work were purchased in an isolated region of Arkansas and consisted of five mature cows, two four-year-olds, four yearling heifers, two heifer calves, and a young scrub bull. The animals were purchased in this section of Arkansas to make reasonably certain that they possessed no blood of an improved dairy breed. They were small and narrow, thus lacking in capacity, and they were highly deficient in dairy character and mammary development. As may readily be understood, the environment under which these cattle had been kept in Arkansas was not conducive to abundant milk production. Feeding had been carried on by random methods, and no concentrates had been used. The animals had been forced to subsist largely on a scanty supply of grass and hay. The owners of the cows had been totally indifferent to the amount or quality of milk produced and to the length of the lactation periods.

It is interesting to note that the yearly production records for the scrub cows was 154 pounds of butterfat for the mature cows, 166 pounds for the four-year-olds, and 191 pounds for the heifers. In other words, the production record of butterfat for the mature scrub cows in the experiment was only slightly less than the butterfat production record of the average cow in Nebraska (the average Nebraska cow produces about 160 pounds of butterfat a year). The greater production of the four-year-olds and heifers over the mature scrub cows is traceable to a more effective response to improved treatment accorded the animals at the experiment station.

The objective of the experiment was to determine the improvement in milk production that farmers may expect from the offspring of purebred dairy sires and common cows. The cows were mated with scrub sires, and purebred Holstein, Guernsey, and Jersey sires.

The daughters from the scrub sires and dams produced only 11 per cent more milk and 13 per cent more butterfat than did their dams. Since better feeding methods produced even greater improvement in production records than this, it may be assumed that the scrub sires were valueless and contributed nothing to the increased production.

Table 6 shows the production records of the scrubs, of two generations of grade Guernseys and Jerseys, and of four generations of grade Holsteins.

If we assume that butterfat is worth 30 cents a pound, the second generation of grade Guernsey grossed the owner $45.90 more per cow per year than did the scrub grand dams.

The improvement in percentage in the second generation of grade Jerseys was substantially the same as it was with the second generation of

[7] Weaver, Earl, Mathews, C. A., and Kildee, H. H., "Influence of Environment and Breeding in Increasing Dairy Production—III," *Bulletin 251*, Agricultural Experiment Station, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, 1928.

TABLE 6.—*Production Record of Scrubs, Two Generations of Grade Guernseys and Jerseys, and Four Generations of Grade Holsteins* *

	No. of Lactations		Average production		Increase over scrubs		Increase over previous generation	
			Milk pounds	Fat pounds	Milk per cent	Fat per cent	Milk per cent	Fat per cent
Guernsey								
Scrubs	(5)	27	4,480	202	..	..	..	..
First	(6)	18	5,129	253	14	25	14	25
Second	(10)	23	7,155	355	60	76	40	40
Jerseys								
Scrubs	(3)	20	4,047	194	..	..	..	..
First	(3)	9	5,015	270	24	39	24	39
Second	(3)	12	6,539	331	62	71	30	23
Holsteins								
Scrubs	(2)	10	3,766	173	..	..	..	..
First	(2)	11	6,796	276	80	60	80	60
Second	(2)	3	9,653	358	156	107	42	30
Third	(2)	7	13,308	426	253	146	38	19
Fourth	(3)	4	11,215	364	198	110	–16	–15

* Weaver, Earl, Mathews, C. A., and Kildee, H. H., "Influence of Environment and Breeding in Increasing Dairy Production—III," *Bulletin 251*, Agricultural Experiment Station, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, 1928, pp. 302, 303, and 309.

grade Guernseys. The increased production was substantial and highly profitable

As Table 6 shows, the experiment was carried further with the grade Holsteins than with the grade Guernseys and Jerseys. It will be noted that the improvement in milk and butterfat production was highly substantial throughout the first three generations of grade Holsteins. Assuming a value of 30 cents a pound for butterfat, we find that the great granddaughters grossed $75.90 more in return per year than their great grand dams.

It is interesting to note that the fourth generation of grade Holsteins, as a group, fell short of the third generation in production. This merely indicates that as the production records of the dams increase, it becomes increasingly more difficult to improve consistently the record of the daughters.

The study of the Agricultural Experiment Station of the Iowa State College on the influence of environment and breeding is commendable in that it indicates the vast possibilities in milk-cow-improvement work. It proves clearly that the vast majority of farmers could make their milk enterprise more profitable by the use of selected purebred sires. Obviously, bulls vary widely in their ability to transmit high production to their daughters. Sagacious and thrifty dairymen will take no chance with an unproved bull. Unfortunately a great majority of farmers select young male animals who have not demonstrated their value. It is impossible for a bull to have proved his worth through production records of his daughters

before he is five years old. Farmers are hesitant about purchasing older, frequently more ill-tempered animals. However, a safe bull pen may be constructed at a modest cost, and every farmer with a dairy bull should have one. By thus protracting the period of usefulness of older bulls, additional animals need to be proved less frequently, and the cost of the tested animals becomes proportionately less. To prevent interbreeding, male animals need to be exchanged or sold. Nebraska farmers, among other things, need more proved dairy sires.

Culling the Milk-Cow Herds

Proper feeding and care serve to induce the maximum of milk and butterfat production that a cow is constitutionally capable of producing. A striking difference, however, will remain among the production records of various cows, even if such animals are all of a good dairy strain. A considerable number of poor-producing cows cannot be maintained without a loss in dairy operations. It is for this reason that every dairyman and farmer should manage to obtain records of production, feed cost, and income for every cow on his farm. Such records must serve as the foundation upon which better herds may be built.

The most satisfactory and economical method of getting necessary records of dairy cows is through membership in a dairy herd-improvement

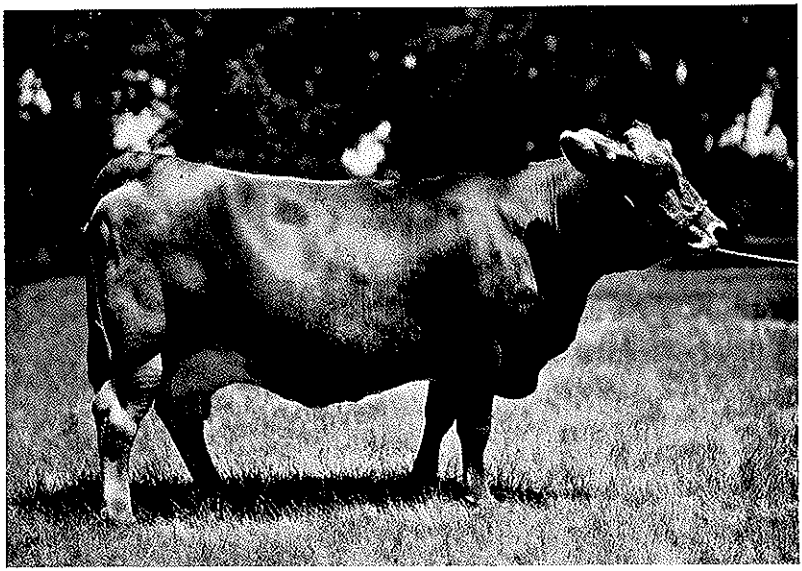

FIG. 30.—A good type Brown Swiss female (Picture taken on the Dan Stephen farm near Fremont, Nebraska).

association. Such an organization is composed of about 25 dairy farmers who cooperatively employ a man to test their cows for milk and butterfat production and to determine the cost of this production for every cow in the herd.[8] The information obtained enables the owner to determine the kinds and amounts of feed that may be fed to each animal for economical production as well as to determine which cows need to be eliminated from the herd because of poor production. Membership in one of these associations costs about $3.00 per cow a year.

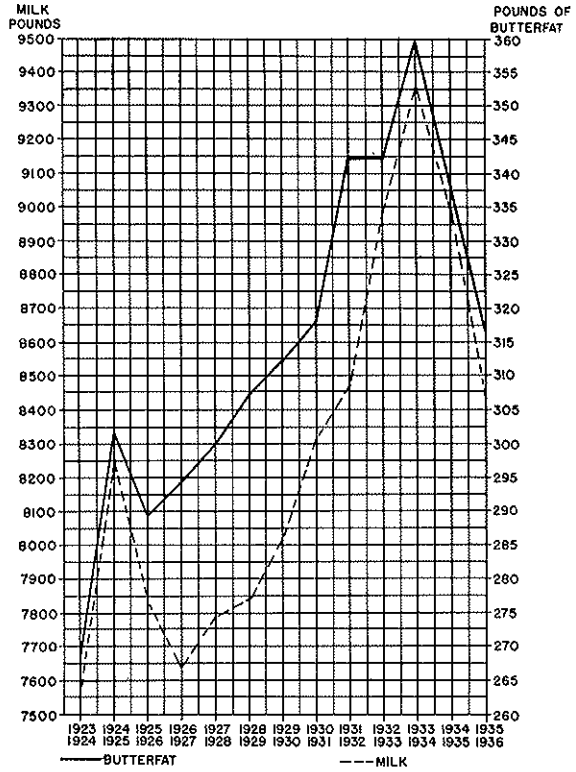

FIG. 31.—Trend of milk and butterfat production in Nebraska Dairy Herd-Improvement Association work, 1923-24 to 1935-36. Source: Dairy Extension Department, College of Agriculture, University of Nebraska.

[8] Further information about dairy herd-improvement work may be obtained from the Dairy Extension Department, University of Nebraska. Publications on this work are *Dairy Herd-Improvement Association Plan,* by J. E. Derman, U. S. Dept. of Agriculture, Bureau of Dairy Industry, Washington, D. C., 1933, and *Dairy-Herd-Improvement Associations, and Stories the Records Tell,* by J. C. McDowell (Farmers' Bulletin No. 1604, 1929), U. S. Dept. of Agriculture.

Dairy herd-improvement association work has been conducted in Nebraska by the Dairy Extension Department, University of Nebraska, since 1923-24. During the first year of operation in the state there were two associations, and 904 cows were tested. During this year the average association cow produced slightly over 7,500 pounds of milk and about 262 pounds of butterfat (Fig. 31). As testing work proceeded and as the poor animals were eliminated, the average-production record was improved materially. By 1932-33 the average association cow produced nearly 9,150 pounds of milk and 335 pounds of butterfat a year. The increase in production record offsets many times the cost of conducting the association tests.

Table 7 shows the growth and also the decline in the number of dairy herd-improvement associations in Nebraska from 1924 to 1936. The associations increased materially until 1930, only to decline considerably from 1930 to 1935. This decline in the number of associations is traceable to the severe depression prevailing during these years, and hence a marked increase in associations is expected as soon as times become less stringent.

TABLE 7.—*Growth of Nebraska Dairy Herd-Improvement Work* *

Year	Number of Associations	Number of Cows Tested
1924	2	904
1925	4	2,462
1926	10	3,542
1927	16	5,860
1928	23	7,369
1929	28	9,867
1930	31	10,322
1931	29	10,051
1932	26	7,073
1933	19	4,475
1934	17	3,574
1935	16	4,243
1936	17	3,886

* Figures from Dairy Extension Department, University of Nebraska, Lincoln, Nebraska.

Dairy Cows versus Dual-Purpose Milk Cows

The fact that the average Nebraska cow produces about 160 pounds of butterfat a year suggests that she is not a specialized dairy animal. As a matter of fact, we know that about half of the milk cows are of dual-purpose breeds. With many Nebraska farmers the beef qualities of a cow and of her offspring take precedence over the milk and butterfat production capacity. The fact that a large percentage of our milk cows are beef producing types means that the return from dairy products is not the only or even the major income in which the farmer is interested. Dual-purpose cows and their offspring can be marketed for beef more profitably than

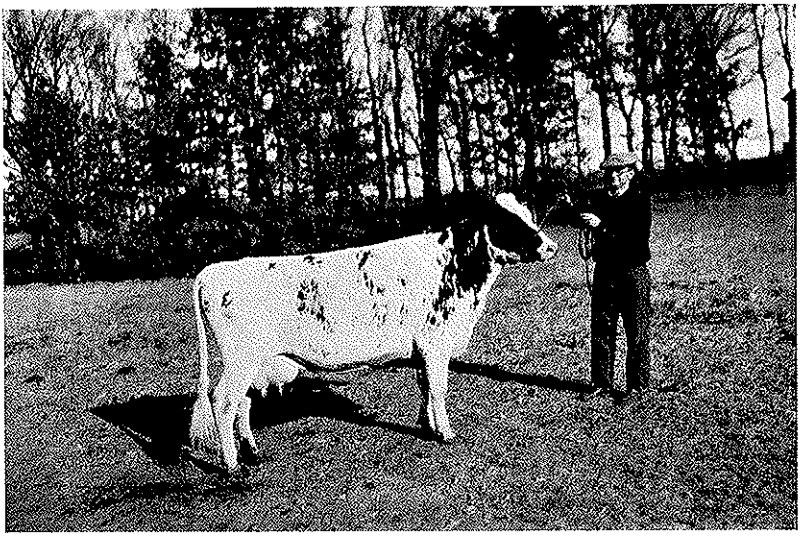

FIG. 32.—A good type Ayrshire female (Courtesy, Department of Dairy Husbandry, University of Nebraska).

can dairy-type animals. The question as to which will ultimately net the greatest returns for Nebraska farmers is difficult to answer. Nor is the question of the greatest returns per year the only factor that determines the type of farming which will be engaged in. The working program on a dairy farm is markedly different from that on a "beef and pork farm." Many farmers hesitate to develop good dairy herds because of the daily chores which this form of enterprise requires. On the other hand, dairying provides a relatively more consistent form of income than does stock raising, and many thrifty farmers are attracted by this feature.

The environmental conditions in Nebraska, including the absence of many large urban centers and the farming practices in this state, suggest that beef and pork production will take precedence over dairying activities for some time to come. The question then arises, should the average Nebraska farmer continue to milk beef cows and dual-purpose cows or should he obtain specialized, high-producing dairy cows? No dogmatic answer to the question can be made, for the actual and potential returns that various farmers may receive from various types of herds differ considerably, largely according to the care and treatment of the animals.

Tables 5 and 6 leave no doubt as to the greater profitableness of excellent dairy cows over poor milk cows. By computation it may readily be shown that over a period of time the income from a good dairy cow

exceeds the income obtained from a poor milk cow of fair or excellent beef-producing qualities, even if due allowances are made for the income derived from beef calves. From the standpoint of income, therefore, it would be more profitable to make the production of beef animals and the production of dairy products rather distinct enterprises on the farm. This does not necessarily mean that two types of herds would need to be perpetuated on each and every farm. A sufficient number of specialized

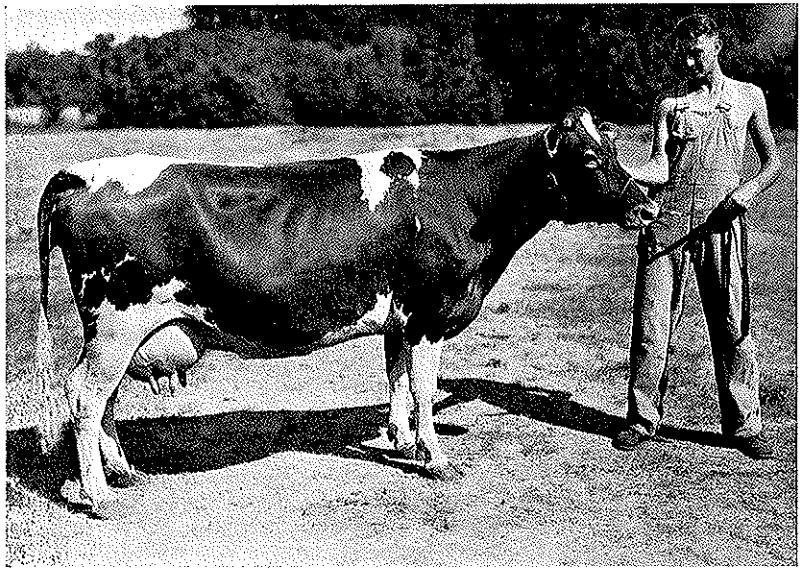

FIG. 33.—A good type Guernsey female (Courtesy, Department of Dairy Husbandry, University of Nebraska).

dairymen in this state as well as in neighboring states may be relied upon to furnish good dairy stock to unspecialized dairy farmers. By a well-considered purchase of dairy calves and dairy cows the latter type of farmers could maintain well-producing herds. Such farmers could, if they wished, perpetuate a small, distinct dairy herd by breeding the cows with a proved male animal in which they could own part interest. The establishment of numerous cooperative dairy-bull associations in Nebraska seems highly desirable.

Improving Production Records by Proper Feeding

The average production record per milk cow in Nebraska, regardless of breed, can be increased materially by proper feeding, culling, and

breeding. No dairyman should waive all attempt and interest in improving the production record of his animals. The first step in any improvement work should be intelligent feeding. The production record of a cow cannot be determined until she has been well fed. Proper feeding bespeaks at least an elementary knowledge of constituents in various feeds as well as a proper record of production, feed costs, and income of every cow on the farm.

The feeding of milk cows in Nebraska varies greatly from farm to farm. Some of the specialized dairymen of the state make good use of the great variety of feeds grown here. On the whole, rather random methods of feeding prevail. During the early spring, cows in this state usually enjoy excellent pasture grasses. As summer progresses, many animals find it necessary to subsist on short and dry grasses. During this period milk production usually declines. During the winter season feeding practices become more varied on the farms of the state because the price and availability of various feeds must largely determine the feeding practices followed. A rigid program of feeding, therefore, cannot be presented in this publication. Therefore a broad suggestive program is submitted.

Summer Feeding. Cows will gather about as much roughage as they can well handle in a good pasture. A concentrated feed, such as grain, should therefore be the material used in supplementing such pasture. Since a good pasture alone will provide the nutrients for cows producing a pound of butterfat a day, grain need be given only to animals producing more than that quantity. As a general rule, it is advisable to feed grain to Holstein cows producing more than 30 pounds of milk a day, to Jersey cows producing more than 20 pounds, and to other breeds producing intermediate amounts. Generally from 0.4 to 0.6 pounds of grain are required to provide the nutrients for one pound of butterfat.

Pastures in Nebraska are in the best of condition only for a month or so in the spring. As the better grasses become short and dry, feed becomes less plentiful and less succulent. The condition of the milk cows should be observed closely at such times to determine the need of additional feeds. When the roughage in the pasture becomes short, then hay, silage, or grain may be used as supplementary feed, or, better still, supplementary pastures may be used.

Winter Feeding. In winter the cows should be given all the good hay they will eat twice a day. Because of its high protein and calcium content, its palatability, and its substantial yield per acre, alfalfa is considered the best hay for cows. In the absence of alfalfa, other legume hays such as the

clovers, soy beans, cowpeas, and the vetches may be substituted for alfalfa in preference to non-legume hays. As a class the legume hays are superior to other hays in palatability, in quantity and quality of protein, and in lime content. As a rule, they are also more economical to feed to dairy cows, even though their price is somewhat higher than that of other hays. Nebraska is the second highest alfalfa-producing state in the Union, and for this reason it has an abundance of excellent hay for dairy-feed uses.

Good alfalfa hay, fed as the sole ration, will be consumed at the rate of about three pounds a day for each 100 pounds of live weight. When a medium quantity of silage is fed with hay, cows will consume from one to one and one-half pounds a day of medium to good hay for each 100 pounds of live weight. Cows will obtain more nutrients when silage or roots are fed with hay than when hay is fed alone.

The amount of silage to be fed to cows ranges from 20 to 50 pounds per day, depending on the size of the cow and the quantity of other roughages fed. The relative amount of silage, hay, and grain fed to cows may be varied somewhat in accordance with the respective prices which these feeds command. Ordinarily it is advisable to feed three pounds of silage a day for each 100 pounds of live weight.

A wealth of literature on feeding rations for dairy cows is available, and a great diversity of rations are recommended. Feeding experiments with dairy cows on the United States farm at Beltsville, Maryland, have resulted in some rather simple suggestions with regard to winter feeding rations for dairy cows. Because of their simplicity these recommendations are herewith presented:[9]

> Feed each cow about 3 pounds of silage for each 100 pounds of live weight. A cow weighing 800 pounds, therefore, would receive 24 pounds of silage, whereas one weighing 1,200 pounds would receive 36 pounds of silage. Twice a day give the cow all the good hay she will eat, exclusive of coarse stems and weeds. To Jersey cows yielding 10 pounds of milk or less give no grain, but for every pound over 10 give 0.6 pound of grain. A Jersey cow giving 20 pounds of milk, therefore, would receive 6 pounds of grain; one giving 30 pounds of milk would receive 12 pounds of grain. To Holsteins yielding 16 pounds of milk or less give no grain, but for every pound over 16 give 0.4 pound of grain. A Holstein cow yielding 30 pounds of milk, therefore, would receive 5.6 pounds of grain, whereas one giving 40 pounds would receive 9.6 pounds of grain.
>
> Although this system of feeding has not been tried out with other breeds, it is probable that Guernseys should receive 0.5 or 0.55 pound of grain for each pound of milk above 12 and Ayrshires 0.45 pound of grain for each pound of

[9] Woodward, T. E., and Nystrom, A. B., "Feeding Dairy Cows," *Farmers' Bulletin No. 1626,* U. S. Dept. of Agriculture, Washington, D. C., June 1933, pp. 15, 16. Another excellent publication recommended to Nebraska Dairymen is "Feeding the Dairy Cow," by H. P. Davis, *Extension Circular 621,* published by the University of Nebraska, Agricultural Extension Service and the U. S. Dept. of Agriculture cooperating, Lincoln, Nebraska, 1933.

milk above 14. If the hay is of poor quality, the cows will not eat so much of it and therefore must have more grain. On the other hand, if the hay is of the best quality the cows will eat more of it, and less grain than specified will be required. If the roughage is the very best, a cow may produce 1 pound of butterfat daily or even more on roughage alone, without losing weight. The above directions are based on the supposition that the cow eats at least 1¼ pounds of hay per day for each 100 pounds of live weight. In the absence of exact weights, a feeder must be guided largely by the condition of the individual cows. If any are getting thin, give them more grain; if they are getting fat, reduce the grain. For most economical production, cows should be kept in a medium state of flesh, neither fat nor thin.

Record the quantity of feed consumed by each cow. A convenient and practical way to feed concentrates is to use a cart or truck to which are attached feeding charts or cards showing the amount of feed to be given each cow. A small blackboard can be attached to the cart and the figures recorded.

A spring-balance scale suspended above the cart on an arm is of great help. If the allowance of silage and hay is weighed occasionally, the quantity can be measured with reasonable accuracy.

The Silo for Nebraska Milk Cows. As has been indicated, the dairy cow, to produce well, must have an abundance of nutritious, tasty, and, if possible, succulent feed. Nebraska produces a great wealth and variety of feeds on which cows thrive. Climatic conditions, however, are such that a variety of cheap, balanced, and tasty feeds is not available at all times of the year unless some succulent forms of feed are preserved as silage. Most milk cows in Nebraska pass through a subsistence-feeding stage during the hot, dry period of the summer, when pastures are short and dry. In winter the feed, in most instances, is not varied enough or sufficiently succulent to bring about a maximum production of milk. The silo is in a large measure the answer to this feed problem. The tremendous advantages offered by the silo have been known for several decades. No substitute for supplying economical and tasty feed has been found. That Nebraskans have largely been indifferent to its adoption must in a measure be ascribed to insufficient pressure and to insufficient need to make the utmost of their available feed resources.

The severe drouths of 1934 and 1936 compelled nearly all Nebraska farmers to make the most of available feeds. The hay and grain crops promised to be failures to varying degrees, and so the dilemma suggested the need of silos to preserve the blighted corn crop. The success of this enterprise proved a revelation to many Nebraskans. As a result, it seems reasonable to believe that the silo will play a more prominent part in the future than it has in the past on Nebraska farms.

The silo answers to a large degree the feeding problems which more or less regularly confront the feeders of this state. In the eastern part of Nebraska corn silage would serve well to sustain the production record of dairy cattle and the growth record of beef cattle during periods of short pasture in summer. It also provides excellent supplementary feed in winter.

In the drier middle and western sections of the state, where the feeding problem becomes more pronounced, the silo would serve an equally, if not more, valuable service in preserving crops which usually grow well during most spring and early summer months. In addition, the silo could be of immeasurable value to these sections during periodic drouths. As is generally known, a silo will preserve feed for a considerable number of years. Years of plenty can therefore provide for years of crop and feed shortages. In these drier sections of the state the sorghums seem to be more dependable than corn in growth and yield, and they may well be used for silage purposes. For successful silage it is important that the saccharine sorghums be harvested when the seed has become hard. If harvested earlier, a silage with a high acid content is produced.

Nebraska grows an abundance of corn and can grow adequate quantities of sorghum in the western part of the state to be stored as silage. Corn and sorghum converted into silage have a greater feed value than the mature dry stalks and grain produced. Dried corn stalks are not only less palatable for cattle but have also lost an appreciable amount of food value. Livestock receiving some form of succulent feed such as silage has keener appetites, softer and more pliable skins, and a more healthy appearance than livestock fed exclusively on dry rations. The Nebraska dairy industry would benefit materially by a more widespread use of the silo.[10]

BARNS AND METHODS OF STABLING MILK COWS

Spacious and immaculately clean dairy barns do exist in Nebraska but are much more common in specialized dairy districts in northeastern United States. Inclement weather during a considerable period of the year in the specialized dairy districts makes considerable investment in dairy barns necessary in order to house the relatively large, well-bred dairy herds. In regions where the climate is less rigorous and dairying is less specialized, large investments in dairy barns are inadvisable. In such regions dairy herds are usually small and frequently of indifferent milking strains. Investment in dairy facilities under such conditions must be modest to make milking activities profitable. It follows that the objectives of a farm with varying numbers and types of dairy cows should determine the type of

[10] The following publications, which may be obtained from the sources listed, give further and more detailed information about the construction of silos and the making of silage:

Woodward, T. E., et al., "The Making and Feeding of Silage," *Farmers' Bulletin No. 578,* U. S. Dept. of Agriculture, Washington, 1928.

Metcalfe, T. Pryse, and Scott, George A., "Pit Silos," *Bulletin No. 825,* U. S. Dept. of Agriculture, Washington, 1931.

Wood, Ivan D., and Lewis, E. B., "The Trench Silo in Nebraska," *Extension Circular 713,* The University of Nebraska, Agricultural Extension Service and U. S. Dept. of Agriculture cooperating, Lincoln, 1931.

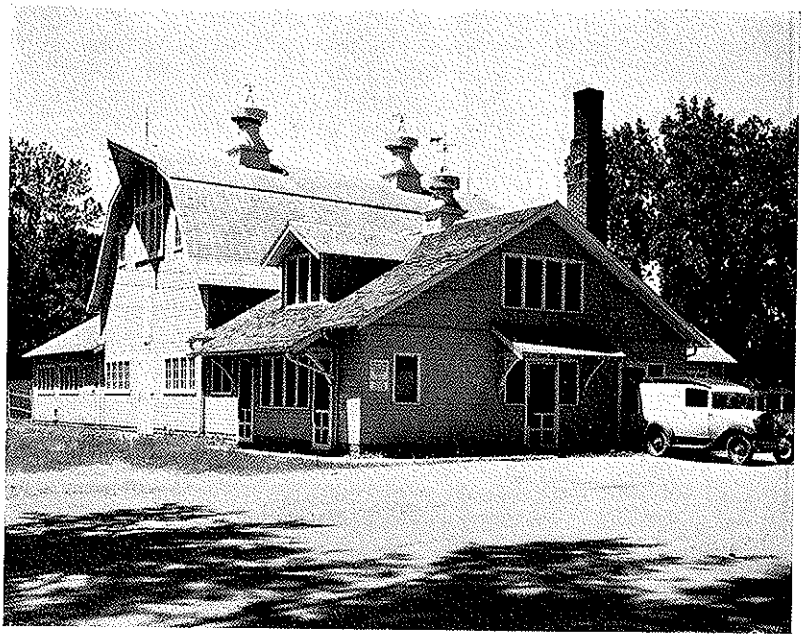

FIG. 34.—A clean, attractive dairy barn and building (Picture taken on the Dan Stephen farm near Fremont, Nebraska).

dairy barn or shed to be constructed. In all instances facilities and structures should be such that only quality dairy products are produced.

Purpose of the Dairy Barn

The purpose of the dairy barn varies somewhat in different regions as well as with different types of dairying practices within the same region. In the specialized dairy districts in the northeastern part of the United States, large expensive dairy barns are necessary to house the large herds of selected dairy cattle during inclement weather. Such barns are also provided with excellent feeding and milking facilities. During exceptionally warm weather they are used to shelter the cows from heat, and when the flies are bad the well-screened barns shelter the animals from these pests. The dairy barn in these specialized dairy districts represents the scene of most of the activities carried on by the dairymen. A costly and well-equipped barn in such districts may, therefore, be desirable and warranted.

In general, the dairying conditions in Nebraska are different from those of the specialized dairying districts. Some specialized dairymen in the state have large, well-equipped dairy barns, but their number is small

and will likely remain so. The bulk of the dairy products produced in Nebraska comes from the farmer with a limited number of cows. Here the average-sized herd of milk cows numbers between 5 and 6 head. The cows are largely of dual-purpose breeds and do not receive the amount of solicitous care that is shown the more specialized animals in dairy districts. The climate of Nebraska makes it unnecessary to stable the milk cows constantly for long periods during the cold months, nor is it the common practice in this state to stable the animals for much of their feeding. These considerations make it inadvisable to build large and costly dairy barns for the average dairy herd. It is for these reasons that this bulletin will emphasize the need and use of small, well-arranged, and well-equipped milking sheds instead of large, costly dairy barns.

Dairy Barns versus Dairy Sheds in Nebraska

The cost factor and the objectives of a dairy structure should never be lost sight of by dairymen and farmers. The highly specialized dairyman in Nebraska may find it profitable to construct a large, costly dairy barn.

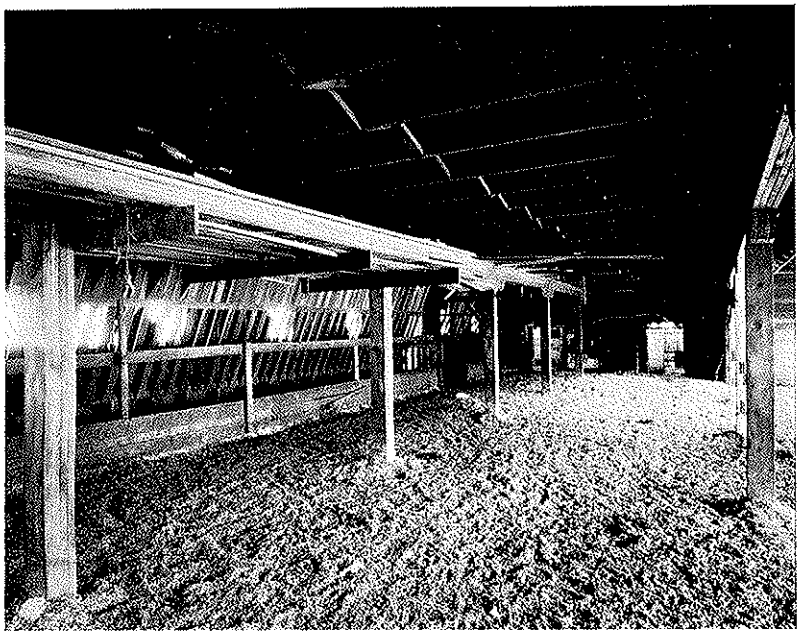

FIG. 35.—A clean, well constructed shelter shed for dairy cows. The cows are not secured in the shed but are free to walk about and obtain exercise as well as shelter when desired. This arrangement seems desirable under Nebraska climatic conditions (Picture taken on the Don Morton farm near Beatrice, Nebraska).

Such a structure may cost from $200 to $300 or more per cow housed and must, obviously, serve more purposes than merely to shelter the milk cows from varying degrees of inclement weather. Milk production may be stimulated by feeding rationed feeds to cows while they are kept inactive in the barn. More energy may thus be converted into producing milk. Diseases may be kept at a minimum in such herds by expert observation and testing. Such dairying practices, however, are uncommon in the state.

Climatic and agricultural practices in this state suggest dairying practices unlike those followed by highly specialized dairymen. As stated, climatic conditions in Nebraska make it unnecessary to stable the dairy cow for long periods of time. Available shelter for milk cows, however, should be provided during certain weather conditions. They should also have sanitary, well-equipped milking and part-feeding stables. These considerations have led to the opinion that milking sheds and shelter sheds are appropriate and economically feasible for Nebraska conditions. Under such a plan milk cows are stabled only for milking and part-feeding and are kept loose in the yard and pasture at other times. The cows should be free to seek a shelter shed at any time.

A number of advantages follow from such sheltering. Milk cows that are unattached in a barn or stable have the opportunity of moving about and of obtaining desirable and even essential exercise. By exercising they maintain their vitality and the ability to resist disease. Quartered cows are usually troubled much more by sickness and disease than the cows which lead a freer, more natural life. Besides offering the advantages of providing opportunity for exercise and promoting the health of cows, the combination of milk shed and shelter shed offers the advantage of reducing the care of the animals to a minimum.

Figure 36 shows a convenient arrangement of cow barn or shed, open shed, bull pen and lot, yards, water tank, silo, and hay stacks.[1] The advantages offered by a structure such as the one pictured are obvious to any dairyman or farmer. The placement of the building in compact form provides desirable shelter from the north winds. Feeding may be accomplished with a minimum of effort. Hay and silage are fed to the cattle in the open shed, while grains and concentrated feeds may be fed in the barn during milking. Ordinarily milk cows are not quartered in the barn for a period longer than is required for milking. Location, topography, purpose, and other variables should be taken into consideration to modify these plans to suit the farmer's needs best.

It should be noted that the plan also includes a bull pen, a bull lot, and a breeding rack. These features should be standard equipment for

[1] Designed by the University of Nebraska, Department of Agricultural Engineering, drawn by R. M. Loper, March 12, 1930.

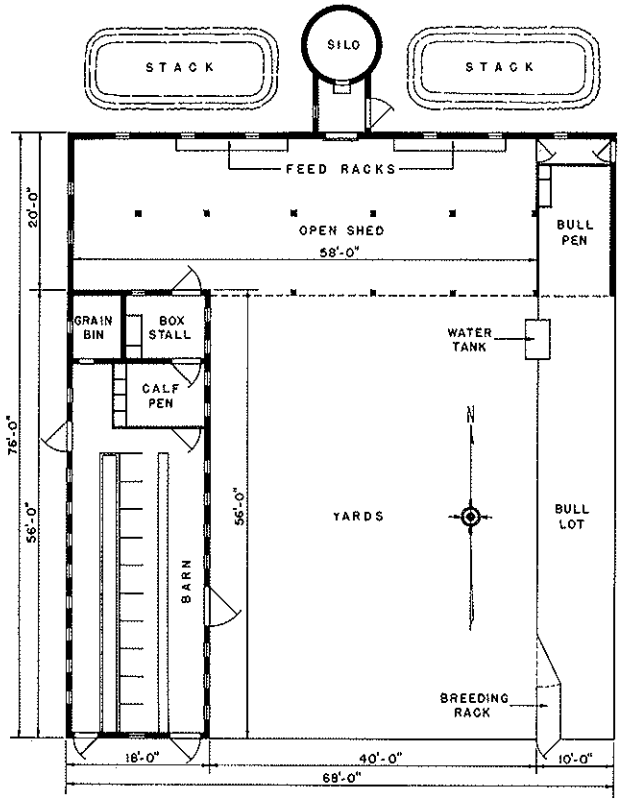

FIG. 36.—Open shed and barn arrangement (Courtesy, Department of Agricultural Engineering, University of Nebraska).

every farm with a dairy bull. The temperamental nature of this animal makes it untrustworthy, and it should not be kept in the yards where it may endanger the life of any member of the family.[2]

It will be noted that the barn in Figure 36 has ten stalls for milking and feeding. This is a greater number than the average Nebraska farmer requires. Farmers intending to milk fewer than ten cows may readily change the construction plans and avoid unnecessary expense and space. In fact, it may be advisable for a farmer with ten milking cows to construct a milking and feeding shed with only five stalls. Ten cows can readily be milked in two shifts in a five-stall shed.

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[2] Complete details about a safety bull pen and the care of dairy sires are described in "Selection and Care of Dairy Sires—The Nebraska Safety Bull Pen," *Extension Circular 626*, by M. L. Flack, University of Nebraska, Agricultural Extension Service, Lincoln, 1932.

The milking structure may be either a barn or a shed, although the latter form of building seems more desirable.[3] Since the dairy cattle do not receive hay in the milking stalls, there is no occasion to have a second story for the storage of hay. The purpose of the milking shed under this plan is to provide clean suitable milking quarters during all forms of weather. Therefore the structures should have good ventilation and sufficient window space for the access of sunlight. The windows should be screened to keep out flies. The floors should be of concrete, and adequate gutter space should be provided. The building should be cleaned daily. Running water is highly desirable in the milking shed. With a hose connection, the floors of the stable may readily be cleaned at frequent intervals. Water is also essential for cleaning the udder of the cow properly before milking begins.[4]

General Status of Nebraska Dairy Barns and Stabling Methods

Climatic conditions in Nebraska are such that cows need merely to be sheltered instead of stabled in costly warm barns. To provide this shelter we find a great variety of structures on the many farms of the state. Most structures are rectangular barns of various sizes, with or without lean-to additions. These barns usually serve several of many possible purposes. Most barns have a second story, known as the hay loft, for the storage of hay and are also provided with at least one grain bin. Animals kept in the barn may then be fed with a minimum of effort.

Most of the Nebraska barns are combination barns. This means that the structures house more than one kind of stock. They have quarters for both cattle and horses. The quarters for the cattle may or may not be especially arranged for milk cows.

The combination barn is common in Nebraska because of economic considerations. The limited number of cows in the average milking herd can be sheltered more cheaply in quarters which are part of a larger structure. The quartering of horses and milk cows in the same building is not necessarily undesirable, provided the quarters are divided by a solid partition and the odors from the horse section are excluded from the dairy-cow portion of the barn. Dairy products of the highest quality cannot be made from milk or cream that has been exposed to objectionable odors. At

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[3] A barn usually is distinguished by the storage space it has for hay, grain, and other articles, in addition to shelter space for stock; a shed is characterized by its limitations in use, frequently being merely a shelter structure. A shed rarely has a second story or loft.

[4] Dairymen or farmers interested in the construction of dairy barns or sheds are urged to write for "Farm Buildings for Nebraska," *Extension Circular 722*, University of Nebraska, Agricultural Extension Service, Lincoln, 1929, and "Dairy-Barn Construction," *Farmers' Bulletin No. 1342*, by K. I. Parks, U. S. Dept. of Agriculture, Washington, D. C., 1923.

present Nebraska has far too many combination barns which are not properly partitioned for dairy uses.

With respect to ventilation Nebraska dairy structures do not fare so badly. The nature of the ventilation is usually such that sufficient ventilation is provided by cracks and other openings, even if doors and windows are closed. Particularly is this true when the milk cows are sheltered only for milking and are free to seek available shelter at other times.

A surprisingly large percentage of the barns in which cattle are milked has inadequate light and sunshine. A standard requirement for dairy barns is at least three square feet of window for each stanchion or cow. Very few barns are so equipped. A study of the milking practices in the Lincoln, Nebraska milk shed revealed that only 17 per cent of the barns on a representative group of farms had as many as one window, regardless of size, for every two stanchions, and that 22 per cent of the barns contained no windows.[5] Since the investigation deals with milking conditions in an area of Nebraska where dairying is relatively important, it seems safe to assume that the light conditions in most of the dairy barns of the state are equally poor and perhaps even poorer. The purpose of light and sunlight is to destroy and arrest the growth of bacteria, particularly disease germs. Milk with a low bacteria count cannot be produced in an atmosphere charged with these minute forms of life.

A dairy barn or shed is incomplete without a proper floor and gutter. The nature and type of floor construction contributes much to the cleanliness of the animal as well as to the purity of the air that will prevail in such a structure. A good floor and a good gutter expedite the cleaning of the stable, a chore which should be performed at least once a day. Concrete makes a satisfactory floor for a barn because it is easily laid, reasonable in cost, and easily cleaned. At present but a limited number of the dairy quarters in this state have concrete floors. In the study referred to above it was found that of the floors in 92 barns, 33 were concrete, 22 were wood, 17 were dirt, 16 were dirt and wood, 2 were wood and concrete, and 2 were dirt and concrete. It may be repeated that the conditions in the Lincoln milk shed are somewhat superior to those in many sections of the state and perhaps inferior to certain other sections.

A visit to a representative group of Nebraska milk shelters will reveal the fact that conditions under which cows are milked can and should be improved very materially. Chemical analysis and the microscope reveal that altogether too much filth and unwholesome material find their way into many dairy products. It may be expected that the Federal government will materially raise the standards of butter shipped in interstate commerce. To produce such butter will necessitate proper handling of milk

[5] Downs, *op. cit.*, p. 9.

from the time it is obtained from the cow. This demands, among other things, a proper dairy shed or barn.

PASTURES IN NEBRASKA

Fresh, green pasturage grown on proper soil provides in a palatable form nearly all of the substances required for the perfect nutrition of the dairy cow. Good grasses are rich in protein, carbohydrates, minerals, and vitamins. These are all essential for the proper sustenance of the cow. Pasturage also permits milk cows to replenish their store of minerals and vitamins, which may become depleted during the winter months. Furthermore, pastures are important to the dairy cow, because they provide the animal with an opportunity to obtain the necessary exercise and sunshine. Cows constantly confined to yards and barns are more likely to contract diseases than those that are not so confined.

The composition and palatability of grasses vary with different stages of maturity. Young grass is relatively high in protein and low in crude fiber. As the grass matures, the percentage of protein decreases and that of crude fiber increases. Young grass is more efficient for milk production than mature grass. Hence it is more desirable from the standpoint of nutrition as well as palatability.

Grass must be abundant so that a milk cow may obtain her fill without undue exertion. To support her body weight and to produce one pound of butterfat a day, a cow weighing 1,200 pounds must daily consume about 25 pounds of dry matter, containing about 17 pounds of total digestible nutrients.[1] A dry cow will require about half of this quantity. The dry matter of pasture plants varies from less than 20 per cent when the plants are young and growing to more than 40 per cent in time of drouth, or when the plants are nearing maturity.[2] If it is assumed that the average content of dry matter is 25 per cent, then a cow producing one pound of butterfat a day will need 100 pounds of grass daily. A cow will have difficulty in obtaining this amount of feed if the grass growth in the pasture is sparse or too short. A cow should not be expected to graze continually during all her waking hours for ruminating requires from 7 to 8 hours.

A good pasture will supply sufficient nutrients for a milk cow producing up to a pound of butterfat a day. Grain or concentrated feeds should supplement the feed of dairy cows which produce a greater quantity of butterfat. However, the number of cows producing 300 pounds or more of butterfat a year are very limited in this state; consequently supplemental grain feeding is not necessary as long as a plentiful supply of good feed is available in the pasture. Unfortunately conditions are such in Nebraska and

[1] Semple, et al., *A Pasture Handbook*, Miscellaneous Publications, U. S. Dept. of Agriculture, Washington, D. C., 1934, p. 71.

[2] *Idem.*, p. 71.

in many other states that nearly all grasses become dry, dormant, and perhaps short during part of the growing season. Such conditions are brought about by lack of sufficient rain, by seeding, and by overgrazing. As a result, the problem of feeding the dairy cow becomes more complicated and calls for a planned and varied pasture program as well as for supplemental feeding during certain subnormal pasture conditions.[3]

Kinds of Pastures in Nebraska

Pastures may be divided into *natural* or *native pastures* and *tame pastures*. Native pastures in Nebraska may again be divided into *range* and *woodland pastures*. A range is an extensive area of uncultivated land on which native grasses grow. Prior to the advent of the white man, all of Nebraska was covered with native grasses known as prairie land. As the state became settled, much of this prairie was broken for crop purposes, particularly in the eastern part. Woodland pastures are wooded areas in which grasses and other plants grow in the open spaces.

Tame pastures may also conveniently be subdivided into *permanent, rotation, supplemental* or *temporary,* and *annual pastures*. Permanent pastures are grazing plots occupied by perennial pasture plants or by self-seeding annuals, usually both, which remain unplowed for a considerable period of time, usually five years or more. Rotation pastures are fields used for grazing which are seeded to perennials and to self-seeding annuals, but which form a unit in crop-rotation plans and which are plowed within five-year intervals or less. Supplemental or temporary pastures are, as the name implies, temporary grazing plots which supplement inadequate permanent or rotation pastures. Supplemental pastures may be provided by the aftermath of meadows, small-grain stubble, seedling small-grain pasture, annuals like Sudan grass, lespedeza (the latter is used very little in this state), or biennials like sweet clover. Annual pastures are seeded each year to replace or supplement permanent pastures. Such pastures are seeded to winter rye, Sudan grass, or rape. When properly combined, these plants will furnish pasturage during the greater part of the growing season.

Upon the advent of the white man, Nebraska was a huge prairie pasture or range sustaining great numbers of buffalo, deer, and other forms of wildlife. The prairie represented an ideal grazing ground for the stock of the pioneer and so was of immeasurable value in tiding the early settler over the first few years of adjustments and hardships on the plains. The

[3] Full information on feeding the dairy cow is given in the following publications: Davis, H. P., "Feeding the Dairy Cow," *Extension Circular 621,* University of Nebraska, Agricultural Extension Service, Lincoln, June 1933; Woodward, T. E., and Nystrom, A. B., "Feeding Dairy Cows," *Farmers' Bulletin No. 1626,* U. S. Dept. of Agriculture, Washington, D. C., June 1933.

intent of the early settlers, however, was to break the sod as rapidly as possible and convert it into cultivated fields. In this manner great portions of the prairie in all sections of the state were destroyed in a few years. It was soon discovered that drouth conditions prohibited the growing of unacclimated cereals in the western portions of the state, and so considerable prairie remained unbroken. Moreover, many fields that had been broken were permitted to revert to prairie conditions. It is for these reasons that considerable areas of native pasture are still to be found in western Nebraska, the sandhills being covered almost entirely by this form of grass. At present the native grasses still remain the best permanent pasture grasses in the sandhill region of the state and in the area north, south, and west of it.[4] In the eastern third of the state, because of extensive cultivation, only scattered fields of prairie remain.

The more common native grasses in Nebraska are little blue stem, big blue stem, slough grass, blue grama, side-oats grama, buffalo grass, June grass, wild rye, western wheat grass, porcupine grass, switch grass, Indian grass, and northern dropseed.[5] Of these, little blue stem, big blue stem, buffalo grass, and the grama grasses are the better and more widespread grasses. According to Frolik and Keim, little blue stem grows in all parts of the state.[6] In the eastern sections of the state this grass is largely confined to the upland meadows and native pastures, while in the central part it is generally distributed where the water table is high and on the slopes of valley hillsides where the soils are pervious and where drifted snow accumulates, supplementing the normal precipitation.

While once one of the common grasses of the sand dunes, little blue stem has been largely supplanted by more vigorous grasses because of the damaging effects of overgrazing and drouth. Big blue stem does best on alluvial soils where there is a concentration of moisture. Because of this it is most widely distributed over the lowlands in eastern Nebraska and over certain of the subirrigated valleys of central and western Nebraska.

Buffalo grass is one of the most highly prized grasses in the more arid sections of the Great Plains. It withstands drouth exceedingly well and forms a palatable and nutritious grass either green or dry. It is best adapted to dry, heavy soils. Originally it appeared on such soil and vegetative areas in the western half of Nebraska. Buffalo grass is poorly adapted to sandy soils and hence grows sparingly in the sandhills. Where there has been

[4] Stewart, P. H., and Gross, D. D., "Permanent and Temporary Pastures for Nebraska," University of Nebraska, Agricultural Extension Service, *Extension Circular 102*, August 1933, pp. 5-6.

[5] According to an unpublished manuscript entitled *Common Native Grasses of Nebraska*, by A. L. Frolik and F. D. Keim, Department of Agronomy, University of Nebraska, June 1937.

[6] Authors of manuscript referred to in last footnote. The manuscript of Messrs. A. L. Frolik and F. D. Keim is used as an authority on the distribution of the various native grasses as presented in this publication.

continued overgrazing, buffalo grass has found it possible to invade pastures in the eastern part of the state, and in such instances it sometimes occupies up to fifty per cent of the grass cover.

Blue grama is highly important in central and western Nebraska. Although blue grama may be found in all parts of the state, it is largely confined to the dry, heavier soils in the more arid western half. Blue grama makes excellent feed in green or field-cured form and in combination with buffalo grass, makes an excellent form of winter forage.

In addition to the more prominent native grasses mentioned, western wheat grass, a very rugged but impalatable form of vegetation, deserves special notice because of its capacity to do well on clay or moderately alkaline soils. According to Dr. Keim of the University of Nebraska, western wheat grass is now becoming more common in southern Nebraska. Considerable areas of moderately alkaline soils in western Nebraska are rendered useful and productive by this grass. It furnishes feed and in addition has the qualities of resisting drouth and cold exceedingly well.[7]

Improving Some of the Native Pastures

As stated, native grasses are generally best adapted for permanent pastures in all parts of the state except the eastern third. This does not mean that these pastures cannot be improved in some instances by the addition of some tame grass and legumes. For instance, in some of the hay flats of the sandhills where the water is within three feet of the surface, the pasture can be greatly enriched in quantity and quality by the seeding of red and alsike clovers. Timothy and redtop may also be used in such places. Legumes increase the protein content of native pastures, and in this manner greatly enhance the feeding value of such ranges or pastures.

In the areas south and west of the sandhills, subhumid conditions and hot winds make tame grasses for permanent pasture less satisfactory than native grasses. Only in irrigated and subirrigated sections can cultivated grasses be introduced to advantage.

In the more humid eastern part of Nebraska, tame forage grasses and legumes in combination frequently provide a productive pasture. The more common grasses and legumes suggested for Nebraska are brome grass, orchard grass, timothy, Kentucky blue grass, meadow Fescue, redtop, red clover, white (Dutch) clover, alsike clover, alfalfa, and crested wheat grass.[8]

[7] The manuscript *Common Native Grasses of Nebraska* by A. L. Frolik and F. D. Keim is to be published soon. Farmers and students interested in the types of native grasses in Nebraska and their distribution will be able to obtain this interesting booklet when published by writing to the University of Nebraska Agricultural College Extension Service, Lincoln.

[8] Full particulars about various seed mixtures for Nebraska pastures may be found in "Permanent and Temporary Pastures for Nebraska," *Extension Circular 102* (revised), by P. H. Stewart and D. D. Gross, University of Nebraska, Agricultural Extension Service, Lincoln, 1933.

Of the various tame forage grasses, Kentucky blue grass is distributed mostly widely in Nebraska. While in the eastern part of the state it grows on both uplands and lowlands, having largely replaced the bluestem grasses, in the western portion of the state it is confined largely to the subirrigated creek and valley land.

Kentucky blue grass, as a pasture grass, is highly palatable during the moist spring and fall months. During the warmer, drier seasons it seeds, dries up readily, and lapses in growth. This characteristic makes it somewhat less desirable than some of the other native and cultivated grasses.

With the possible exception of the sandhill area, most of the permanent pastures in Nebraska become short and dry during midsummer, and cattle grazing on them go through a modest—frequently too modest—feeding period. During such periods the flow of milk is considerably reduced, and the growth of beef cattle is arrested. The reduced flow of milk during such periods is frequently ascribed to the abundance of pestiferous flies and the prevailing heat. Evidence indicates, however, that the dearth of appetizing feeds is in large measure responsible for this somewhat suspended milk production and growth. It becomes desirable, therefore, to supplement the permanent pasture feed with temporary and supplementary pastures and perhaps even with silage, hay, and cereals whenever this is possible. Most Nebraskans find the use of temporary and supplementary pastures desirable and profitable.

The use of temporary and supplemental pastures is not sufficiently planned and executed to provide an uninterrupted source of palatable green feed. In the more humid sections of the state winter wheat is commonly pastured in fall and in spring. Rye and oats may be planted to form pasturage during various periods of the growing season. Meadows are at times grazed for supplemental feed. Legumes and Sudan grass lend themselves well to grazing and can profitably be worked into a rotation program so that an abundance of feed is available at all times. In grazing the animals on legumes care must be taken against bloating.

Some Prominent Milk-Contaminating Pasture Weeds and Feeds

Among the common cultivated pasture crops in Nebraska that may produce decided off-flavors in milk are rye, wheat, rape, and, under certain conditions, sweet clover. The urgent need to supply supplementary pastures in this state prompts most farmers to ignore the off-flavor condition of milk and cream which may result from these nourishing feeds. The dairyman selling fluid milk finds the problem of off-flavors a more serious one, since milk consumers promptly detect the condition of the milk and forthwith complain and reduce the consumption of this food. Cheese producers complain when such milk must be converted into inferior cheese.

Unless this condition of the milk is prevented by feeding management, the fluid-milk dairyman may find it undesirable to use these feeds. The producer of cream in Nebraska has not, generally speaking, been penalized directly for the production of off-flavored cream. As cream-grading practices are instituted more generally, a reduced price in return for off-flavored cream may be expected. It follows, therefore, that every producer of surplus dairy products is or will be concerned with the quality of the product he offers for sale.

The pasturing of seedling wheat, rye, and oats is carried on with varying emphasis in different parts of the state. Seedling rye and wheat will produce a decided off-flavor in milk if pastured indiscriminately as to time, and green oats will also cause slightly abnormal flavors if fed under such a program. Fortunately these off-flavor conditions can be minimized and even entirely eliminated if these feeds are properly fed. It is highly doubtful that an abnormal condition in the milk can be detected if milk cows are permitted to graze on these cereal pastures several hours after milking and are then removed to different pastures or feeding lots. If milk cows have been removed from these cereal pastures four hours or more preceding the milking period, little if any off-flavor will be noticeable in the milk.

Rape is perhaps one of the worst offenders in causing off-flavor in milk. So offensive can this off-flavor become that consumers revolt very vigorously against rape-contaminated dairy products. It has been found, however, that even rape may be fed to dairy cows if it is fed judiciously. If fed to cows one or several hours before milking it will produce varying degrees of abnormal flavors and odors in milk. When fed to milk cows immediately after milking, it has little effect on either the flavor or the odor of the milk produced.[9]

Ordinarily sweet clover should present no problem of producing off-flavors in milk and cream. During extremely dry periods, however, cows may eat considerable quantities of this legume without bloating, and under such conditions off-flavored milk may be produced. This condition can readily be overcome by supplementing sweet clover pastures with other feeds so that no excessive amount of the clover is consumed.

Among the various weeds in Nebraska that are particularly offensive in producing off-flavored milk are ragweed, penny cress, wild onion, and wild mustard. Of this group, ragweed is the most offensive because of its widespread distribution in the state. All of these weeds have a tendency to invade overgrazed pastures and, because of their proliferation, to replace many of the valuable grazing plants. Ordinarily cattle do not prefer these

[9] Babcock, C. J., "Effect of Some Succulent Feeds on the Flavor and Odor of Milk," *Technical Bulletin No. 9*, U. S. Dept. of Agriculture, Washington, D. C., 1927, p. 6.

weeds for food but when dry conditions prevail and other feeding plants have disappeared, the animals are compelled to subsist on them. Milk cows eating these weeds will produce a bitter milk with an unpleasant odor.

Weeds prosper largely because of man's neglect and improper grazing practices but if overgrazing is prevented they will not readily invade a pasture. A consistent effort should be made to prevent overgrazing and the resultant weed invasion.

Pastures versus Cereals on Nebraska Farms

Every farmer seeks to devote his land to the most profitable use. It is in pursuit of such a plan that there is a tendency to convert as much land as possible to cereal crops. It is generally conceded that land planted to grain crops ordinarily produces about 50 per cent more nutriment for livestock than similar land in pasture.[10] Generally speaking, therefore, most farmers may find it immediately more profitable to grow a maximum of grains and to reduce the pasture to a minimum. Financial stress and taxation policies usually act as further inducements to carry on such a farming policy. But this type of program also has its unfortunate aspects. Pasture conserves the fertility of the soil and materially prevents erosion. If steep slope-land is plowed, it is usually advisable to seed it with such crops as legumes, which will promptly anchor the soil. Much slope-land with considerable relief should never be plowed. From the point of view of dairying, pastures are also desirable in providing healthful breeding and foraging grounds and in reducing labor cost to a minimum. All things considered, it seems highly desirable that ways and means be found to permit the profitable use of larger pastures in this state.

BOVINE TUBERCULOSIS ERADICATION

Man, as well as his domesticated animals, is susceptible to tuberculosis. This disease is particularly prevalent in cattle, hogs, and poultry. Tuberculosis is readily transmitted among members of the same species by direct and indirect contact. Transmission among species varies as to frequency because of the existence of three more or less distinct types of tubercle bacilli, the human, the bovine, and the avian. In general the first is most common to man, the second to cattle, and the third to fowl. This study is interested in the second or bovine type.

The bovine tubercle bacilli, although most common to cattle, do not confine their ravages to cattle. Hogs contract the disease readily when fed on infected milk and when run in fields with tuberculous cattle. More unfortunate is the fact that human beings are not immune to the bovine type of tuberculosis. Evidence of the most authoritative kind shows that this dis-

[10] Sample et al., *op. cit.*, p. 45.

ease rarely causes the lung form of infection in adult human beings but is responsible for certain other forms of tuberculosis in infancy and childhood. Dr. L. Van Es of the Department of Animal Pathology and Hygiene of the University of Nebraska, one of the foremost authorities on bovine tuberculosis, writes of this form of infection in human beings as follows:

> When the results of the various investigations are subjected to analysis there can, however, be no doubt that the bovine type of infection is extremely rare in the chronic pulmonary tuberculosis of adult man on the one hand and on the other that this type of infection is relatively frequent in the acute tuberculosis and glandular infections of early age.
>
> Infection of bovine origin is thus, above all, to be feared in children, and this not only because they are more exposed to the virus conveyed to them by infected milk, but also by reason of their greater susceptibility to intestinal infection on account of the greater permeability of their digestive organs. In adult man, bovine infection appears to play a less important part.[1]

Although it is definitely known that bovine tuberculosis is frequently contracted by children, it is not known with equal certainty what percentage of tuberculous children contract the disease from infected cows. However, Dr. A. H. Francis of the United States Bureau of Animal Industry and Dr. L. Van Es of the Nebraska College of Agriculture believe that fully one-third of the tuberculosis that exists in children is contracted by the consumption of products from tuberculous cows.[2] When one remembers that tuberculosis exacts a larger death toll of children under 15 years of age than does any other acute communicable disease,[3] one realizes that the control and eradication of bovine tuberculosis is a major problem.

Bovine tuberculosis is transmitted to human beings almost entirely through infected milk. If such infected milk is properly pasteurized, the tuberculosis bacillus is killed and rendered innocuous. This is one of the important reasons that nearly all milk consumed in urban centers is so treated. In Nebraska a state law requires that cattle from which milk or cream is sold, exchanged, or delivered for human consumption, be tuberculin tested within a year immediately prior to the time the milk or cream is so used, except that cattle located in counties that have been established and are maintained as areas for the eradication of tuberculosis, which includes modified accredited counties, need not be further tested.[4] This statute has done much to foster the selling of more wholesome milk in

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[1] *Bovine Tuberculosis,* University of Nebraska College of Agriculture Experiment Station, Lincoln (revised January 1929), p. 69.

[2] Francis, A. H., and Van Es, L., "Interesting Facts Regarding Bovine Tuberculosis," *Extension Circular 218,* Revised, University of Nebraska, Agriculture Extension Service and the U. S. Dept. of Agriculture cooperating, Lincoln, January 1935, p. 1.

[3] Chadwick, Henry D., "The Incidence of Tuberculosis in School Children," *Journal of the American Veterinary Medical Association,* March 1935.

[4] *Compiled Statutes of Nebraska,* Sec. 81-1004, 1929.

Nebraska, particularly in cities where local health officials have insisted upon its observance.

The Relation of the Human Tubercular Death Rate to the Eradication of Bovine Tuberculosis

It has been suspected and even known for a considerable number of years that a direct relationship exists between the human tuberculosis death rate and prevalency of bovine tuberculosis. No statistical data, however, were available to establish this relationship until recently. With the advent of bovine-tuberculosis eradication in a number of states since the period of the World War such data are now available. The relationship is most astounding. The experiences of a number of states in this respect should be of interest in this connection.

In 1918 the state of Michigan began to stamp out bovine tuberculosis. In that year 4.6 per cent of the cattle tested reacted to the tubercular test. During this same year, the death rate from all forms of tuberculosis in the state of Michigan was 103.3 per 100,000 population. With eradication work in progress until in 1932, only 0.1 per cent of the cattle reacted to the test. During this same period of time the number of human deaths resulting from tuberculosis was cut in half, and was only 48.0 per 100,000 population in 1932.[5]

The state of Indiana can well match Michigan in this respect. In Indiana, 4.6 per cent of the cattle tested in 1918 were tuberculous and 136.3 people per 100,000 population died from all forms of tuberculosis. By 1932 only 0.4 per cent of the cattle were tuberculous and the human death rate from tuberculosis was reduced to 59.9 per 100,000 population.[6]

Nebraska still had a considerable number of unaccredited counties[7] prior to 1934-35. Fortunately the human death rate from the disease has shown distinct signs of decrease since the inauguration of eradication work in 1918. In that year 4.0 per cent of our cattle were found reactive[8] and the human death rate from all forms of tuberculosis was 39.6 per 100,000 population in Nebraska.[9] By 1933 the proportion of reacting cattle was reduced to 0.46 per cent and the tuberculosis death rate reduced to 21.7 per 100,000 population.

A similar story can be told about Ohio, Wisconsin, Illinois, Iowa, Minnesota, and perhaps certain other states for which no figures have been obtained.

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[5] According to statistics furnished by the Michigan State Department of Agriculture.

[6] Statistics furnished by the Indiana State Department of Agriculture.

[7] An accredited county is one in which bovine tuberculosis is less than one-half of one percent as shown by an official tuberculosis test.

[8] Nebraska State Department of Agriculture.

[9] Nebraska State Department of Health.

In contrast to the conditions noted in the states mentioned in the preceding paragraphs are the records of certain other states in which the work of eradicating bovine tuberculosis had been carried on in a less thorough manner. Up to October 4, 1933, the state of Wyoming had no accredited counties for tuberculosis eradication, and less than 220,000 cattle were tested for this disease at that time. Correlating with this result, the death rate from tuberculosis in Wyoming was as high in 1932 as in 1911, which is as far back as records are available.[10]

Conditions in South Dakota are similar to those in Wyoming in this respect. Prior to the enactment of the Jones-Connolly Cattle Act by Congress (1934), the work of eradicating bovine tuberculosis in South Dakota was carried on in a very indifferent manner. By 1932, 1.5 per cent of the cattle tested were still reacting and only a few counties were accredited. In the light of this it is interesting to note that the annual death rate from all forms of tuberculosis remained relatively constant, being about 50 persons per 100,000 population. In contrast we find that in North Dakota, where geographic and climatic conditions are similar to those of South Dakota, but where all breeding cattle have been tested and all counties accredited, the human death rate from tuberculosis was approximately half as high in 1932 as in 1917.

It is clearly apparent from such data that the dairy industry of Nebraska and every other state cannot compromise with half-hearted measures in stamping out this frightful disease. Such a program of eradication is also of interest to raisers of beef cattle. Unchecked, the disease would tend to infect increasing numbers of otherwise excellent beef stock. With increased infection, losses by death and condemnation in packing houses would mount to higher and higher levels. It is estimated that in recent years the stock raisers of the United States have lost from 30 to 40 million dollars annually from the ravages of tuberculosis. Since Nebraska is one of the foremost states in the raising of livestock, a considerable percentage of this loss falls on the shoulders of Nebraska farmers.[11]

Incidence of Bovine Tuberculosis

Bovine tuberculosis, being an infectious disease, is most common in areas where cattle have been bred for a long time, particularly in sections where the animals are closely quartered for a considerable part of the year. The disease seems to be most widespread in the dairy sections of northwestern Europe. In certain specialized dairy sections of European countries as high as 80 per cent of the cattle have been found tuberculous.[12] For those

[10] According to H. R. Smith, Livestock Commissioner, National Live Stock Exchange, Chicago, Ill., October 5, 1933.

[11] Francis, A. H., and Van Es, L., *op. cit.*, p. 4.

[12] Van Es, L., *Bovine Tuberculosis*, pp. 7-8.

countries, as a whole, it has been found in a number of instances that from 20 to 50 per cent of all cattle are reacting. With such widespread infection, the program of eradicating tuberculosis is exceedingly expensive and difficult. It is a condition, however, that would also develop in many sections of this country in the absence of effective eradication work.

Prior to the institution of bovine tuberculosis eradication work in the United States, this disease was very widespread in the more specialized dairying sections in the northeastern part of the United States and in the state of California. In some of the eastern states where the disease has been of long standing, the percentage of cattle infected ran as high as 40 per cent and even higher. In Nebraska it was found that 4 per cent of the cattle reacted when tuberculin testing was instituted in 1918. Since then eradicating work has been carried on, largely the result of federal promotion, and with the result that today Nebraska shares the distinction with 43 other states of having all counties on the modified accredited list. This means that in all counties bovine tuberculosis is found in less than one-half of one per cent of the animals tested. At the present time only New York, New Jersey, Maryland, South Dakota and California are not accredited, but it seems that all these states, with the exception of California, will shortly be accredited. The latter state is still badly infected.

Eradication of Bovine Tuberculosis

At present every state in the union is cooperating with the Federal government in a program of bovine-tuberculosis eradication. For the past eight years an average of more than a million cattle have been tuberculin tested each month. So successful has this work been that by April 30, 1937, 94.9 per cent of the counties in the United States were declared modified accredited areas.

The program of bovine-tuberculosis eradication in the United States was begun in 1917 and is sponsored to varying degrees by both state and Federal governments. In 1917 only about 20,000 cattle were tuberculin tested, whereas more than 13,000,000 head were tested annually during 1931, 1932, and 1933. Since 1934 the work has been executed on a larger scale, as a result of the Jones-Connolly Act of 1934.

Eradication Work in Nebraska. The work of eradicating bovine tuberculosis in Nebraska was begun in the latter part of 1918 on what is known as the accredited-herd plan. The work was sponsored by the state and Federal governments, and so cattle could be tested at a very modest cost. The passage of a state law in 1919, which required that cattle from which milk or cream was sold, exchanged, or delivered for human consumption should be tuberculin tested within a year immediately prior thereto, unless certain extenuating circumstances existed, compelled the testing of a considerable number of herds during 1919 and the early 20's. A rather critical

and skeptical attitude continued to prevail towards eradication work during the early 20's, and the state appropriations sponsoring this work were rather modest. By 1927 the merits of the eradication program were sufficiently appreciated that the Nebraska legislature passed a law which provided for the systematic areal eradication of tuberculosis.[13]

Sixty per cent of the cattle owners of a given county owning at least 51 per cent of the cattle may, by signing a petition, request the Department of Agriculture and Inspection that the cattle in the county be tested for tuberculosis. The department is then authorized to make such tests without expense to the owners, to the extent of the funds provided for eradication work. All cattle in such "area counties" are under the supervision of the department and the movement of cattle into and within such counties is governed by definite regulations.[14] Tuberculin testing and other measures for the eradication of tuberculosis are under the supervision of a veterinarian assigned to the service by the department. When the fact has been established that the number of reactors is less than one-half of one per cent the county is designated as a "modified accredited county."

Owners of tuberculous cattle are indemnified from state and Federal funds for all cattle condemned, except steers and spayed heifers. The Federal and state governments combined pay the owner two-thirds of the difference between the appraised value and the salvage received, with a maximum of $35 on grade animals and $60 on purebred animals. Under the present arrangement the state pays the whole indemnity on grade bulls, which cannot exceed $30 per animal. Under the Jones-Connolly Cattle Act the Federal government pays the first $25 on grade cows and the first $50 on purebred animals. Where the indemnity exceeds the amount paid by the Federal government, the state may add up to $10.

Under the area plan counties are called upon to pay certain incidental expenses connected with eradication work. They may be held for a cost not exceeding fifteen cents per head for each animal tested. The actual cost charged to the counties, however, has not approximated this maximum. During 1933 and 1934 the counties operating under the area plan were charged, on an average, the modest sum of 4½ cents per animal tested.

Bovine Tuberculosis Eradication Work in the Future. Great progress has been made in Nebraska and in the country as a whole in the eradication of bovine tuberculosis. Unquestionably, the eradication of tuberculosis from dairy cows was and is a large factor in the decreased death rate from nonrespiratory tuberculosis. This alone seems adequate justification for the program as carried out up to this time. It does not follow, however, that eradication work may be discontinued in Nebraska or other modified

[13] *Compiled Statutes of Nebraska,* Sec. 54-906 to 54-920, 1929.

[14] Full details concerning the area plan in Nebraska are given in *Bulletin No. 41* (revised) of the Department of Agriculture and Inspection, Lincoln.

accredited areas. All infectious bacteria that cause this disease cannot be eradicated, and hence some cattle will continue to react to the tuberculin test. From a few infected cattle the disease will spread to other animals as well as to man. Eternal vigilance is, therefore, the price that must be paid for tubercular-free cattle.

It is also well to remember that accredited states will jealously guard the healthy condition of their cattle and state laws will prevent the shipping in of cattle for feeding or milking from states that are unaccredited or lapse into an unaccredited condition. This consideration is of interest to Nebraska farmers and ranchers. Nebraska feeders frequently feed range cattle from other states, and Nebraska range cattle are frequently fed elsewhere, particularly in Iowa. If this state wishes to maintain its feeder market in the corn belt, it is essential that interest be sustained in bovine-tuberculosis eradication work.

TARIFFS AND THE DAIRY INDUSTRY

A glance at a map showing the distribution of dairy cattle in the United States and in the world as a whole shows that the dairy industry is prominent only in restricted sections and areas. Few milk cows are found in the Tropics and in the Orient. Generally speaking, this type of stock is most common in the middle latitude countries of the Western Hemisphere, New Zealand, and parts of Australia. The countries in the middle latitudes of the Western Hemisphere are not all equally prominent in the production and consumption of dairy foods. While some countries are self-sustaining with reference to dairy products, others may have a market surplus or a deficiency. Prominent exporting countries of dairy products are Denmark, the Netherlands, Switzerland, New Zealand, Canada, and, with respect to canned milk, the United States. Prominent importing countries are England, certain islands and countries in the Tropics and the Orient, and, with respect to cheese, the United States.

Specialized dairying is localized in various parts of the world because of environmental conditions as well as economic and cultural practices. Consumption of dairy products in varying amounts, however, is nearly world-wide. Relatively high value with reference to weight and size makes feasible the transportation of most dairy products to distant markets. New Zealand butter, for instance, is regularly marketed in European countries and in various American countries in which tariff barriers are not too high.

Brief Survey of the Foreign Trade of the United States in Dairy Products

Butter. Prior to 1850, international trade in dairy products was small. Some butter, however, was shipped from America to Europe even in Colonial days. This export trade gradually gained in volume until 1880,

the peak year.[1] After 1880, it declined more or less irregularly up to the period of the World War. During the pre-war period our exports of butter fluctuated between 3 million and 6 million pounds annually (Table 8). The war and its aftermath raised the trade to another high point of about 34 million pounds in 1918-19, only to make so much more striking its precipitous decline during the twenties and early thirties. From 1931-32 to 1933-34 our exports of butter averaged about 1,500,000 pounds per year.

With two marked exceptions, the butter imports of the United States usually have been small. Because of the dislocations resulting from the Civil War, the country annually imported from 2 to 6 million pounds of butter in the decade beginning with 1860.[2] Following this period, foreign butter purchases declined until the five-year period immediately following the World War. During these years, 1919-20 to 1923-24, from 10 to 30 million pounds of butter were imported annually (Table 8). From 1924-25 forward such purchases abroad have declined to less than one million pounds. Since the United States produces and consumes slightly over two billion pounds of butter annually, the present imports of this food are negligible.

Cheese. The United States was a prominent exporter of cheese until shortly after the beginning of the present century. The high point in cheese exports was reached between 1875 and 1884.[3] After 1890, except during the World War period, imports increased rather consistently until 1927 when about one-fifth of the cheese consumed in this country was imported. During that year the United States imported about 90 million pounds of cheese (Table 8), mainly of types not made in this country and of certain less common varieties. The World War, on the other hand, caused a brief flourish in the export business of cheese. Our exports of this produce increased from 2½ million pounds in 1912-13 to 66 million in 1916-17, only to decline to a low level in 1933-34 of slightly over one million pounds.

Condensed and Evaporated Milk. Foreign trade in condensed and evaporated milk was of small significance prior to 1910. The World War served as a remarkable stimulus to this industry, and by 1918-19 the United States was exporting in excess of 700 million pounds of these dairy products (Table 8). By 1933-34, these exports declined to about 38 million pounds, an amount approximately one-sixteenth of the one-time high. Imports of condensed and evaporated milk are inconsiderable; they totaled slightly over one million pounds in 1931-32.

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[1] Renne, Ronald R., *The Tariff on Dairy Products*, The Tariff Research Committee, Madison, Wisconsin (1933), p. 25.

[2] *Ibid.*, p. 25.

[3] *Ibid.*, p. 25.

TABLE 8.—*Foreign Trade of the United States in Butter, Cheese, and Condensed and Evaporated Milk, 1910-33* (in thousands of pounds).*

Year	Butter		Cheese		Condensed and Evaporated Milk	
	Exports	Imports	Exports	Imports	Exports	Imports
1909-10	3,141	1,360	2,847	40,818	13,311	
1910-11	4,878	1,008	10,367	46,569	12,180	
1911-12	6,092	1,026	6,338	46,542	20,643	
1912-13	3,586	1,162	2,599	49,388	16,526	
1913-14	3,694	7,842	2,428	63,784	16,209	
1914-15	9,851	3,828	55,363	50,139	38,236	
1915-16	13,487	713	44,394	30,088	159,578	
1916-17	26,835	524	66,050	14,482	259,141	
1917-18	17,736	1,806	44,303	9,839	528,759	
1918-19	33,740	4,131	18,792	2,442	728,741	
1919-20	27,156	20,771	19,378	17,378	708,463	
1920-21	7,829	34,344	10,826	16,585	262,688	23,756
1921-22	7,512	9,551	7,471	34,271	277,311	19,273
1922-23	9,410	15,772	8,446	54,555	157,038	2,037
1923-24	5,425	29,466	3,938	66,597	213,613	7,276
1924-25	8,284	7,189	9,432	61,489	173,547	7,679
1925-26	5,280	6,440	4,094	62,412	135,865	4,621
1926-27	5,048	10,710	3,773	89,782	108,942	1,663
1927-28	3,965	4,955	2,873	75,424	108,943	2,623
1928-29	3,778	3,299	2,572	84,606	112,492	2,609
1929-30	3,582	2,851	2,339	78,261	101,572	2,634
1930-31	2,293	1,329	1,733	57,972	78,986	1,611
1931-32	1,578	1,838	1,564	57,235	65,623	1,245
1932-33	1,396	991	1,346	55,923	40,013	
1933-34	1,416	763	1,253	46,904	38,088	
1934-35**	761	22,393	1,344	48,446	47,430	

* Compiled from *Yearbook of Agriculture.*
** Preliminary.

Brief Survey of Tariff Rates on Dairy Products

Tariff protection has been extended to the dairy industry of the United States since 1789 (Tariff Act of 1789).[4] The early tariffs on dairy products applied particularly to cheese, a product that could readily be shipped great distances because of its keeping qualities. As other products became important in international trade, they also received protection. The tariff of 1789 placed a duty of 4 cents per pound on cheese and a 5 per cent ad valorem tax on other dairy products. As early as 1794, the duty on cheese was raised to 7 cents per pound and the duty on other products to 10 per cent ad valorem. During the War of 1812, these rates were doubled for a period ending one year after the war. By 1816 the duty on cheese was fixed at 9 cents per pound, while other dairy products were placed on the free list. With the exception of the war-time rate of 1812, this remains an all-time high tariff on cheese in this country. It prevailed until 1846, when

[4] *Yearbook of Agriculture,* 1922, p. 389.

it was changed to 30 per cent ad valorem, and a 20 per cent ad valorem tax was placed on other dairy products. From 1861 to 1909 the rates on cheese and butter have ranged from 4 to 6 cents a pound.[5] Table 9 presents in detail the tariff rates on dairy products fixed by acts since 1909.

TABLE 9.—*Tariff Rates on Dairy Products Since 1909**

Product	Unit of Measurement	Rates of Duty			
		Act of 1909 (cents)	Act of 1913 (cents)	Act of 1922 (cents)	Act of 1930 (cents)
Whole milk	gallon	2.00	free	2.50	6.50
Cream	gallon	5.00	free	20.00	56.60
Evaporated milk	pound	2.00	free	1.00	1.80
Condensed milk	pound	2.00	free	1.50	2.75
Dried whole milk	pound	free	free	3.00	6.50
Dried cream	pound	free	free	7.00	12.33
Dried skimmilk	pound	free	free	1.50	3.00
Malted milk	pound	free	free	20%**	35%**
Butter	pound	6.00	2.50	8.00	14.00
Cheese	pound	6.00	20%**	5.00	7.00

* Compiled from Tariff Acts of 1909, 1913, 1922, and 1930.
** Ad valorem.

Tariff Act of 1909 (Payne-Aldrich Tariff). Of the various dairy items receiving protection under the Tariff Act of 1909, butter, cheese, and canned and evaporated milk are important because they represent the more common dairy articles of international trade. Protection was extended to the milk-concentrating industry largely because of its youth and lack of development. Subsequently this industry has become rather prominent, so that the United States has constantly exported more canned and evaporated milk than it has imported. The tariff of 6 cents per pound placed on butter discouraged the importation of this food to the vanishing point. Table 8 shows that the importation of butter in 1909 was already negligible. A tariff of 6 cents per pound was also placed on cheese to encourage domestic production, but importation of cheese did not decline as a result of this tax.

Tariff Act of 1913 (Underwood Tariff). The next important tariff legislation, enacted in 1913 under President Wilson's administration, is known as the Tariff Act of 1913 or the Underwood tariff. Table 9 indicates what was accomplished in this measure. The Underwood tariff made many additions to the free list and materially reduced the rates on many other products. Of all the dairy products, only butter and cheese retained some measure of protection.

The lack of tariff protection for most dairy products and the modest protection given to butter and cheese by the Underwood law did not result in the importation of great quantities of dairy products. As a matter

[5] *Ibid.*, p. 389.

of fact, imports of most of these commodities decreased, as is shown in Table 8. This decrease in imports, however, is not related to the tariff. The World War, into which European nations were shortly precipitated, seriously disturbed all previously established trade relations, and the United States became the great food provider for many of the warring nations. It is therefore impossible to ascertain the effects of the Underwood tariff with any degree of certainty.

The World War and Trade Dislocations. The World War caused pronounced economic dislocations throughout the world. While the European nations were bending all their efforts toward the destruction of life and property, other countries, including the United States, were called upon to produce vast amounts of finished industrial products as well as raw food products. As a result, many new industries were developed in the United States, and much marginal land was pressed into various agricultural uses. This production program increased exports phenomenally, and financial books showed that the United States became the foremost creditor nation. With the cessation of hostilities this abnormal production program crumbled. As soldiers again became producers of commodities in their respective countries, fewer goods were obtained from the United States. The fact that it was a creditor nation, with most of the other warring nations its debtors, made it imperative that the latter countries must shortly export goods to the United States to pay their obligations. There was no other method of payment available for them. In short, it was imperative in the unfolding of an economic dilemma that this country must lose much of its foreign market, as well as permit the importation of goods if debts were to be collected. It is in the light of this background that we must view the Fordney-McCumber tariff of 1922 and the Hawley-Smoot tariff of 1930.

Tariff Act of 1922 (Fordney-McCumber Tariff). The Fordney-McCumber tariff of 1922 in general increased import rates. Concentrated forms of milk and cheese received less protection than under the Act of 1909, but on all other dairy products the rates were higher. Modest rates were placed on condensed and evaporated milk because the imports of these commodities were small in proportion to the amount exported. The rate of protection on cheese was also modest, largely because the imports of this food were still considerably below the pre-war level. Other rates on dairy products served to reduce to a minimum the importation of products that were produced in adequate quantities domestically.

The Fordney-McCumber tariff did not accomplish the miracle expected of it. Farm prices, which declined radically after the war, remained distressingly low. A large share of the high-priced foreign market had vanished and could not be revived. Nonagricultural industries were,

momentarily, less severely shocked by the loss of the foreign market. The new industries, auto, radio, and power farming, still had virgin markets to conquer, largely domestic markets. It is important to remember in this connection also that certain foreign markets were sustained by huge foreign loans, many of which have never been collected. In addition, installment buying and stock-market booms served to forestall for American industries the depression that had hit the farmers in the early twenties. By November 1929, however, the industrial boom of the country also was punctured. Industrialists as well as farmers now realized that something was amiss. Congress was called upon to do something. The party in control again resorted to the tariff. It proceeded to raise still higher the barriers that were already throttling foreign commerce.

Tariff Act of 1930 (Hawley-Smoot Tariff). The Tariff Act of 1930 was designed to preserve the American market for the many domestic depression-ridden industries. Farming interests had suffered most and felt that the new measure should be designed to provide them the maximum relief. To accomplish this, agricultural bodies asked for a marked increase in tariff rates on oils, fats, dairy products, hides, skins, and numerous other agricultural products. The debenture plan was advocated to make the tariff effective on such agricultural products of which we had a surplus. The agricultural leaders asked also that the tariff rates on numerous industrial products be lowered so as to moderate the prices on commodities that the farmer had to purchase. The legislators from industrial states, however, had no intention of giving the farmer the benefit of a "give and take" form of tariff. As might be expected under these conditions, when the Hawley-Smoot tariff came out of the legislative hopper, it was found to contain increased rates on nearly all products.

Table 9 shows the various rates on dairy products provided by the Tariff Act of 1930. In each instance the duties were higher than under the Fordney-McCumber tariff of 1922. As indicated in Table 8, a rather sharp decline in the imports of cheese, butter, and condensed and evaporated milk occurred. This decline was, no doubt, in part traceable to the higher rates placed on these dairy products.

Reciprocal Trade Agreements (1934). The tariff acts of 1922 and 1930 did not restore prosperity, although they did afford protection to certain forms of industry. The butter industry, for instance, has profited to some degree from the tariff because only small amounts of this food could be imported over our high tariff. On the whole, stagnation in industry resulted. The desperate situation demanded some kind of action. Unless we agreed to purchase foreign commodities on reasonable terms, we could not expect to sell our surplus cotton, lard, wheat, tobacco, fruits, and certain other products. It was this condition that prompted President

Franklin D. Roosevelt to ask for legislation giving him power to enter into reciprocal trade agreements with foreign countries. The Reciprocal Trade Agreement Act was passed by Congress and signed by the President on June 12, 1934.

The act of 1934 gives our chief executive the power to negotiate reciprocal trade agreements with foreign countries and provides that public notice of the intention to negotiate such agreements be given to interested persons so that they may have an opportunity to present their views. The law provides further that the President, before concluding agreements, shall seek information and advice from the United States Tariff Commission and from the departments of State, Agriculture, and Commerce. When foreign trade agreements have been made, the President proclaims the changes in duties or restrictions placed upon imports and other terms of the agreements. It is provided, however, that no agreement shall be made increasing or decreasing an existing rate more than 50 per cent, nor may any article be transferred from the dutiable to the free list, or the reverse. The provisions of proclamation shall apply to all countries not discriminating against the commerce of the United States. The President may at any time terminate the agreement in whole or in part.

The authority of the President to change tariff rates under the Reciprocal Trade Agreement Act has been applied to dairy products only to a limited extent.[6] It is not likely to be so applied to increase significantly the imports of dairy products. Few tariff provisions are more widespread in their influence than those relating to the dairy industry.

[6] The Canadian Trade Agreement, signed on November 15, 1935, has reduced the import duty on the first 1,500,000 gallons of fresh and sour cream from 56.6 cents to 35 cents per gallon. Additional imports during the year are not affected. The rate on cheddar cheese in original loaves was also reduced from 7 cents per pound, but not less than 35 per cent ad valorem to 5 cents per pound and not less than 25 per cent ad valorem.

SUMMARY

The first cattle came to the area now included in Nebraska in about 1820 and a large number passed through in the 1840's and 1850's in transit to more western settlements. The majority of pioneers, coming to Nebraska after 1854, brought domesticated cattle with them. The Texas Longhorn entered the central and western part of the state from the South but contributed little to the dairy industry. The raising of beef cattle has always been more important in Nebraska than the production of dairy products.

Commercial dairying in the United States began about the middle of the 19th century. Nebraska ranked thirteenth in the number of cows milked and thirtieth in average milk production per cow in 1929. Nebraska is exceeded only by Iowa in total number of dual-purpose milk cows and only by Wyoming in percentage of dual-purpose cows. Our state ranks among the lowest four states in percentage of purebred milk cows. Nebraska farmers received about 11 per cent of their gross income from the sale of dairy products in the 1929 to 1932 period. The average herd of milk cows in the state consisted of 5½ animals in 1929.

The depression of recent years has served to encourage milking activities in every section of the state. Milking practices generally are lagging behind modern approved methods because the production of dairy products is an unspecialized activity in Nebraska.

About 70 per cent of the milk produced in Nebraska is separated for use in making country or creamery butter. The average milk cow in the state produced 4200 pounds of milk during 1933, an amount only slightly greater than the average figure for the entire country. The returns per cow become progressively greater as the milk production per cow increases.

Many unspecialized dairymen of the state do not take full advantage of the varieties of food grown and do not follow scientific feeding methods. More extensive use of the silo should be made.

The profit or loss per cow can be economically and reliably determined by assistance of membership in a dairy-herd improvement association. The selection and use of proved purebred bulls will increase the production record of the offspring of average cows.

A combination milk and shelter shed is generally more practicable for the average milk producer in Nebraska than is a costly dairy barn. Sanitation, proper lighting, and ventilation should be considered in construction.

Fresh, green pasturage provides nearly all substances required for the perfect nutrition of the dairy cow but grain or other concentrated foods should supplement the feed of cows producing more than a pound of butterfat per day. Native grasses are more suitable in much of the state while tame forage grasses and legumes provide a productive pasture in

eastern Nebraska. Off-flavored milk can be avoided by feeding materials responsible for off-flavors only immediately after milking. Larger pastures are desirable.

Bovine tuberculosis rarely causes the lung form of infection but is sometimes responsible for other forms of tuberculosis among infants and children. It is transmitted to human beings almost entirely through infected milk. Pasteurization of the milk kills the bacillus tuberculosis. Records show a decline in human tuberculosis death rate in regions where a bovine tuberculosis eradication program has been followed

Specialized dairying is localized in certain parts of the world while consumption of dairy products is almost world-wide. International trade in dairy products was negligible before 1850. The tariff acts of 1909, 1922 and 1930 have, generally, placed progressively higher rates on imported dairy products.

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