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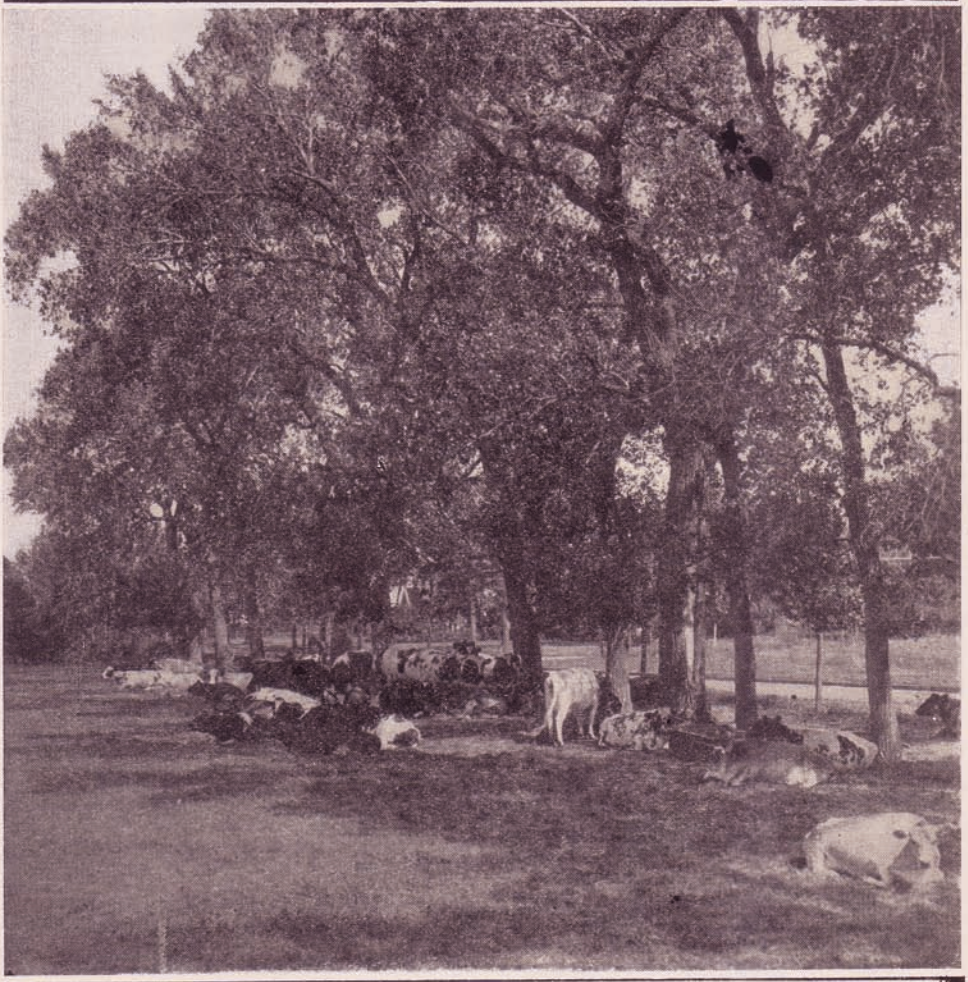
BULLETIN 270 APRIL, 1932

A SEVEN YEAR STUDY OF A MILK SUPPLY

BY P·A·DOWNS
DEPARTMENT OF DAIRY HUSBANDRY



THE UNIVERSITY OF NEBRASKA
COLLEGE OF AGRICULTURE
EXPERIMENT STATION · LINCOLN
W·W·BURR · DIRECTOR

This bulletin shows what has been done to improve the quality of milk delivered to the Dairy Husbandry Department of the University of Nebraska. It should be of interest to distributors and manufacturers of dairy products and to health officials of cities and towns of Nebraska and other states.

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SUMMARY

Many farms in eastern Nebraska that produce milk for the Lincoln market do not have the barns, milk houses, and cooling or other dairy equipment necessary to produce the best quality of milk. Only by the exercise of exceptional care in handling milk is it possible to produce the best quality of milk under prevailing conditions.

Milk was graded for quality on the basis of its sediment content and bacterial count. A sediment score of seven or above and a bacterial count of less than 100,000 per cubic centimeter, as determined by the direct microscopic method, were considered as the minimum standards for a good grade of milk.

As soon as the milk producers realized that dirt in the milk lowered the quality, there was a rapid improvement in that respect.

While there was a decrease in the percentage of unsatisfactory milk and an increase in the percentage of good milk, the improvement has varied greatly throughout the period.

The frequent changing of patrons tends to lower the quality of milk, since new patrons are usually inexperienced in producing good quality milk. Many farms are operated by tenants; under such conditions improvement in physical equipment is very slow.

Summer temperatures are so high that there is practically no cooling effect from the air. Unless water is used effectively in a cooling tank, milk is delivered in poor condition. There is a rather close correlation between air temperatures and milk quality. The distance the milk was hauled had little effect upon its quality.

While some patrons who used milking machines produced high-quality milk, the tendency was to produce milk below the average of all patrons.

Systems of reports to patrons on sediment and bacterial count brought about only slight improvement. After the inauguration of bonuses and deductions based upon milk quality, improvement was much more rapid.

A Seven-Year Study of an Eastern Nebraska Milk Supply

P. A. DOWNS [1]

Department of Dairy Husbandry

The amount of butter produced by the grain-belt states is evidence that a great many cows are milked by the midwestern farmer. Most of this milk is separated on the farm, the cream is sold, and the skimmilk is fed to hogs and other livestock. As the market for fluid milk has developed, many farmers near the cities have turned to the sale of milk, because it affords a better return for the butterfat sold. Much of the milk produced for sale as fluid milk is produced under practically the same conditions as milk which is produced primarily for the sale of cream.

In the milk-producing territory surrounding the larger cities, certain sanitary regulations with reference to buildings, equipment, and care have been in operation to govern fluid milk produced for sale. These regulations and requirements, which are made by health departments, differ in various parts of the country. The milk supply of many Nebraska cities has not been produced under strict regulations in the past and might be considered at present as passing through the "cream to milk" stage.

The Department of Dairy Husbandry of the University of Nebraska, in conducting its instructional and investigational work, comes in contact with the milk producer. An effort has been made, therefore, to study the relation of milk quality to farm conditions as found among the milk producers or patrons who have delivered milk to the department. The study was carried on in an effort to find possible ways of bettering the conditions without upsetting the economic balance existing between the production of cream and fluid milk.

THE MILK SUPPLY

The source of supply has varied from year to year and the number of patrons has changed as the demand for milk has increased in the locality. During the first years the farms which supplied the milk were located close to Lincoln and to the south of the city as shown in Figure 1. In the course of seven years new ones were added and old ones dropped. In this way the location of the farms supplying milk has shifted toward the east and northeast. The distance from the plant

[1] The author wishes to acknowledge the assistance of Professor H. P. Davis in the preparation of the manuscript.

FIG. 1.—Maps showing location of farms delivering milk during the different years of the study.

has gradually increased; in fact, some of the milk has been carried 20 miles. Most of the distant farmers depend upon route trucks to deliver milk, while some closer in deliver it themselves. In general the group is typical for eastern Nebraska.

The length of time that patrons have delivered milk to the plant has varied greatly. Of the 144 farmers who have delivered at some time, only three have continued throughout the entire period. Four others lacked only a few weeks of delivering for the full time. Fourteen farmers delivered for five years and a large number delivered for three years.

Ninety-two farmers delivered milk for a period of one year or more, of whom 37, or 40 per cent, were tenant farmers. The other 55 were owners or members of a family that owned the farm. This condition complicated attempts to better conditions, especially when they required the outlay of capital for changes in buildings or equipment.

The number of cows milked per farm also may have an effect upon the housing and care of the milk cows. On 52, or 56 per cent, of the farms studied fewer than 10 cows were milked. On 22 of these, six or fewer were milked. Twenty-nine farms milked between 10 and 20 cows, while eight farms milked between 24 and 30 cows, and on only one farm were over 30 cows milked.

BARNS AND METHODS OF STABLING

The equipment for confining cows in the barns was as follows: eight barns used ties, 80 used stanchions, and four used neither. Most of the stanchions were made of plank, although 21 barns were equipped with metal stanchions.

A fact that should be kept in mind is that climatic conditions are such that the stabling of cows is not absolutely necessary throughout the winter as it is in some of our northern states. Moderate weather conditions do not stimulate the building of large barns and the use of other sanitary equipment considered a necessity by the average dairy farmer of the older milk-producing sections. The stabling of cows only at milking time, as well as milking in the open, is common practice except in very severe weather. This no doubt explains to some extent the lack of barn equipment on the farms studied.

The type and condition of the barns on the 92 farms studied varied greatly. On 75, or 81.5 per cent, of the farms the milk cows were housed in combination barns. The plain rectangular barn, No. 3, Figure 2, was the original type, to which lean-to additions have been attached in numerous ways

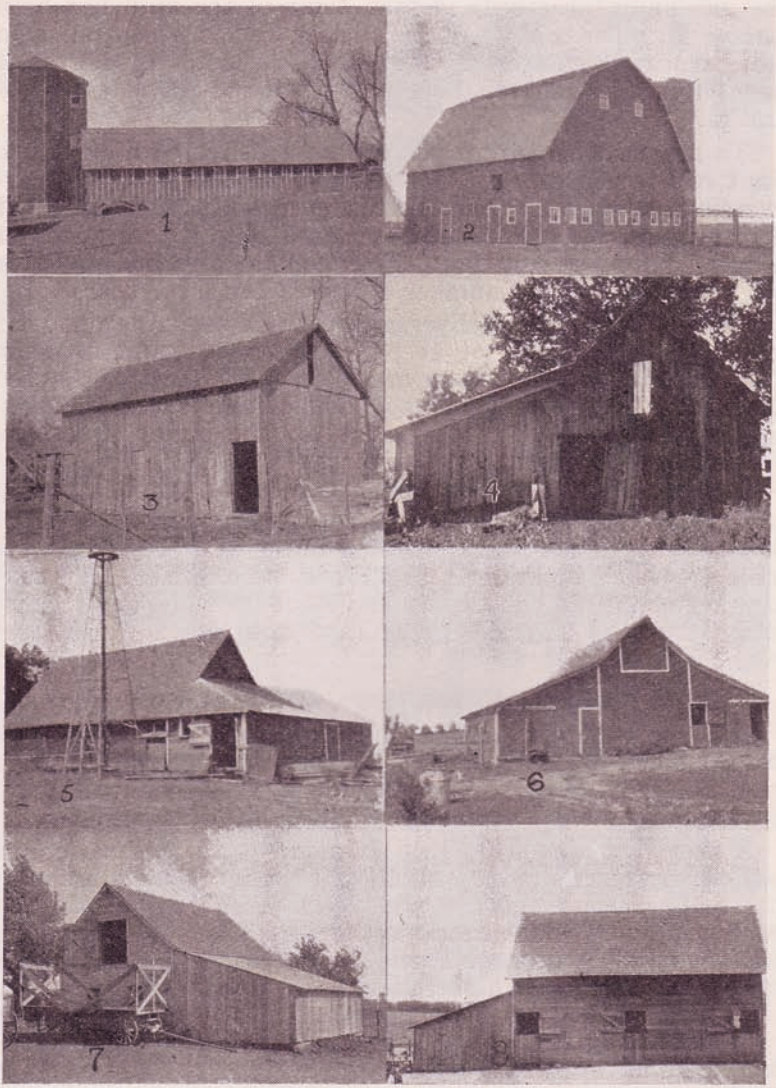

FIG. 2.—Typical barns on farms where milk was produced.

as shown by the other pictures. The usual practice is to stable the cows in a part of the barn, which is open throughout and also houses the horses and, in rare instances, other farm animals.

Well-located separate cow barns, as shown in Nos. 1 and 2, Figure 2, equipped with stanchions, cement floors, and sufficient windows, were found on three farms. Fourteen others had means for housing the cows separately from other animals. For this purpose the separate rectangular barn or first floor of the hay barn was often used. One used an old schoolhouse, three had open sheds, and one a straw shelter.

The lack of light in many barns, as shown by the absence of windows, is quite evident. It was found that 20, or 22 per cent, of the 92 farm barns had no windows in the cow stable, and 36, or 39 per cent, had only one or two windows. A standard requirement for dairy barns is at least three square feet of window for each stanchion. It was found that only 16 barns, or 17 per cent, had even one window, regardless of size, for every two stanchions.

In some cases, as shown in No. 7, Figure 2, a lean-to was added to the barn with no provision for light. This plan, especially in connection with dirt floors and poor drainage, very often resulted in unsanitary conditions in the barn.

The study of floors and gutters showed that 33 were concrete, 22 were wood, 17 were dirt, 16 were dirt and wood, two were wood and concrete, and two were dirt and concrete. Twenty-two barns with dirt or wood floors had no gutters. In some instances the floors were in such condition that it was practically impossible to clean them.

The walls and ceilings were finished with smooth lumber in four barns, and 85 had only the outside of the barn for walls. Many side walls had wide cracks between the siding boards, as shown in Nos. 3 and 4, Figure 2. In two cases the walls were cellar walls of concrete and stone and in one case they were of straw. The ceilings were roofs in 38 barns and loft floors in 51. These were in various states of repair and often were open to the hay above, which was a source of considerable dust, especially during windy weather.

MILK HOUSES AND UTENSILS

The use of a milk house where the milk can be taken as it is milked and then cooled is a recognized sanitary method of handling market milk. Of the 92 farms studied, 13 had buildings that were used as milk houses as well as for other purposes. Only 6, or 6.5 per cent, of the farms had milk houses in such repair that they could be kept sanitary. On the majority of the farms the milk was handled in the barn or in the open. The most common storage place for the milk cans was at the well (No. 6, Fig. 2) and the utensils, such as pails and strainers, were washed and kept in the house.

Milking machines were used on 9 farms and were washed and cared for in the house, milk house, or barn. In some instances the distance from the house to the barn made it impractical to carry hot water for the care of the machine. In these cases oil stoves in the barn or milk house furnished a means of obtaining hot water.

COOLING EQUIPMENT

The equipment for milk cooling on the farms studied varied in kind and condition. The regular livestock watering tank was the only cooling equipment on 52 farms, which was more than 56 per cent of those studied. The stock tank is usually a large tank located in the open so that the water is warmed by the sun during the day. If it is to be used as a place to cool the milk the warm water must be replaced with cold water of a temperature low enough to cool the milk properly. As this is generally a difficult task, the use of the stock tank often results in improper cooling. A satisfactory and inexpensive method is that of pumping the water direct from the well through a small tank and then to the stock tank. Seven farms used concrete cooling tanks in this way, five used wooden tanks, and 16 used small metal tanks. Seven farms used wooden barrels, two used metal barrels, and two used washtubs in which the cans of milk were placed to cool.

The location of the cooling tank is of importance, as it involves the factor of labor. Anything that makes the cooling process inconvenient often determines whether the milk will be cooled. This is especially true between seasons, when the producer is uncertain whether or not the milk should be cooled. It was found that less than half of the farms had their cooling equipment, regardless of kind, within a reasonable distance of the barn. Many tanks were located several hundred feet from the stable door and in very inconvenient places, such as on the far side of the barnyard.

The source of water and the ease with which fresh, cold water can be obtained have their effect upon the promptness and regularity with which the milk is cooled. As the sole source of water was the deep well, the method of pumping is of interest. Hand pumping alone was used on four farms, and electric power on two. The rest depended upon the windmill, supplemented by gas engines and hand power. This introduces another factor, especially if cooling is attempted in the stock tank where a large amount of water is necessary. If the wind is not blowing sufficiently, other power must be used. This is inconvenient and the milk may not be cooled

properly. The cooling tank should be as close as possible to the well so that the water will be cold when it reaches the tank. Fifteen farms had storage systems for the water supply, and these generally furnish water considerably warmer than water pumped directly from the well. Where such systems are used the milk cooling should be done with fresh water. On farms where the well is away from the buildings and the water flows in pipes for some distance it is difficult to cool milk properly. Water that has stood in a tank during the summer day is not suitable for this purpose. On many farms, simple changes in the methods would make it possible for the producer to cool his milk and keep it cool if he so desired.

BUTTERFAT AND QUALITY DETERMINATIONS

At the beginning of this study the method of determining the value of the milk was to test it by the Babcock method at irregular intervals but at least once every 15 days. The record showed considerable variation in the fat content, and the testing of daily samples was begun.

Quality determinations were made by running the sediment test and bacterial counts once a week. Sediment disks were obtained by filtering one pint of each patron's milk. The disks were then scored, zero being allowed for very dirty samples and ten for clean samples, according to the system outlined by Kelly.[2] In recording the sediment scores, numerical values from 0 to 10 were used. Whole points were used between 0 and 8 and one-half points between 8 and 9 and quarter points between 9 and 10. All samples were obtained at the "weigh can" as the milk was received and taken to the laboratory. In the early part of the study the mixed milk in the "weigh can" was used for testing. Later the sample was taken from one of the cans of night's milk as it was poured into the "weigh can."

The bacterial counts were made by the direct microscopic method, which consists of making smears of 1/100 cubic centimeter of milk on slides as soon as possible after the milk samples reach the laboratory. After drying they were treated and stained with methylene blue as outlined in Standard Methods of Milk Analysis [3] or by Neuman's Stain No. 2 as described by Neuman.[4] The first method of staining was used during the early part of the study but was later discontinued

[2] Kelly, Ernest: Milk and Cream Contests. U. S. D. A. Circular No. 384, Revised 1929, 19 pp.

[3] American Public Health Assoc.: Standard Methods of Milk Analysis. Fifth Edition, 1928. pp. 21-27.

[4] Neuman, R. W.: Monthly Bul. Calif. State Dept. Agr. 1927. pp. 1-9.

and Neuman's method used in its place. Both gave satisfactory results but the latter saved considerable time. The stained smears were counted by the use of a binocular microscope having a multiplication factor of 300,000.

MILK GRADING

The methods and systems used in the grading of milk are numerous, each one apparently fulfilling a need in a particular situation. The advisability of basing a grading system upon only one method of examination is often questioned. As information on almost 15,000 samples was available in this study, it was felt that a tabulation in different ways might be of interest. Table 1 shows the distribution of all samples when graded by sediment score alone, by bacterial count alone, and by a combination of the two. The basis of determining grades is shown on the report blank below.

UNIVERSITY OF NEBRASKA, DAIRY HUSBANDRY DEPARTMENT

Weekly Report of the Quality of

Milk as delivered by.....

Date ..... Quality or grade .....

SEDIMENT REPORT

The cotton disk shows the amount of sediment or dirt found in one pint of the milk delivered by you on the above date. Sediment Score.....

BACTERIA REPORT

The number of bacteria found in one cubic centimeter of the milk delivered by you on the above date was .....

Remarks .....

.....

.....

HOW THE GRADE OF YOUR MILK WAS DETERMINED

Milk, in order to be classed as "Excellent," must have less than 10,000 bacteria per c.c. and a sediment score of at least 9.

Milk, in order to be classed "Good," must have less than 100,000 bacteria per c.c. and a sediment score of at least 7.

Milk to be classed as "Fair," must have less than 500,000 bacteria per c.c. and a sediment score of at least 5.

Milk having a bacterial count of between 500,000 and 1,000,000 will be classed "Poor".

Milk not included in the above classes will be graded as "Unsatisfactory" and should be given attention at once.

Milk showing very high bacterial counts and low sediment score will be graded "Very Unsatisfactory" and should be considered as subject to return if conditions are not remedied at once.

TABLE 1.—*The grading of milk for quality as determined by sediment score, bacterial count, and a combination of both*

Method of grading	1924	1925	1926	1927	1928	1929	1930
Sediment score	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
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	52.7	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	28.8	23.8	20.2	14.8	19.2
Unsatisfactory, above 1,000,000 per c.c.	30.8	18.9	36.9	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

It is evident from the table that a single method of examination may give results that differ from those obtained by the combination of methods. While the sediment test is simple and economical to operate, when it is used alone it may cause improvement in the cleanliness of the milk but not improvement in the bacterial count. It was observed early in the study that during very cold weather many very dirty samples would have low bacterial counts, and also that many clean samples would have high bacterial counts. No doubt the sediment disk when returned to the producer has an influence upon the future care of his milk, because it is something he can see. The bacterial count usually has a mysterious atmosphere about it which does not exist in the case of the sediment disk. For that reason where the greatest improvement in quality is desired a combination of these two methods seems advisable. This plan makes use of a recognized standard of quality, the bacterial count, and a very useful and simple test, the sediment test and score. By these methods the grading throughout this study has been carried out. The particular method used to obtain the bacterial count can be varied to suit the conditions.

METHODS USED TO ENCOURAGE BETTER CARE OF MILK

During the first three years no reports were sent to the producers. One or two meetings were held to point out to the producers the condition of the milk being delivered. Some in-

terest was taken but no organized effort to improve the quality of the milk was made at that time. In March, 1927, the plan of reporting each week to the producer the quality of his milk by the use of the report blank (page 11) was started and continued throughout the remainder of the period. It was hoped that, since no organized field work could be carried on, the reports would stimulate the producer to take better care of his milk.

In July, 1928, an additional stimulus was added in the form of a bonus of three cents per pound of butterfat, over and above the regular price, 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 plan of deducting five cents per pound of butterfat from the regular price for all milk that showed a count of over one million per cubic centimeter or was below three in sediment score was put in operation. The greatest improvement in quality with the least possible expense is of economic importance. Under this plan the ability of the producer to adapt himself to the production of good milk without unnecessary expense increases his earning capacity. From the standpoint of the purchaser of the milk any method that will help to bring about an improvement in the milk supply, with a minimum of expense to him, is of financial importance.

TABLE 2.—*Distribution of sediment scores throughout the period*

Sediment score	1924	1925	1926	1927	1928	1929	1930
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
0	61.1	7.4	8.0	3.7	0.6	0.2	0.1
1	3.6	2.8	1.7	0.3	....	....	....
2	4.4	4.4	4.1	0.5	0.1	....	0.1
3	3.1	7.4	5.8	5.2	0.5	0.2	0.4
4	4.3	12.6	8.1	5.8	0.3	0.3	1.4
5	9.1	21.4	14.3	16.4	4.6	1.5	2.4
6	4.3	23.6	24.5	22.9	9.3	6.6	7.5
7	5.8	13.9	19.1	21.2	18.1	15.2	19.0
8	3.9	5.0	8.9	12.1	22.3	24.5	21.5
8.5	0.2	0.6	2.5	5.9	12.9	31.1	36.1
9.0	0.2	0.9	2.0	5.2	28.1	18.1	10.6
9.5	....	....	1.0	0.9	3.2	2.3	0.9
10.0	....	....	....	....	....	....	....
Percentage of all samples scoring 7 or above	10.2	20.4	33.5	45.3	84.6	91.2	88.1
Total number of samples	984	1236	1534	1885	2630	3288	3355

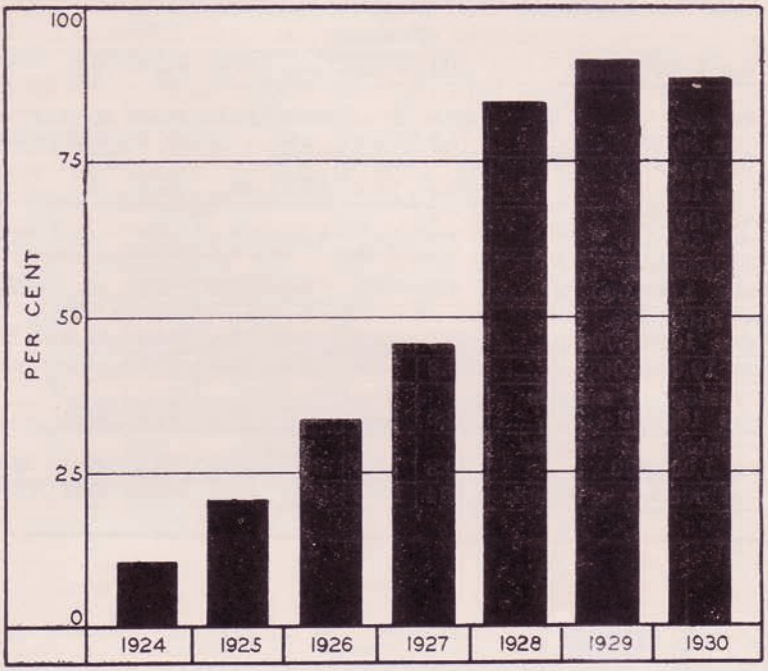

FIG. 3.—Percentage of all samples scoring 7 or above by the sediment test. This milk was clean enough to be graded "Good" or better.

CLEANLINESS OF MILK DURING PERIOD OF STUDY

The sediment test is the most common method of determining the amount of dirt in a sample of milk. It requires very little experience and is inexpensive. As clean milk is always desirable it can be used as a routine method for the study of the cleanliness of the milk delivered to a milk plant. Table 2 shows that the percentage of all samples scoring zero, or those that were very dirty, decreased from 61.1 per cent in 1924 to 0.1 per cent in 1930. During the last three years this figure remained below one per cent. The percentage of milk classed as good or satisfactorily clean (having a score of seven or above) gradually increased. In 1924 only 10.2 per cent fell in this group, while in 1928, 1929, and 1930 the percentages were 84.6, 91.2, and 88.1 respectively (Figure 3). The reduction in percentage of very dirty milk and the increase in the percentage of good milk occurred after the plan of sending weekly reports to each patron and the bonus and deduction systems were introduced. No doubt each of these had its effect upon the change that took place.

TABLE 3.—*Distribution of bacterial counts throughout period of study*

Bacterial counts	1924	1925	1926	1927	1928	1929	1930
Per c.c.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Under 10,000	36.1	45.4	4.8	7.6	27.4	47.1	42.3
Over 10,000 Under 100,000	16.4	18.4	29.5	40.6	24.0	16.8	23.0
Over 100,000 Under 500,000	8.8	11.8	19.4	17.4	13.7	9.7	13.9
Over 500,000 Under 1,000,000	7.9	5.5	9.4	6.4	6.5	5.1	5.3
Over 1,000,000 Under 10,000,000	15.0	10.2	27.9	16.1	16.4	13.4	11.2
Over 10,000,000	15.8	8.7	9.0	11.9	12.0	7.9	4.3
Percentage of samples under 100,000	52.5	63.8	34.3	48.2	51.4	63.9	65.3
Percentage of samples over 1,000,000	30.8	18.9	36.9	28.0	28.4	21.3	15.5
Total number of samples	984	1236	1534	1885	2630	3288	3355

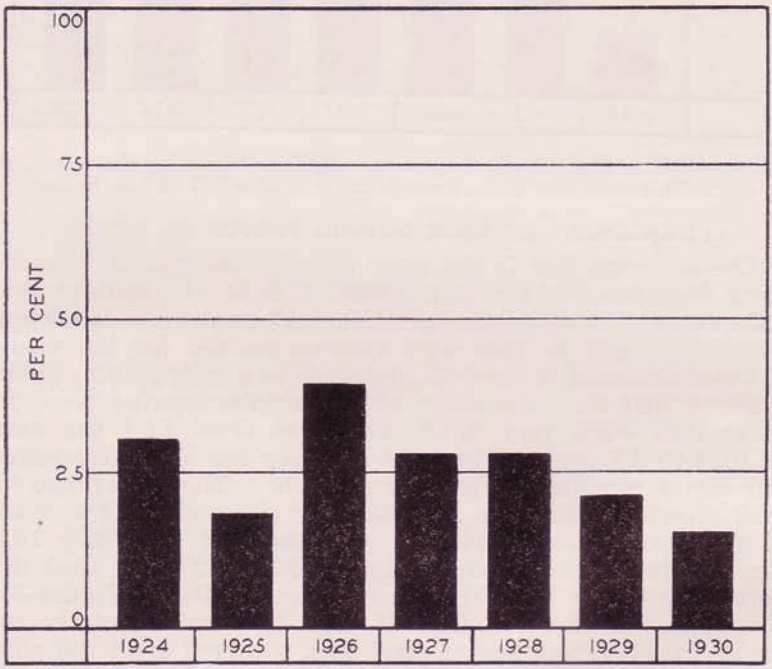

FIG. 4.—Percentages of all samples with bacterial counts over 1,000,000. This milk had a count which would grade it as "Unsatisfactory."

QUALITY OF MILK AS SHOWN BY THE BACTERIAL COUNT

The bacterial count is one means of judging the quality of milk. The study of all samples during the seven years by the direct microscopic method has provided some interesting information, shown in Table 3. It will be noted that the "unsatisfactory" milk, containing over 1,000,000 bacteria per cubic centimeter, was less in 1925 than in 1924 (Figure 4). This reduction from 30.8 per cent in 1924 to 18.9 per cent in 1925 was no doubt due in part to the fact that approximately the same group of producers delivered milk in 1925 as in 1924. During the same period the "medium" quality milk remained about the same but the "good" milk, with a count of less than 100,000 bacteria per cubic centimeter, increased (Figure 5). It will also be noted that from 1926 to 1930 the percentage

TABLE 4.—*Number of patrons delivering milk*

Year	Patrons	Old patrons	New patrons	
	Number	*Number*	*Number*	*P. ct.*
1924	26	26	....	.....
1925	28	25	3	10.7
1926	59	23	36	61.0
1927	68	35	33	48.5
1928	70	52	18	25.7
1929	80	57	23	28.7
1930	74	63	11	14.9

of "unsatisfactory" milk gradually decreased to 15.5 per cent and the "good" milk gradually increased to 63.9 per cent in 1929 and 65.3 per cent in 1930. Evidently the addition of new patrons, who had not sold milk before, had a detrimental effect upon the quality of the milk. As these patrons continued to sell milk and to receive weekly reports and payment according to quality, the percentage of good milk increased from 52.5 in 1924 to 63.8 per cent in 1925. In 1926 the "unsatisfactory" group increased to 36.9 per cent and the "medium" to 28.8 per cent, while the "good" grade decreased to 34.3 per cent. This was a considerable decline in the quality of the milk supply when compared with the improvement of 1925 over 1924. A possible explanation of this is the fact that a considerable number of new patrons were added in 1926. Table 4 shows the number of patrons delivering each year throughout the study and offers some interesting figures.

EFFECT OF DAILY TEMPERATURES UPON BACTERIAL COUNT

The secretion of milk by the cow at body temperatures presents a very important problem to the milk producer. The

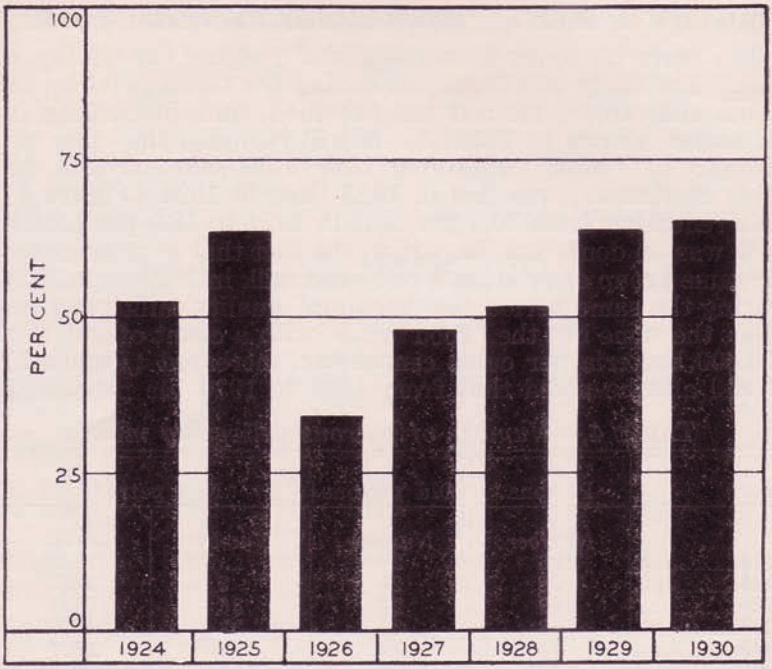

FIG. 5.—Percentages of all samples with bacterial counts of less than 100,000. This milk had a count low enough for grade "Good" or better.

problem then is how to get the milk cooled as quickly as possible to a temperature approaching 50° F. Naturally in very cold weather when the air, pails, cans, and everything else that the milk comes in contact with are cold, the milk cools rapidly. Much of the time during summer, both day and night, the temperature of the air is so high that there is little cooling effect from the air or from the utensils. Table 5 shows within a ten degree range the lowest air temperature recorded on the days that the milk samples were taken.

It will be seen that in general the daily temperature does not drop as low as might be expected. Table 5 shows that minimum temperatures of 50° to 70° F. are common, while temperatures of 70° to 80° F. occur frequently. Approximately 24 per cent of the days had a minimum temperature below 30° F., while 40 per cent of the time it was above 50° F. This indicates that it is not advisable to depend upon the air to cool milk on the farm. This is further emphasized in Table 6, which shows the effect of the lowest daily temperature upon the bacterial counts of milk

TABLE 5.—*Distribution of the lowest air temperatures during the days the milk studied was held on the farm*

Lowest daily temperatures	Days							Total days
	1924	1925	1926	1927	1928	1929	1930	
Degrees F.	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
−20 to −10.1	0	0	0	0	0	0	1	1
−10 to −0.1	2	0	1	0	0	4	0	7
9 to 9.9	2	4	0	4	1	2	1	14
10 to 19.9	1	3	3	3	3	1	3	17
20 to 29.9	6	5	7	4	6	7	9	44
30 to 39.9	12	10	6	12	14	7	7	68
40 to 49.9	5	8	7	9	6	12	10	57
50 to 59.9	5	9	7	6	8	7	8	50
60 to 69.9	7	5	11	11	8	9	10	61
70 to 79.9	3	7	4	3	6	2	4	29
80 to 89.9	0	0	0	0	0	1	0	1
Total number days	43	51	46	52	52	52	53	349
Below 30°	11	12	11	11	10	14	14	83
50° and above	15	21	22	20	22	19	22	141

delivered to the plant during the first year. In Table 6 it will be noted that when the lowest daily temperature was above 30° F. it had a marked effect upon the bacterial count of the milk.

From these tables it is evident that the producer of milk in this section of the country must cool his milk on the farm if low-count milk is to be delivered. Only during a short period of the year is the air temperature low enough to be of any great help in this process and for that reason the producer must use some method that will take the heat from the milk quickly and also protect it from the heat of the air while on the farm and in transit to the plant. The prev-

TABLE 6.—*Showing effect of lowest daily temperatures upon bacterial counts in milk during the first year*

Lowest daily temperature	Samples	Average bacterial count
Degrees F.	*Number*	*P. ct.*
Below zero	69	5,276
0 to 9.9	38	111,350
10 to 19.9	70	193,530
20 to 29.9	250	412,871
30 to 39.9	212	1,830,944
40 to 49.9	121	2,429,553
50 to 59.9	176	3,857,156
60 to 69.9	189	5,664,887
70 to 79.9	50	22,878,000

alence of high temperatures throughout a large part of the year makes this a very important factor in the production of high-quality milk.

Table 7 presents figures showing the percentage of the milk samples that were in the best and poorest grades for the first and last years of the study. It will be noted that in 1924, which represents the original supply, the quality was more largely affected by the air temperature, while in 1930 the percentage of low-count milk was relatively high even when the lowest daily temperatures were in the seventies.

The introduction of the report systems, the payment of a bonus for good-quality milk, and the penalty for low-grade milk have without a doubt encouraged producers to take better care of their milk.

TABLE 7.—*The distribution of all samples during periods of different daily temperatures*

Lowest daily temperatures	1924 samples		1930 samples	
	Under 100,000 bacterial count	Over 1,000,000 bacterial count	Under 100,000 bacterial count	Over 1,000,000 bacterial count
Degrees F.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
–20 to –10.1	0	0	93.6	3.2
–10 to –0.1	97.4	2.4	0	0
0 to 9.9	97.7	2.3	93.5	3.2
10 to 19.9	96.0	0	84.0	7.0
20 to 29.9	80.9	9.9	86.8	2.4
30 to 39.9	72.1	13.6	75.9	7.8
40 to 49.9	50.9	30.2	55.6	18.4
50 to 59.9	22.1	46.7	57.1	15.9
60 to 69.9	16.3	62.2	47.5	31.3
70 to 79.9	4.0	72.0	54.2	26.5

EFFECT OF METHOD OF COOLING UPON QUALITY

In studying the farm conditions it was found that some farms had cooling tanks and others did not. While the presence of a cooling tank on the farm did not give any assurance that the milk would be cooled, it is interesting to compare the average quality of the milk from all farms having cooling tanks with those that had only the stock tank that could be utilized for cooling purposes. In making this comparison, only those farms that delivered milk for one year or over were considered. In Table 8 is a comparison of the percentage of milk falling into the poorest and best grades. From Table 8 it would seem that there was a significant difference in favor of those farms that had cooling tanks. The use of the stock tank for cooling purposes makes it necessary to

TABLE 8.—*A comparison between the milk produced on farms having cooling tanks and those using stock tanks*

Equipment	Farms	Distribution by bacterial counts		
		Under 100,000 per c.c.	100,000 to 1,000,000 per c.c.	Over 1,000,000 per c.c.
	No.	*Per cent*	*Per cent*	*Per cent*
Cooling tank	38	47.8	32.0	20.2
Stock tank	50	33.7	38.3	28.0

pump large volumes of water and requires a great deal of attention. While there are many other factors that affect the quality of the milk, one may expect that farms having cooling tanks should on the average produce better milk.

THE EFFECT OF MILKING MACHINES UPON QUALITY OF MILK

The common use of the milking machine on the dairy farm makes a study of the quality of milk produced on such farms of interest. The available information makes it possible to compare the percentage of weekly samples that fall in the various groups according to the bacterial count.

TABLE 9.—*A comparison between the bacterial counts of milk produced on nine farms where milking machines were used and the average of all patrons in 1930*

Distance of each farm from plant	Distribution of samples by bacterial count		
	Under 100,000 per c.c.	100,000 to 1,000,000 per c.c.	Over 1,000,000 per c.c.
Miles	*Per cent*	*Per cent*	*Per cent*
5 to 10	84.9	15.1	0
5 to 10	62.3	28.3	9.4
10 to 15	58.5	22.6	18.9
5 to 10	53.8	25.0	21.2
10 to 15	52.9	24.5	22.6
5 to 10	52.8	22.7	24.5
5 to 10	43.4	32.1	24.5
5 to 10	47.2	20.7	32.1
10 to 15	37.8	24.5	37.7
Average of patrons using milking machines	53.8	24.2	22.0
Average of all patrons in 1930	65.3	19.2	15.5

Table 9 shows a comparison of quality of milk produced on the nine farms using milking machines with the average of all patrons. One patron using a milking machine was above average and one approached the average, while the other seven farmers produced milk which was below the average of all patrons. Some produced rather poor milk, making the average of those using milking machines considerably below the average of all. It is especially interesting to note the wide variation in the percentage of milk samples appearing in the groups showing less than 100,000 and in those showing over 1,000,000 bacteria per cubic centimeter. This table indicates that high-quality milk can be produced by the use of the milking machine but that in the group studied the tendency seemed to be to produce milk below the average.

EFFECT OF DISTANCE HAULED UPON QUALITY OF MILK

A study of the patrons delivering milk during 1930 shows the effect of distance hauled on the quality of the milk delivered. Only air-line distances were considered in this study. All the patrons were tabulated in groups, according to the distance from the creamery. Table 10 shows a tabulation on this basis and compares the patron delivering the best milk and the one delivering the poorest milk with the average for the group. While the number of patrons is small in the 15-to-20-mile group the figures show some interesting facts.

TABLE 10.—*Effect of distance hauled upon the quality of milk as determined by bacterial counts in 1930*

Distribution of patrons			Distribution of samples by bacterial counts		
Patrons	Distance hauled	Milk quality	Under 100,000 per c.c.	100,000 to 1,000,000 per c.c.	Over 1,000,000 per c.c.
Number	*Miles*		*Per cent*	*Per cent*	*Per cent*
13	Less than 5	Best	90.6	9.4	0
		Poorest	46.1	15.4	38.5
		Average	74.8	13.8	11.4
23	5 to 10	Best	84.9	15.1	0
		Poorest	47.2	20.7	32.1
		Average	63.3	20.2	16.5
32	10 to 15	Best	86.8	11.3	1.9
		Poorest	32.1	26.4	41.5
		Average	62.3	21.0	16.7
4	15 to 20	Best	71.7	13.2	15.1
		Poorest	36.0	12.0	52.0
		Average	69.0	12.9	18.1
All patrons			65.3	19.2	15.5

It will be noted that in all the groups the best patron produced milk considerably better than the average for all the patrons, and that the poorest patron was materially below the average, regardless of distance. All the patrons shown in the tabulation delivered milk each week of the year with the exception of the poorest patron in the 15-to-20-mile group. It will also be noticed that the percentage of poor milk (over 1,000,000 per cubic centimeter) was about the same for the average of each group as the all-patron average, except in the less-than-5-mile group, which was somewhat lower. The slight increase in the 15-to-20-mile group is not considered significant because of the small number of patrons in it. Distance evidently does not have any marked effect upon the quality of the milk delivered. No doubt the low percentage of poor milk found in the less-than-5-mile group is due somewhat to the large number of long-time patrons in this group.

RELATION OF TYPE OF FARM TO QUALITY OF MILK PRODUCED

The large number of renters producing milk makes it possible to compare the quality of milk produced on the farms operated by owners and those operated by renters. Table 11 shows the percentage of milk samples showing high and low bacterial counts produced on farms delivering more than a year during the period of study.

TABLE 11.—*A comparison of the milk produced by renters with milk produced by owners*

Farms operated by	No. of farms	Distribution of samples by bacterial counts		
		Under 100,000 per c.c.	100,000 to 1,000,000 per c.c.	Over 1,000,000 per c.c.
	No.	*Per cent*	*Per cent*	*Per cent*
Owners	53	38.1	38.3	23.6
Renters	33	41.6	32.7	25.7

This would suggest that there was very little difference between the milk produced by these two types of farmers. The fact that great improvement has been made indicates that the desire to produce good milk is as important as the equipment available. Anything that stimulates this desire is reflected in the quality of the milk produced.