THE INFLUENCE ON MILK PRODUCTION OF A DEFINITE TIME INTERVAL FOR MILKING COWS BY MACHINE

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ABSTRACT

WHEN cows were milked by machine in an average time of 9 to 10 minutes per cow, milk production was maintained less uniformly throughout the lactation period than when the cows were milked by hand. Decreased production was noticeable after the third month of lactation.

When the cows were milked by machine in 4 to 5 minutes, using a timer to determine the milking period, milk production was maintained as uniformly throughout the lactation period as by hand milking. Some limited observations also indicated less trouble with udder infections.

These results clearly indicate that milking machines should be removed from cows promptly after the cow has been milked and that cows can be trained to milk out rapidly without excessive hand stripping. One operator with two single units should milk 20 cows per hour.

It is suggested that a timer would be a very desirable accessory to any milking machine to aid the operator in judging the intervals used for milking.
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It has been a common opinion of better dairymen for years that cows should be milked rapidly and at uniform rates from milking to milking. This applies to both hand and machine milking. Data to support this contention are meager and old, yet practical experience indicates its truth. The present investigation has dealt with this problem as a probable method of securing improved milking by machine. The experiment was planned to show the influence of more rapid and more uniform machine milking upon milk production, but incidental observations were also made on the effect on the udder.

In early work published by this Station, one man milked the cows with two double units requiring about 12 minutes per cow for milking, stripping, and transferring the machine to another cow. One man milked 20 cows per hour, milking four cows at a time. The machine was actually milking each cow 10 minutes. In an endeavor to secure faster milking, the two double units were replaced by three single units and later with two single units. One man milked 10 to 12 cows per hour and the time required per unit per cow was about 10 to 12 minutes. The machine was on each cow about 9 to 10 minutes. It will be noted that the time to milk each cow was reduced only slightly even tho the number of cows milked per hour decreased greatly. The point of real significance is that the data published in 1935 showed that cows produced milk less uniformly thru the lactation period by machine than by hand milking.

1A preliminary report on this investigation was presented before the International Association of Milk Dealers and appears in volume 13 (1941) of the Bulletin of the Association (pages 336-340) as Journal Paper No. 406 of this Station, entitled "Milking Machines: Their operation and effect upon milk production and mastitis."


These conclusions have been verified by others as cited by the author in an earlier publication.4

The reason for the slightly reduced production by machine milking was not known but was thought to be due to slow milking rather than to the method of milking. As stated in 1935, "The author does not believe that the results affect the extent to which milking machines should be used on the farm, as differences in total production per cow were small, but rather that they should stress the need for care in the operation of these machines. The results secured might be affected by the breed of cattle, the skill of the person milking, the make of milking machine, etc., so that exact uniformity from farm to farm should not be expected."

Aside from any theoretical assumptions which might be given on the desirability of rapid milking by machine, it is well established that a good hand milker can milk seven or eight cows per hour which means that the actual time for milking would not exceed 8 minutes. Since the hand milker milks two teats at a time while the machine milks four, it is obvious that a machine must milk a cow in 4 minutes to equal the rate of milking by a good hand milker. Such being the case, machine milking should proceed much faster than previously reported at this Station.

PLAN OF PRESENT EXPERIMENT

The investigation on the influence of machine milking upon milk production reported in 1935 should have been repeated in full with faster milking, but labor was not available to do so. Hence the experiment was designed to require no extra labor even tho the results are subject to some experimental error due to lack of control cows being milked in the barn at the same time either by hand or slower by machine.

The problem of securing faster milking of cows is not easily solved and some drastic changes in procedure must be made to secure positive results. This is especially true when no experimental data are available to show that faster milking could be done with the cattle at hand; and the men doing the milking believed that the milk could not be taken from the cows in less time.

Several changes in milking procedure were made abruptly. For years the udders of all cows had been gently massaged by hand toward the end of each milking to aid in reducing hand stripping to a

4Lon. cit.
minimum. This practice was stopped with the understanding that the milking would be finished by hand, if necessary. Then another make of milker was installed and the men were instructed that faster milking would be expected.

A few days later (September 1935) an electric timer\(^4\) was installed which repeatedly rang a bell at definite time intervals. When the bell rang the udder was wiped off and the milking machine attached to it. At the next interval the other milker was started. When the bell rang the third time, the first milker was removed, the cow was stripped, if necessary, and the machine was placed on the next cow. The total interval per cow was 7 minutes and 40 seconds. Later this time interval for milking was reduced to 6½ minutes per cow. In this interval the machine was taken off one cow, the cow was stripped, the machine was placed on another cow, and the cow was milked. The actual milking time that the machine was on the cow varied from 4 to 4½ minutes.

After 4 years of milking with a definite time interval, the production records of all cows that completed records in 1939 were computed. The records were compared with those previously published. The cows were milked three times per day. All records were used except that the number of 2-year-old records was limited to be comparable to those previously published, as 2-year-olds maintained production more uniformly throughout the lactation period than mature cows.

For years it has been the policy in the Station barn to record all udder irregularities, including injuries and obvious cases of garget as indicated by swollen, inflamed udders and thin, clotted, or bloody milk. These records are valuable in showing trends in udder infections, but they include only the worst cases of the disease. Then, too, cell counts on the milk and data on mastitis studies were available at irregular intervals to indicate the degree of udder trouble.

RESULTS

DEVELOPMENT OF MORE RAPID MILKING

The adjustment of the cows to more rapid milking was somewhat troublesome. It was possible because the milking period was too long and exceeded 6 minutes. Then, too, the operator was willing to try conscientiously to milk the cows in less time. In preliminary trials, the operator was instructed to use his judgment when the cows had been

\(^4\)Eagle Signal Corp., Moline, Ill.
milked but to take the machines off in less time than required for complete milking and finish stripping by hand. Data on one milking showed that the machine was on each cow from 3 to 12 minutes for an average time of 6.5 minutes. The strippings varied from 0 to 6 pounds with an average stripping per cow of 1.8 pounds. Then the electric timer was used to allow 7 minutes and 40 seconds per cow. Each cow was stripped by hand and the time for stripping and changing the machine from one cow to the other was included in the total time. After 3 weeks had elapsed, data on one milking showed the machine was on each cow from 3 to 6 minutes and an average of 4.3 minutes. The amount of strippings varied from 0 to 2.8 pounds with an average of 1.0 pound.

It was the intention gradually to eliminate stripping, except for cows that held up appreciable quantities of milk. In 2 months after the experiment began, however, strippings still averaged 1 pound per cow per milking, but the time to milk each cow had increased to 5.4 minutes. Apparently less time was then required for stripping. To reduce this time of milking the timer was now adjusted to ring to allow a total of 6½ minutes per machine per cow, including the removal of the machine and placing it on the next cow. This means that one man, operating two single units, milked 18 to 20 cows per hour, stripped the cows that required it, and weighed and strained the milk. It might have been possible to increase this speed so far as the cows were concerned, but this time was rapid enough for the man doing the milking. If the timer would ring only for the time the machine was on the cow and could be varied slightly per cow, then one man might milk 20 to 22 cows per hour. These rates of milking are in accordance with the best current practice, but unfortunately this good practice is not general and there is no way for one to be certain that the time interval is correct or constant.

A year after the milking was commenced with the timer only one-third of the cows were being stripped by hand and the actual milking time was 5 minutes. The weight of strippings was 0.4 pound per cow. It will be seen that the time to change the machine from one cow to another was greatly reduced and the time for stripping was almost negligible.

As heifers have freshened they readily adjusted themselves to the system of milking in 4 to 5 minutes without stripping. In 1940, just

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This time has been reduced to 6 minutes per cow or exactly 20 cows per hour with satisfactory results.
5 years after milking for a definite time interval was started, there were 3 cows out of 35 which required stripping by hand. This was true without any massaging of the udder to remove the last milk by machine. Furthermore, production from milking to milking was more uniform now than when massaging had been practiced.

Evidently the cows gradually adapted themselves to the method of milking. When the machine was left on for irregular long periods and the udder was massaged near the end of the milking period, the cows eventually became slow, hard milkers. When the machine was left on for a short period and massaging and stripping was minimized or eliminated, they eventually milked out quickly and completely by machine.

**INFLUENCE UPON MILK PRODUCTION**

The data (Table 1 and Figs. 1 and 2) include three different milking procedures. The butterfat production records for hand milking and for

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**Fig. 1.—The Influence of Machine and Hand Milking Upon the Pounds of Butterfat Produced per Month.**
### Table 1.—Monthly Butterfat Production for Cows Milked by Hand and by Machine.

<table>
<thead>
<tr>
<th>Method of Milking</th>
<th>Lactation Period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Hand*</td>
<td>63.1</td>
</tr>
<tr>
<td>Machine, 9–10 min.</td>
<td>55.4</td>
</tr>
<tr>
<td>Machine, 4–5 min.</td>
<td>52.8</td>
</tr>
</tbody>
</table>

#### Pounds of Butterfat

#### Percentage Production with First Month as 100

- Hand: 100.0 | 92.5 | 83.0 | 80.3 | 80.9 | 70.8 | 68.3 | 67.9 | 66.0 | 66.7
- Machine, 9–10 min: 100.0 | 96.0 | 84.2 | 73.2 | 72.2 | 66.9 | 65.1 | 61.1 | 55.0 | 49.4
- Machine, 4–5 min: 100.0 | 96.6 | 92.4 | 84.7 | 82.8 | 76.5 | 71.0 | 67.8 | 61.2 | 52.8

*Data include seven lactation periods by seven cows.
†Data include 21 lactation periods by the seven cows that were also hand milked.
‡Data include 19 lactation periods by 19 cows.
machine milking in 9 to 10 minutes were previously published\textsuperscript{7} and are given again for comparative purposes. The results were secured under comparable conditions with the same cows and with control cows in the barn at the same time. The new data for machine milking in 4 to 5 minutes were secured many years later with a few older cows from the previous experiment, but chiefly with the progeny of cows used in the former experiments. General management and feeding was as uniform as could be maintained from year to year.

In studying the results it must be remembered that the cows milked by hand were 4 years of age so that their total production would be a little higher than for the machine-milked cows which included 2-, 3-, and 5-year-olds in one group and all ages in another. As previously stated, the cows milked by hand produced butterfat more uniformly throughout the lactation period after the third month of the lactation period than did cows milked by machine in 9 to 10 minutes per cow. This is especially noticeable in Fig. 2 where the

\textsuperscript{7}See footnote 3.
butterfat production is expressed as percentages of the first month's production. This rate of milking by machine was 10 to 12 cows per hour by the two units and 15 to 18 cows per hour by three units.

The butterfat production for the more rapid and uniform milking presented a different picture. Cows milked by machine using a timer to hold the milking time short and constant maintained milk production as well as cows milked by hand until the ninth and tenth month of lactation. Actually, the maintenance of production month after month by machine milking was slightly better than by hand milking for the first 7 months. Apparently the milking period should have been shortened toward the end of the lactation period. The machine was on the cows from 4 to 5 minutes and 18 to 20 cows were milked per hour with two single units. This milking schedule agrees quite well with accepted best practice so there is nothing unusual about it except that the schedule could be positively adhered to thru the use of a timing device. Without a timer the operator must depend upon his own speed of working to judge the time.

**INFLUENCE UPON MASTITIS**

The Station herd has always had more or less mastitis even tho blind quarters are not common. Some cases occur each year, and for irregular periods of time mastitis has caused real difficulty. More than likely the herd could be considered as comparable to an average, well-managed commercial herd. However, it should be pointed out that no special program for the control or eradication of mastitis has been regularly used in the herd management. The same herdsman has been in charge since 1910.

Unfortunately, the condition of the udders of the cows as indicated by the examination of the milk has not been under continual laboratory test, but some extensive data secured at irregular times are available. These data cannot be applied too conclusively as it is well known that the degree of infection with mastitis is not constant but may vary from one year to another. The available data are very suggestive, however.

The first year the more rapid timed milking was used the herd milk was carefully graded for mastitis. Eleven of the 25 cows in the barn gave milk with cell counts below 10,000 in all quarters and only

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4 cows gave evidence of mastitis. It was noticed that udder inflammations were limited to the results of udder and teat injuries. In former years there had been occasional cases of irregular milking which were often followed by definite udder inflammation. Such instances have occurred rarely in recent years.

In an endeavor to secure evidence on the relative prevalence of mastitis in the herd now as compared with former years, two types of data were used. The barn records compiled by the herdsman show obvious cases of mastitis (garget) indicated by udder inflammation and milk of abnormal appearance. Records also show the udder injuries produced by one cow hooking the udder of another or teat injuries caused by cuts and stepping on them. These data (Table 2) show three consecutive years with no obvious cases of garget, but injuries have been fairly constant throughout the years.

**Table 2.—The Number of Cows with Udder Trouble in Station Herd as Shown by Barn Records, Counting Only the First Appearance of Garget for Each Infected Cow.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Garget not caused by injury</th>
<th>Udder or Teat injury, with or without subsequent garget</th>
</tr>
</thead>
<tbody>
<tr>
<td>1930</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>1931</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>1932</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>1933</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>1934</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>1935</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>1936</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>1937</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1938</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1939</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>1940</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

Recent available data on cell counts have been computed (Table 3) to compare with previously published counts. In 1914 and 1924, the average cell counts of the milk were given as 437,000 and 673,000, respectively. This past year 31 cell counts on the pasteurized milk gave an average count of 168,000. No doubt the pasteurized milk may give lower counts than raw milk, yet this fact alone could not account for the observed decrease. Samples taken one day from individual cows averaged 150,000 with the highest count being 480,000. This decrease in cell count indicates healthier udders, a fact borne out by the lowered incidence of obvious inflammation. The greatest single
cause of udder trouble in the herd at the present time is injury to udders and teats.

**Table 3.—Cell Count of Jersey Milk in the Station Herd.**

<table>
<thead>
<tr>
<th>Date</th>
<th>Author</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1914</td>
<td>Breed*</td>
<td>439,000</td>
</tr>
<tr>
<td>1924</td>
<td>Dahlberg and Marquardt†</td>
<td>673,000</td>
</tr>
<tr>
<td>1940</td>
<td>Eglinton and Durham‡</td>
<td>168,000</td>
</tr>
</tbody>
</table>

*Breed, R. S. Cells in milk derived from the udder. *New York Agr. Exp. Sta. Bul. No. 380, 1914.* (The average is based upon daily composite samples of each cow taken at irregular intervals between February 10 and August 31, 1911.)

†Dahlberg, A. C., and Marquardt, J. C. Filtration and clarification of milk. *New York State Agr. Exp. Sta. Tech. Bul. No. 104, 1924.* (The average is based upon raw milk of 36 days from November 8, 1923, to March 7, 1924.)

‡Unpublished average counts on the mixed pasteurized milk of 31 days scattered thruout the year.

It is recognized that these statements on mastitis are based chiefly upon circumstantial rather than experimental data, but the facts seem reasonably evident. The prevalence of mastitis in any herd does vary for unknown reasons. The cows in any herd continuously change and the average age of the herd is not constant. Young cows should be freer of the disease than old cows. In spite of the many reasons that might be given to discredit the data presented, the fact remains that the herd now has evidence of the lowest incidence of mastitis for any time that data are available and this happens to coincide with the period of rapid machine milking.

**DISCUSSION AND SUMMARY**

Milking cows by machine in uniform periods of 4 to 5 minutes per cow resulted in the maintenance of monthly production of butterfat throughout the lactation period as well as by hand milking and better than when milking by machine for longer and more irregular periods. The results indicate that the milking time should be reduced toward the end of the lactation period. Furthermore, the somewhat meager evidence indicated less udder trouble. The cows gradually adjusted themselves to the shorter milking period and heifers started on it without difficulty. In a period of 5 years with 35 milking cows, all cows have been milked within the definite time schedule. About 1 cow out of every 8 to 10 required hand stripping.

As a consequence of these studies and observations the conclusion is logical that milking machines should be equipped with timers. Two intervals, namely, 4 and 5 minutes, would be especially advantageous
to make allowances for differences in the ease of milking of cows even tho only one was used in this study.

The timer should be set when the machine commences to milk the cow and should ring a bell at the end of the specified period when the machine should be removed. Such a timer would take the guess work out of the milking time and would make it possible to milk with definite regularity. Altho the operator may, at first thought, react against such a timer, it will soon become an accepted aid to him in the improved milking of cows by machine.