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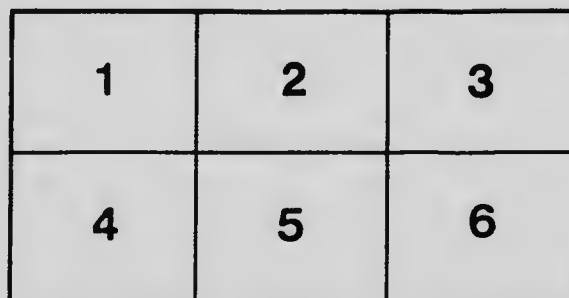
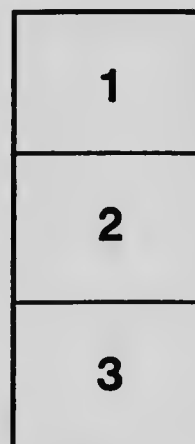
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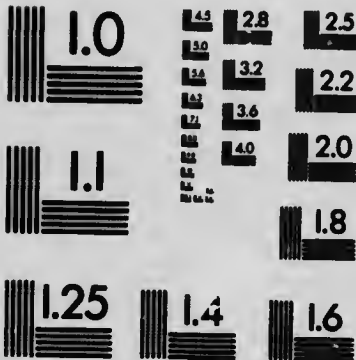
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# Ontario Department of Agriculture.

## ONTARIO AGRICULTURAL COLLEGE

### MILKING MACHINES.

BY H. H. DEAN, PROFESSOR OF DAIRYING.

The milking of cows by machinery is a very live topic at the present time among dairymen. Having had considerable experience with these machines, we may be allowed to discuss the matter briefly. All our spare time for experiments in the dairy stable during the past year has been devoted to a study of the problems connected with the milking of cows by machinery. We shall consider the question from three viewpoints, viz., physiological, mechanical, and practical operation of the machines. We shall also give results of experiments made this year.

Under physiological, we may first look at the various theories which have been propounded in order to explain the secretion of milk. The problem is a very complicated one, and no very satisfactory explanation of milk secretion has yet been offered. One theory says it is the result of changes in the cells which go to make up the organ of the cow known as the udder. In other words, according to this theory, milk is the liquefied cells which largely compose the mammary glands. The chief objection to the metamorphic or change theory is that a cow giving a large quantity of milk would have to build up the cells of the udder several times during a day, which is practically impossible for her to do.

The second theory is known as the transudation or filter theory, which assumes that milk is merely filtered from the blood by the mammary glands. The chief objection to the filter theory is that blood and milk are not of the same composition. There are substances found in the milk which are not found in the blood, e.g., casein, which is probably the result of cell action. If we combine the metamorphic and transudation theories regarding milk secretion we shall probably have the most satisfactory explanation of the mysterious process of milk secretion.

There is also the ferment theory, which ascribes the secretion of milk to the action of ferments in the cow's udder. We are not inclined to favor this theory, although it may explain some of the phenomena in connection with milk secretion.

There is nothing in the physiological processes so far as we can see, to prevent the satisfactory milking of cows by machinery, and we have always had faith that such a machine would become practicable. Nearly all modern milking machines have been operated on the principle of suction, or have imitated the milking of cows by calf sucking. We have

to bear in mind that all the large milk records have been made by hand milking. The development of dairy cows to their present large production has been done by a process of hand milking and not by suction. It is possible that inventors of suction milking machines have been working on a wrong principle. Who can tell? It is a fact that a non-suction milking machine has recently been invented in New Zealand, whose promoters say that it is the only correct principle for milking cows. Who can tell if this be so? It will require years of experience to determine which type of machine will prove most satisfactory, and whether or not machine milking is practicable.

Fleischmann, a German authority, says: "It is only those who are entirely ignorant of the nature of the milking operation who can abandon themselves to the idea of using milking machines of any description."

*Mechanical Problems.* A milking machine to be popular must be simple, cheap, durable, easily cleaned, require a minimum amount of power, time, and labor to operate it, and one person must be able to milk from four to six cows at once with the machine. While not wishing to disparage any manufacturer of milking machines, we must say that nearly all the machines which have been put on the market up to the present have been too complicated for the average man to operate. They are also too expensive for small farmers, and some of them have required altogether too much power, time, and labor to operate them. One, at least, of those who have tried was impossible to keep clean. However, we have faith in the ultimate triumph of mechanical skill over the many difficulties connected with the problem of milking cows by machinery.

#### PRACTICAL EXPERIENCE WITH THREE TYPES OF MACHINES.

Our first experience in 1895 was with the "Murchland" suction, non-pulsating machine, operated by means of a hand vacuum pump. After working with this machine for some time we gave it up. The chief difficulties were in maintaining a uniform vacuum which resulted in the cows not being milked out clean, consequently they gave less milk and milk containing a lower percentage of fat, as compared with hand milking.

Our second experience was with the "Thistle" milking machine, which also operated on the suction principle, but combined a double action, viz., sucking and squeezing of the teat. In other words, this machine aimed to combine the motions of calf sucking and hand milking. For a time we got very good results, and it seemed as if the problem had been solved. However, when hot weather came we found an odor in the milk which tainted it so badly that we were forced to give it up. By some means or other, milk was drawn into the vacuum pipes and when this milk began to decay the odor was very bad. As there was no way of cleaning these pipes, except by taking the pipes down each time, which was not practicable, we gave up the "Thistle" and laid it on the

scrap heap. Another serious objection to this machine was the large amount of power required to operate it.

There was a lull in milking machines at our College for nearly ten years—1895 to 1905. This was partially filled in with a hand milker invented in England, which milked four teats at once by pressing the teats against a rubber surface by means of revolving rollers covered with rubber. This was impracticable, because all cows' teats are not of the same size, nor do they hang perpendicularly and evenly from the udder. With a perfectly shaped udder and all teats the same shape and size, the machine might work. This, too, was laid on the scrap heap.

The "Calfette" milker was tried during the summer of 1906, but was not satisfactory.

In December, 1905, we installed a Burrell-Lawrence-Kennedy eight-cow milker. We began using the machine January 1st, 1906, and have used it during most of the past year. Of all the machines we have tried, this has been the most satisfactory, and yet it is far from perfection. The Burrell-Lawrence-Kennedy (B-L-K) milking machine works on the pulsating, suction plan, i.e., a vacuum is created by means of a double acting vacuum pump, which in our case is driven with an electric motor. However, any kind of power may be used for driving the pump. The estimated power required to milk eight cows at once is about  $1\frac{1}{2}$  to 2 horse power. The vacuum created for milking the cows is equal to about 16 inches of mercury, or about half the pressure of the atmosphere. The pump is connected by means of galvanized iron pipes with the stalls where the cows are milked. Between each pair of cows is located a stopcock, which is connected to the milker by means of about four or five feet of ordinary rubber hose. The pulsating apparatus sits on the milk pail, and in this respect differs from the "Thistle," in which the pulsating took place at the machine, consequently a great deal of power was required to operate it. The pulsations are obtained by an ingenious device for allowing air to enter, thus reducing the vacuum, but not sufficient to allow the milk to drop off the cows' teats. The milker, having the pulsator or vibrator, a receptacle like a milk pail below, is connected with the cows by means of a rubber tube on which are four branches near the cows' teats. The four branches have each a cone-shaped metal teat cup at the end, covered with a rubber mouth-piece having an opening in the centre for admitting the cow's teat. A "sight glass" on top of the milker enables the operator to see when the cow is finished and whether or not she is "giving down" her milk.

A stopcock on the milker connects the milker with the cows' teats by means of the teat cups, which latter are of different sizes to accommodate different sized teats. The pressure of the atmosphere having been removed from the outside of the cows' teats, the milk begins to flow because of body or blood pressure on the milk formed in the udder. This seems to be the weak point. With most cows the milk starts to flow freely and to the casual observer everything appears to be all right. To the close

observer, however, there is a defect. After leaving the machine on for some time after the milk ceases to flow, the careful milker notices in many cases that the udder is still somewhat tense and that the cow has not given her usual flow of milk. In some cases, and particularly with some cows, all the milk is removed in a very short time, and there is practically no "strippings." In many cases after removing the machine, the ordinary person would declare the cow to be milked out clean, but a little patience will often enable the milker to get from 3 to 10 pounds, or even more, of "strippings." This, of course, is very bad for the cows. If these "strippings" be not removed it tends to cause the cows to "dry up" much sooner than usual. To overcome this, the manufacturers recommend "manipulating the udder" in order to induce them to "let down" their milk. From close and careful observation on our own herd, we feel quite sure that "manipulation of the udder" does little or no good, and in most cases does harm, although we have followed this plan during most of the year because the makers of the machine seemed so confident that this was very essential.

Our reasons for thinking that "manipulation" is of little or no value are that close watching of the cows at the time when "manipulation" commences, enables us to see a contraction of the muscles of the abdomen, which muscles are connected with those closing the numerous milk ducts, and so far as we have noted, with very few exceptions, the milk flow is not increased by "manipulation." A gentle pulling downward on the cups tends to secure the last of the milk, but in most cases we have found hand stripping necessary. There was a time when it seemed as if hand stripping would not be necessary. Soon after July 1st, the cows began to fail so much in their milk, although the pastures were excellent, that we were obliged to resort to hand stripping, and in the case of some cows to milk them altogether by hand, in order to prevent them drying two or three months before they ought. How much these results were due to visitors it is difficult to say.

Before closing these general observations, we think the whole situation may be summed up in the words of our herdsman, Mr. Wood:—"The machine will milk the cows all right, *if the cows will give down their milk.*" Here we have the whole question in a nut-shell. If the cows in our herd represent the attitude of the majority of cows towards the milking machine, as we have it to-day, then we must conclude that it is not altogether satisfactory, as there is no known way of compelling to give down her milk if she will not voluntarily do so.

As previously stated, we began using the "B-L-K milkers" on January 1st, 1906. In order to see whether or not the milk flow and percentages of fat were affected to any extent by the change from hand to machine milking, we have made a table showing the comparative yields of milk, percentages of fat, and pounds of milk fat given by fifteen cows during the months of December, 1905, when the cows were milked by hand, and the month of January, 1906, when they were milked with the



machines. During December each milking from each individual cow was weighed, and sampled for testing. The composite sample made up of the individual daily samples, was tested at the end of the month, and the pounds of milk fat were obtained by multiplying the pounds of milk given by each cow by her test and dividing by 100, e.g., cow No. 15 gave 952 pounds of milk during December. Her composite test was 3.4, and 952 multiplied by 3.4 divided by 100 equal 32.36 pounds fat.

During January each cow's milk was weighed morning and evening and samples were taken for testing every seven days. The pounds of milk and milk fat were calculated from these weights and tests, hence are not so accurate as for December.

Table Showing Comparison of Yields of Milk and Milk Fat for December, 1905 (hand milking) and January, 1906 (machine milking).

No. of Cow.	Lbs. Milk.		Percent. Fat.		Lbs. Milk Fat.		Increase (+) or decrease (-) of machine compared with hand milking for one month.		
	Dec. '05.	Jan. '06.	Dec. '05.	Jan. '06.	Dec. '05.	Jan. '06.	Lbs. of milk.	% of fat in milk.	Lbs. milk fat.
15	952	808	3.4	3.0	32.36	24.24	- 144	- 0.4	- 8.12
21	900	727	3.8	3.8	34.20	27.62	- 173	+ .00	- 6.58
28	401	408	4.5	4.7	20.74	19.08	- 55	+ 0.2	- 0.66
38	1,037	753	3.8	4.0	39.40	30.12	- 284	+ 0.2	- 9.28
44	473	418	3.6	3.4	17.02	14.21	- 55	- 0.2	- 2.81
56	1,707	1,508	3.8	3.7	64.86	55.79	- 109	- 0.1	- 9.70
65	427	416	3.7	4.0	16.22	16.64	- 11	+ 0.2	+ 0.42
66	542	483	4.1	4.3	22.22	20.76	- 59	+ 0.2	- 1.46
67	713	572	3.3	3.6	23.52	20.59	- 141	+ 0.3	+ 2.93
70	518	475	5.4	5.7	27.97	27.07	- 43	- 0.3	- 0.90
78	581	548	3.8	4.2	22.07	23.01	- 33	+ 0.4	+ 0.94
96	402	403		4.0	14.87	16.12	+ 1	+ 0.3	+ 1.25
97	503	455		4.7	23.13	21.38	- 48	+ 0.1	- 1.75
98	329	273	4.7	4.7	15.46	12.83	- 56	+ .00	- 2.52
103	431	380	3.7	3.5	15.94	13.30	- 51	- 0.2	- 2.64
Totals and Averages..	9,976	8,625	3.90	3.97	389.08	342.76	- 13.57	+ 0.07	-47.22

From the preceding table we learn that these fifteen cows gave 1,351 pounds less milk in January, 1906, than they did in December, 1905. The percentages of fat were fairly constant, though the tendency was for a slightly higher average test for January (3.97) as compared with December (3.90). The pounds of milk fat, however, decreased 47.22 pounds in January as compared with December. If we allow an increase of one-sixth on the fat for calculating the butter, the decrease in butter on the

fifteen cows is 55 pounds., or over 3½ pounds butter per cow for the month. Some of this may be due to an advance in lactation, or some to errors in calculation, but the evidence seems to point very strongly towards quite a marked decrease in milk and butter during the first month after the installation of the machines. However, we should expect a decrease with most cows after making so radical a change, as from hand milking to a method new and strange to the cows.

#### SPECIAL TESTS COMPARING HAND AND MACHINE MILKING.

From time to time during the past year special trials comparing hand and machine milking have been made. These tests, however, were not altogether satisfactory, as it is almost impossible to get an exact comparison. There is no way of ascertaining what a cow *might have given* under other circumstances and conditions. The most we could do was to keep feed, water, temperature of stable, etc., as nearly alike as possible during the periods of tests, and assume that any differences in milk yield were due to methods of milking. This may or may not have been correct, but it was about the only thing which we could do under the circumstances. While most of these tests were for but short periods of time, the difficulties of comparison are even greater when we compare one lactation period with another. How can we say that differences in milk yield for one lactation period as compared with another are due to methods of milking or to any other *one* factor? We may *think* and say it is so, but it would be very difficult to prove our assertion.

For the sake of comparison, we give the results of some of these tests which have been made during the year. The machine was installed during the last weeks of December, 1905, and we began using it January 1st, 1906. It was thought advisable to allow the cows at least one month to become accustomed to the machine before making any special tests.

The first comparison was made on four cows, Nos. 15, 56, 106, and 107, beginning February 1st, 1906. The milk of each cow was kept separate, weighed and sampled for testing with the Babcock test every seven days for the two weeks. From February 15th to 28th, inclusive, these four cows were milked by hand. The milk from each was weighed and sampled daily for the two weeks. From March 1st to 14th the same cows were milked with the machine. Milk was weighed and sampled same as for the previous machine milked period. If we average the machine period before hand milking, with the machine period after hand milking, we shall balance as nearly as can be the effects of the period of lactation.

The following table shows the average yields of milk and fat for the two machine periods and also for the period of hand milking:—

*Table Showing Comparison of Yields from Machine and Hand Milking for two-week periods in February and March.*

No. of Cow.	Average for 2 periods of machine milking.		One period of hand milking.		Gain (+) or loss (-) in 2 weeks hand milking.	
	Lbs. Milk.	Lbs. Fat.	Lbs. Milk.	Lbs. Fat.	Lbs. Milk.	Lbs. Fat.
108	629	21.38	656	22.16	+ 27.0	+ 2.58
107	450	16.17	485	18.43	+ 35.0	+ 2.26
56	567	20.39	558	20.64	- 9.0	+ 0.25
15	280	8.50	315	10.39	+ 26.0	+ 1.80
Average of each of 4 cows for two weeks..	483.7	16.38	503.5	18.10	+19.75	+ 1.72

The foregoing table indicates a gain in pounds of milk for the hand milking in three out of four cows amounting to 79 pounds milk in 14 days, or an average of 19.7 pounds per cow in two weeks. Each and all of the four cows gave an increased amount of fat during the period when milked by hand amounting to a gain of 6.89 pounds milk fat in 14 days, or an average of 1.72 pounds fat per cow, which is equal to about 2 pounds butter per cow for the two weeks. Was this apparent gain due to hand milking or to some other factor or factors?

A similar experiment was made from March 30th to May 10th, with cows Nos. 15, 56 and 76. From March 30th to April 13th, inclusive, the cows were milked with the machine. Milk was weighed separately from each cow every seven days, and composite samples were taken every seven days for testing with the Babcock test. From April 13th to 26th these three cows were milked by hand, milk was weighed and sampled daily. From April 27th to May 10th, inclusive, they were milked with the machine.

Averaging the two machine periods, same as in the previous experiment, and comparing the results with the hand milking, we find that the average of the two periods where the three cows were milked by the machine, was 1,085 pounds milk and 34.8 pounds fat for the three cows in 14 days. During the fourteen days when milked by hand the same cows gave 1,005 pounds milk and 33.71 pounds fat. Apparently at this time these cows, two of which were the same as were used in the previous experiment, gave 80 pounds more milk and 1.9 pounds more milk fat when milked by the machine than they did in two weeks when milked by hand. But again we may reasonably ask, was this difference due to methods of milking or to something else?

COMPARISON OF MACHINE AND HAND MILKING FOR A TWO-WEEK PERIOD  
WHEN COWS WERE ON GRASS.

From September 5th to 18th, inclusive, all the cows were milked by hand. For two weeks previous to this, and for two weeks after, the record of four of the cows milked regularly by hand is given, for comparison with the records of seven cows milked with the machine for two weeks previous to hand milking and for two weeks after hand milking. No special tests were made of the fat content of the milk. If we average the periods before and after hand milking, we shall eliminate so far as possible the effects of lactation. The yields of milk for the machine milked cows are calculated in periods one and three by averaging three weighings and multiplying the results by fourteen to obtain the pounds of milk given in two weeks. In period 2, for the machine milked lot, and in all three periods for the hand milked cows, the milk from each cow was weighed morning and evening, daily.

The table shows the weights of milk given in all three periods by both lots of cows.

*Comparison of Hand and Machine Milking, August, September, and  
October, 1906.*

Cows.		Period 1.	Period 2.	Period 3.	Av. 1 and 3.	Gain (+) Loss (-) in Period 2.
		Aug. 27 to Sept 4	Sept. 5 to Sept. 18.	Sept. 19 to Oct. 2.	(Hand milk- ing, Group 1; machine milk- ing, Group 2.)	
<b>GROUP 1.</b>						
No. 106	Regularly milked by hand.	311	259	221	266	- 7
" 98		251	221	205	228	- 7
" 122		361	306	261	311	- 5
" 101		131	114	117	124	-10
	Totals .....	1,054	900	804	929	-29
<b>GROUP 2.</b>						
No. 69	Regularly milked with machine except in Period 2.	252	225	217	234.5	- 9.5
" 86		287	277	231	259	+18
" 90		378	305	326	352	+13
" 78		553	528	470	511.5	+16.5
" 87		370	386	326	348	+38
" 102		322	292	252	287	+ 5
" 70		357	320	284	325.5	- 5.5
		2,519	2,303	2,106	2,317.5	+75.5

When we compare the four cows regularly milked by hand, averaging periods 1 and 3 for comparison with period 2, we find that they all

were slightly lower in the second period, during which period the cows usually milked with the machine were milked by hand. The seven cows regularly milked with the machine gave  $75\frac{1}{2}$  pounds more milk during the period when milked by hand as compared with the average of the two periods when milked with the machine. Five of the cows gave more milk by hand milking and two gave less, although the increase on the group of seven cows was about  $7\frac{1}{2}$  gallons of milk in the two weeks when milked by hand as compared with the average of two weeks milked with the machine.

About the middle of October, 1906, we wrote the manufacturers of the milking machine, saying we were not satisfied with the results we were getting, and requested that they send one of their experts to operate the machines to see if improvements could be made. He came and stayed a week with us. His main suggestion was to "manipulate the udder" more than we had been doing. To follow his plan means that a man could not look after more than one or two machines, and would not be able to milk more than two to four cows at once. As a result of his work the cows appeared to milk out cleaner than they had been doing, i.e., there was less "strippings" from them than usual, but the question arose whether this was due to "cleaner milking" or to a condition which prevented the hand milker obtaining the "strippings." In order to test this point so far as possible and also to compare ordinary and expert running of machines, also ordinary and expert hand milking, a series of tests were made, beginning October 16th. The chief points in the experiments with ten cows are shown in the table, Machine vs. Hand Milking for Short Periods. These tests were made chiefly to see whether "manipulation" enabled the milker to get all of the milk or prevented strippings being got afterwards by hand. Also a comparison of expert and experienced milkers :—

On October 16th the ten cows were milked by the machines operated by our regular men. Next day, October 17th, half of the cows were milked by an expert hand milker and the other half by a milker who had had little experience milking cows. All the cows milked by the expert hand milker increased from 3 to 7 pounds milk per cow, or a total of 23 pounds milk in one day from the five cows. The other five cows milked by an inexperienced person gave practically the same quantity of milk by hand as with the machine on the previous day. Two of the cows gained a pound each, but this is no more than may occur any day.

On October 18th these ten cows were milked with the machines operated by the expert. Most of them were down in their milk as compared with the previous day when milked by hand. The totals for the ten cows were 248 pounds by hand and 226 pounds by expert machine milking. The totals on the 16th from our regular men operating the machines was 223 pounds. It would seem as if the expert operator got more milk (3 pounds) than did our regular men, but the quantity of milk was less than was obtained by hand milking.

As there was practically no "stripping" after the expert "manipulation" of the udder, are we to conclude that "manipulation" secured all the milk, or that it brought about a condition which prevented the hand milker from securing the "strippings"?

Date 1906.	Method of Milking.	No. of Cow.									
		78	90	66	96	97	69	86	87	102	70
Oct. 16	Regular men operating machine	lbs. 35	lbs. 23	lbs. 30	lbs. 18	lbs. 26	lbs. 17	lbs. 19	lbs. 21	lbs. 17	lbs. 22
" 17	Expert hand milking	36	26	33	22	33					
" 17	Inexperienced hand milking										
" 18	Machine operated by expert						17	19	22	18	22
" 19	Inexperienced hand milking	33	25	30	19	27	15	18	20	18	21
" 19	Expert hand milking	35	24	28	19	27					
" 20	"	36	27	33	20	32	17	20	23	20	23
" 20	Inexperienced milker						15	19	19	19	22
" 21	Expert milker						16	19	21	19	22
" 21	"	36	27	32	21	31					
" 22	Inexperienced milker	36	27	33	22	32					
" 22	{ A.M. machine						15	20	20	20	22
" 23	{ P.M. hand milking	34	25	31	21	31	14	19	20	19	21
" 24	Reg. men operating machine	33	24	31	21	31	14	18	20	19	21
" 30	Reg. men operating machine	28	22	28	17	27	15	16	18	15	19

On October 19th those cows usually milked by the expert hand milker were milked by the inexperienced milker, and the expert milker milked those usually milked by the inexperienced person. The table shows that of the cows milked by the inexperienced milker one cow increased two pounds, two were the same as on the previous day milked with the machine, one cow gave one pound, and another two pounds, less milk by hand than with the machine. All the cows milked by the expert milker gave more milk by hand than they did the previous day when these cows were milked by an expert operating the milking machine. The total pounds of milk given by the ten cows on October 18th was 226 pounds, when the machines were operated by an expert. On October 19th, when hand milkers were changed, the total pounds milk were 236—an apparent increase of ten pounds as a result of hand milking.

On October 20th hand milkers were again changed. The expert hand milker got 148 pounds milk from his five cows, and the inexperienced milker got 94 pounds from his cows. On the 19th, with a change of hand

milkers, the results were 133 and 103 pounds respectively. The previous day (18th) when these cows were milked with the machine operated by an expert the weights of milk were 134 and 92 pounds, from the two groups respectively.

The table shows the result from hand milking for the 21st and 22nd, in which the quantity of milk remained fairly uniform for each cow, though there was a tendency towards an increase. On October 23rd these cows were milked in the morning with the machine operated by our own men, and in the evening by hand. The general tendency for the day was downward. The total pounds of milk given by the ten cows on October 22nd, when hand milked, was 247 pounds. Next day when milked in the morning with the machine, and in the evening by hand, the total pounds of milk were 235, an apparent loss of 12 pounds on the ten cows. On October 24th, all these ten cows were milked with the machine operated by our own men. The total yield of milk for the day was 232 pounds—another drop of three pounds from the previous day. The cows were now milked regularly with the machine, two cows in one pail in the usual way, until October 30th, when they were milked separately, and the milk weighed morning and evening. Nine out of ten of the cows gave less milk than they did October 24th. The total yield for the day was 205 pounds—a drop of 27 pounds from the previous weighing on October 24th. At this weighing special note was made of the weight of “strippings” given by each cow after milking as dry as possible with the machines. Three cows gave no “strippings” after the machine either morning or evening; four cows gave from one to two pounds of strippings at night; two cows gave 1 pound of “strippings” each at both night and morning milkings; and one cow gave 5 pounds in the morning and 3 at night in the form of “strippings,” out of a total yield for the day of 27 pounds milk for this one cow.

We are aware that these frequent changes from hand to machine milking, and change of milkers by hand, is not good for the cows, but we considered this was about the only way to get some data on the points at issue. The evidence all seems to point in the direction of greater milk yields by hand, but not much difference between inexperienced hand milking as compared with the machine. The weight of evidence also seems to indicate that “manipulation” of the udder tends to prevent the securing of the strippings by hand milking. However, this is a point very difficult to determine.

#### MACHINE VS. HAND MILKING DURING OCTOBER AND NOVEMBER, 1906

From November 1st to 15th, inclusive, ten cows in the herd were milked by hand. From November 16th to 30th, inclusive, they were milked by machine. In order to compare the milking previous to and after hand milking with the fifteen days of hand milking, we have calculated the yield of milk for the last fifteen days in October based on two weighings made



the latter part of October, and using the monthly test for October in calculating the pounds of fat. This is not strictly correct, but is near enough for the purpose of comparison. During the last fifteen days of November the cows were milked individually with the machine and the weights and samples of milk were taken daily through the half month, the same as in hand milking. This plan gives a more exact method of comparison.

*Table Showing Relative Yield of Milk and Fat for Two-week Periods during October and November, of ten cows.*

No. of Cow.	Machine Milking, 15 days, Oct. (calculated.)			Hand Milking, Nov. 1-15th.			Machine Milking, Nov. 16-30th.		
	Lbs. M.	% Fat.	Lbs. Fat.	Lbs. M.	% Fat.	Lbs. Fat.	Lbs. M.	% Fat.	Lbs. Fat.
66.....	442	3.5	15.49	429	3.6	15.44	382	3.4	12.98
69.....	217	3.3	7.18	220	3.6	7.92	201	3.5	7.01
70.....	300	5.1	15.30	301	5.	15.05	263	5.2	13.67
78.....	457	3.	13.73	517	3.2	16.54	470	3.1	14.57
86.....	255	3.4	8.67	294	3.6	10.58	271	3.6	9.75
87.....	285	3.1	8.84	311	3.2	9.95	267	3.1	8.27
90.....	345	3.	10.35	378	3.2	12.10	344	3.0	10.32
96.....	285	3.9	11.12	288	3.8	10.94	262	3.6	9.43
97.....	435	4.2	18.27	435	3.8	16.53	359	4.0	14.36
102.....	255	3.7	9.44	268	3.7	9.92	238	4.0	9.52
Totals and averages..	3,276	3.61	118.39	3,441	3.54	124.97	3,057	3.59	109.92

The foregoing table shows an increase of 165 pounds milk and 6.58 pounds fat for the ten cows in the two weeks when milked by hand, from November 1st to 15th, inclusive, as compared with the previous fifteen days in October when milked with the machine. From November 16th to 30th, when milked with the machine, these ten cows gave 384 pounds less milk and 15.05 pounds less fat than they did the previous fifteen days when milked by hand.

If we average the milk and fat yields for the last fifteen days of October and the last fifteen days of November, we get 3,166 pounds milk and 114.14 pounds milk fat as the average production of the ten cows during fifteen days when milked with the machine. Comparing this with the intermediate period, November 1st to the 15th, when milked by hand, we have a difference of 275 pounds milk and 10.83 pounds fat, in favor of hand milking, for the ten cows in fifteen days.

The average percentages of fat were practically the same in all three periods.



In order to compare machine milking with experienced and inexperienced hand milkers, two of the ten cows were milked by a hand expert for the first eight days of November and two others were milked by an inexperienced person. At the end of eight days, hand milkers were reversed for seven days, i.e., the expert took the two cows milked by the inexperienced person and the inexperienced person took those milked by the expert. For the last fifteen days of November these cows were milked with the machine and each milking was weighed separately from each cow. The table shows that the average daily yield was increased by the expert during the second week by over two pounds daily with one cow and seven-tenths of a pound daily with the other. The two cows milked the first week by the expert and the second week by an inexperienced milker showed a loss of one pound of milk daily with one cow and practically the same with the other when milked by the inexperienced milker.

During the next two weeks, when these four cows should have maintained their milk flow, the results were downward with all four cows when milked with the machine.

*Table Showing Daily Yield of Four Cows from Expert and Inexperienced Hand Milkers and Machine Milking, November, 1906.*

Milker.	Cow 86.	Cow 87.	Cow 78.	Cow 90.
Inexperienced hand milker, November 1-8.....	Lbs. 18.5	Lbs. 20.4	Lbs.	Lbs.
Expert hand milker, Novem- ber 1-8.....			34.4	25.7
Expert hand milker, Novem- ber 9-15.....	20.8	21.1		
Inexperienced hand milker, November 9-15.....			34.5	24.7
Machine milking, November 16-23.....	18.7	18.7	32.5	23.2
Machine Milking, November 24-30.....	17.3	16.8	30.	32.5

#### ERROR INTRODUCED BY WEIGHING ONE DAY IN SEVEN.

*Error in a two-weeks period.* In the case of short test periods with the milking machine, where the milk is weighed every seventh day, a certain amount of error is introduced. In all the two-week tests, comparing hand and machine milking, the pounds of milk were calculated by taking the average of three daily weighings and multiplying this by 14 to get the pounds of milk given by each cow for two weeks. In a short period, if the weighings were made, say, on the first and eighth days of the period and the calculations for the following weeks be based

on these, the cows would be credited with too much milk, especially where the flow of milk is decreasing, as it usually is, except for the first month or two after freshening. On the other hand, if weighings be made on the seventh and fourteenth days and the weights of milk for the preceding two weeks be calculated on the basis of these weights, the cow would likely be credited with too little milk. By taking the weights on the first, eighth, and fifteenth, and averaging these, we get probably as nearly as can be to the actual amount of milk given by a cow in a two-week period, weighing every seven days.

The following table shows the actual error in a two-week period with cows milked by hand regularly, and by cows usually milked with the machine, but which were milked by hand and weighed daily for two weeks in September, owing to a break of the motor which operates the vacuum pump of the milking machine.

Table Showing Error Introduced by Weighing Every Seven Days, as Compared with Weighing Daily in September, 1906.

Cows.	Actual yield of milk in two weeks.	Calculated yield of milk in two weeks.	Error by calculating increase (+), decrease (-).
106 } 98 } 122 } 101 }	Lbs. 259 221 306 114	Lbs. 270.2 218.4 306.4 112	Lbs. + 11.2 - 2.6 + 0.4 - 2.0
Totals .. . . . . .	900	907	+ 7
69 } 86 } 90 } 78 } 87 } 102 } 70 }	Ordinarily milked with machine, but milked for two weeks by hand. 225 277 365 528 386 292 320	224 270 378 518 364 308 340	- 1 - 7 - 13 - 10 - 22 + 16 + 20
Totals .. . . . . .	2,393	2,402	+ 9

By following the plan indicated of averaging the weights of three daily milkings and multiplying by 14, to get the pounds of milk given in two weeks, we find that the total error introduced in the case of four cows regularly milked by hand, was 7 pounds milk.

In the case of the second group of seven cows the total error in the calculated yield of milk for the seven cows was but 9 pounds. The error

on one cow was 22 pounds too high, and on another 20.2 pounds too little. It seems probable that in a group of cows used for experimental purposes that errors will about counterbalance each other, and that the results calculated in the two-week tests are not far from the actual milk produced by the cows in a group, though the results may be considerably too high or too low for individual cows, in a short test.

*Error during Four Months.* Four cows in the herd were milked most of the time during July, August, September and October by hand. The cow, "Dreamy," was not purchased until about the middle of September, hence her record is available for comparison for only about six weeks. "Adelaide" was milked with the machine for about half of July, during which period her milk was weighed every seven days.

The table shows the error introduced by calculating the monthly milk yield on the basis of four or five weighings monthly. The dates selected were those used for weighing the milk from machine milked cows and multiplying by seven, three or four times and once by three, nine or ten, according to the number of days in the month. An example will illustrate: During July five weighings were made of the milk given by machine milked cows. The dates were July 2, 10, 17, 24 and 31. Cow No. 98 gave 21 pounds on July 2, and was credited with  $21 \times 7 = 147$  pounds for that week; July 10,  $29 \times 7 = 203$  pounds; July 17,  $27 \times 7 = 189$  pounds; July 24,  $25 \times 7 = 175$  pounds; July 31,  $26 \times 3 = 78$  pounds, or a total of 792 pounds for the month.

During each of the other three months only four weighings were made and the weight of milk given at the fourth weighing was multiplied by 9 or 10 according to the number of days in the month.

*Table Showing Error Introduced by Weekly Weighings Instead of Daily, for Four Cows Milked for Considerable Time by Hand and where each Milking was Weighed.*

Month. 1906.	"Kalopathakes" (Jersey).			"Nero's Lass" (Jersey).			"Dreamy" (Jersey).			"Adelaide" (Holstein).			Average error per cow.
	Actual.	Calculated.	Error.	Actual.	Calculated.	Error.	Actual.	Calculated.	Error.	Actual.	Calculated.	Error.	
July ....	Lbs. 807	Lbs. 792	Lbs. -15	Lbs. 709	Lbs. 729	Lbs. +20	.....	.....	.....	Lbs. 966	Lbs. 931	Lbs. -35	Lbs. -30
August ..	655	638	-17	719	720	+ 1	.....	.....	.....	706	746	-20	-36
Sept. ....	464	462	- 2	627	627	.....	246	249	+ 3	541	550	+ 9	+10
October .	498	493	- 5	586	586	.....	407	410	+ 3	387	400	+13	+11
	2,424	2,385	-39	2,641	2,662	+21	653	659	+ 6	2,660	2,627	-33	-45

The foregoing results show that the total actual milk yield of the four cows during four months was 8,378 pounds. The calculated yield of milk was 8,333, making a difference between the actual and calculated of 45 pounds, or .53 per cent.—a little over one-half of one per cent. This we consider near enough for all practical purposes, and indicates that the records of the cows calculated from weekly weighings are substantially correct for weights of milk.

#### NOTES.

Cows No. 66, 96 and 97 (Ayrshires) were frequently changed during the year from hand to machine and from machine to hand milking. Almost invariably the change from hand to machine milking caused a decrease in the daily milk flow of from two to four pounds milk per cow, while a change from machine to hand milking seemed to cause an increase of like amounts. Two of these cows have short teats and are possibly the most difficult cows in the herd to milk by hand, hence we were specially anxious to milk them with the machine, but they did not take to it very well. They offered no resistance to the machine in the way of kicking, but they did not let their milk down well. In the case of No. 97, if the operator commenced to "manipulate the udder" the flow of milk would stop at once and the cups would immediately drop off.

On September 20th cows No. 97 and 66 gave 63 pounds milk for the day. With the machine they gave 29 pounds, and by "stripping" after the machine, 34 pounds were got from the two cows. They were put on hand milking next day. The second day after, they gave 68 pounds milk. The day after machine milking the weights of milk by hand milking were much the same as when milked by machine.

Cow No. 101, a grade Jersey, had been giving about 26 pounds milk per day during the month of June. At the first time of weighing for the next month (July 2) she had dropped to 11 pounds, without any apparent reason, except that it may have been due to more or less excitement during the excursions. She was immediately put upon hand milking. She never returned to her normal flow, but continued milking until November. During July she gave from 12 to 15 pounds milk daily. Our herdsman was confident that had she been continued on the machine she would have been dry by the end of July.

On July 10th, Nos. 106 and 107 (Holsteins) gave 23 pounds as "strippings" after milking with the machine. The total yield of milk from the two cows on that date was 57 pounds. On the 11th about half the yield was in the form of "strippings." On July 12th both these cows were put on hand milking, when the yield was increased to 65 pounds. However, this increase was in part, at least, only temporary, because on the 13th the yield had dropped to 62 pounds, and on the 15th it had dropped to 57 pounds, or the same as it had been when they were milked with the machine on July 10th. Both of these cows were more or less

advanced in lactation, which apparently was affecting the milk flow. The most marked effect in the case of these two cows appears to have been on the percentage of fat. No. 106 tested 2.7 per cent. fat for the two weeks in July when milked with the machine. During August, when hand milked, her monthly composite test was 4.2 per cent. fat, or an increase of 1.5 as compared with the previous month. No. 107 tested 4.0 per cent. for July and 4.5 per cent. fat for August. (In both cases, samples were not taken for testing during the latter part of July when milked by hand.) No. 107 continued milking to the end of September and 106 to the end of November. In both cases they would likely have dried much sooner had they been continued on the machine. However, this is a point very difficult to determine, as it is almost impossible to say that a cow would, or would not, have dried up at any particular time had conditions been other than they were.

#### CLEANING THE MACHINES.

One of the questions frequently asked is the following: "Are the machines difficult to keep clean?" We may answer this, "Yes" and "No." To keep the machines bacteriologically clean is somewhat difficult; to keep them ordinarily clean is not so difficult. We give the directions of the manufacturers, and if this were sufficient it would be comparatively simple to keep the machines clean. However, this is not sufficient to keep the machines *ordinarily clean*. The parts of the machine which come in contact with the milk have to be boiled at least once a week, and all the various tubes have to be thoroughly cleaned with brushes made for the purpose. To obtain sanitary milk or milk with a low bacterial content, boiling and special cleansing should be practised daily. As a rule, this means too much labor for the *average* farmer, and could be followed with profit only on special dairy farms where the milk is sold for an extra price.

The directions sent us by the manufacturers for cleaning are:—

1. "As soon as the milking has been completed, and before the milk has had a chance to dry in the cups or tubes, a supply first of cold and then afterwards hot water should be provided. The bottoms of the machines should be rinsed off with cold water. After this each machine should be placed on top of the milk pail and connected with the vacuum pipe. With the machine running at regular speed and the cocks turned off, hold both sets of teat cups in the cold water and turn on the milk cocks. The water is drawn through the teat cups, and through the rubber tubes, rinsing out all the passages through which the milk has passed. As soon as the cups and tubes are thoroughly rinsed with cold water, hot water in which sal soda has been dissolved (2 heaping tablespoonfuls to each pail of water) should be sucked through the teat cups and machines. All should then be rinsed with fresh, boiling hot water; also, last of all, the bottoms of the pulsators should be thoroughly washed with the hot water. With each milker equipment there is furnished a small brush with long wire handle; this may be used to scrub out the rubber tubes when necessary."

*Note.*—NEVER RUN HOT WATER through the machine and pipes until cool water has first been used. Otherwise, the milk will be cooked onto the surface of the teat cups and tubes.

"Do not use soap powders. So far as we have been able to find, *sal soda* is by far the best for this purpose. The object of its use is to cut the fat out from the interior surfaces of the rubber tubes. If this fat is not thoroughly removed it will injure the rubber.

"After washing the machines, draw out the piston and wipe it and the inside of the cylinder clean and dry, and occasionally wipe these parts with an oily cloth.

"Each evening just before using, it is well to suck soalding water through the cups, tubes and machine, in order to destroy any bacteria which may have lodged in them.

"Before the teat cups are applied to the cow her teats should be thoroughly cleansed with cool water during warm weather and warm water in cold weather, but they should be dried before putting on the teat cups.

"The pieces of hose that connect the pail with the stanchion cocks should be kept clean inside and out.

"During the winter, machines must be kept in a room where the temperature is always above freezing. When the machines are too cold they will not pulsate properly.

"Never leave rubber parts hanging in the sun as it injures the rubber.

"*Soaking in Brine.*—A wooden tank four feet six inches long by six inches wide and six inches deep inside should be provided in which to keep all rubber parts soaking in brine while not in use.

"The brine should be one quart of salt (regular butter salt) to ten quarts of water. The brine is very necessary to keep the tubes sweet and free from bacteria, also it is of great advantage in preserving the rubber.

"*Later Directions.*—In place of soaking the rubber parts in brine we have lately been using lime water, made by adding quick-lime to water—say, about one pound of lime to two pails of water. This seems to be very effective in keeping the rubber parts sweet and sterile, and at the same time acts as a preservative of the rubber and has an advantage over brine in that it does not corrode the metal teat cups and connectors, and we would therefore suggest its use in place of brine.

"*Barn Pipes and Drip Cocks.*—As soon as the milking is finished, both morning and evening, the drip cocks on the pipe which extends through the barn should be opened and left open until the next milking. It is well to occasionally open the stanchion cocks that are on the barn pipe and farthest from the pump, and then run the pump for half an hour or more to thoroughly dry out the pipes."

On one or two occasions we had complaints from customers regarding the flavor of the milk, but upon investigation we were satisfied that any cause for complaint did not come from the milking machine, but probably from a fly repellent which we were using on the cows to keep off flies. Nearly all such substances have a strong odor, and there is danger of tainting the milk unless used with great care.

### INFLUENCE OF VISITORS DURING MILKING TIME.

The manufacturers of the milking machine are strongly of the opinion that the presence of visitors at the time of milking is very harmful. At one time we thought there was something in this point, and we excluded visitors from the Dairy barn at milking time for a considerable period during the summer. Later observations led us to believe that in the case of our herd, at least, the presence of visitors had little or no effect upon the cows, because our cows are accustomed to visitors nearly every day.

Mr. H. B. Gurler, an Illinois dairyman has posted notices in his stable excluding visitors, believing that "the cows will not do their best with strangers in the stable." The Professor of Dairying at one of the American stations where they have milking machines similar to ours, reports on this point as follows: "Of course everyone knows it is not a good thing to have cows unduly excited at milking time, but our cows are certainly accustomed to large numbers of visitors, and it seems to us that the cows even milk better when we have had a crowd in the barn. If the fault is with large numbers of visitors, why is it that the stripper is able to get the milk from the cows after the machine?"

It is possible that cows not accustomed to the presence of strangers while being milked, would become somewhat nervous and give less milk, but where the cows are accustomed to strangers at all times, the effect is probably very slight. It is a point, however, upon which it would be difficult to obtain exact information.

### DURABILITY OF THE MACHINES.

So far as we can see, there is very little in connection with the machines which is likely to get out of repair, with careful handling. The rubber mouth-pieces should be made of material which will stand boiling. We spoiled a number of ours by boiling them.

### CONCLUSIONS.

1. In the comparative tests made of hand and machine milking for short periods, the results were in favor of hand milking in all tests except one.
2. When the machine was compared with *inexperienced* hand milking there was not so much difference between the results got from hand and machine milking, showing that under certain circumstances the machine might be equal to hand milking for at least a short period of time.
3. The general tendency was for the cows to go dry sooner than they were accustomed to do with hand milking. This was more particularly the case with the older cows. However, this is a point not easily solved as cows vary in this respect, from year to year.

4. Some of our young cows have given very good results with the machine, indicating that it may be possible to breed and train cows which will give fairly good results under this system of milking, though they are not likely to be so good as if trained to hand milking.

5. Special care needs to be exercised in the cleaning of the machine, otherwise the milk is liable to be tainted. Simply sucking water through the parts is not sufficient. All parts of the machine that come in contact with the milk must be thoroughly scalded or steamed, at least once a week, and for good results this should be done daily.

6. On average farms, where ten to twenty-five cows are kept, we do not believe that it would pay to install a milking machine at present. On farms where fifty to one hundred or more cows are kept, and where labor is very expensive, and difficult to get, and where the owner of the cows is not so particular about maximum yields from individual cows, the milking machine is worth of careful consideration. However, we do not consider the machines at present on the market as anywhere near perfection, and we look for great improvement in them during the next few years.

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## BACTERIA AND THE BURRELL-LAWRENCE-KENNEDY MILKING MACHINE.

BY S. F. EDWARDS, PROFESSOR OF BACTERIOLOGY.

Our investigation with the Burrell-Lawrence-Kennedy milker was of brief duration. The object was only to determine whether pure milk could be obtained with the machine milker under conditions that would make its use practicable upon the farm.

No attempt was made to determine the species present in the samples beyond the detection of acid producers and those which liquefy gelatin. Milk produced under even more cleanly conditions than usual, either by machine or hand milking, will contain a varying number of species of bacteria. Of these, the acid-producing organisms are largely lactic acid bacteria, which only sour the milk and are harmless. Organisms which can liquefy gelatin can cause a chemical disintegration of the nitrogenous constituents of the milk, visible to the eye in old milk, as a liquefaction of the curd. During this process products may be formed which are poisonous to the body, causing gastro-intestinal disturbances. Aside from the acid producers and liquefiers, other species may be present, some of which, while some, alone or in associative action with others, are apt to produce objectionable odors or flavors in milk, or its products, butter and cheese. Disease-producing organisms may be present if the animal is diseased.

As bacteria are always associated with dirt and filth, the bacterial flora of milk, either machine or hand drawn, will depend upon the cleanliness of the surroundings where the milk is secured. In this connection it may be said that the conditions existing in the College dairy barn are far better than those which prevail upon most farms.

*The Cleanliness of the Milking Machine.* From the time the milker was installed until after the test began, a period of about seven months, the machine was cleaned according to the directions issued by the manufacturers. The first samples were taken as the milker was ordinarily operated, the cows being milked by machine and by hand on alternate days. The results are shown in Table I.

As seen by a glance at the table, every sample of machine-drawn milk showed a very high bacterial content, while most of the hand-drawn samples showed a bacterial content comparatively low. In the production of "sanitary" or "certified" milk in cities, the standard established by

different health authorities varies from 10,000 to 50,000 bacteria per c.cm. In every case but one the hand-drawn milk was as pure as "certified" milk, while in all the machine-drawn samples the limit was far exceeded.

Table I. Bacteria per c.cm. (about 20 drops) in Machine-drawn Milk and Hand-drawn Milk.

Date.	Milking.	Cow.	Total bacteria.	Acid producing.	Liquefying.
July 23.....	Machine.....	*78 and 90..	216,000	22,200	26,700
" 25.....	Hand.....	" " "	8,400	400	3,100
" 26.....	Machine.....	" " "	712,000	26,700	17,700
" 27.....	Machine.....	" " "	267,300	40,000	45,000
" 30.....	Hand.....	" " "	68,900	65,600	1,200
August 3.....	Machine.....	" " "	574,000	102,000	24,000
July 31.....	Machine.....	96.....	322,000	25,000	1,500
August 3.....	Machine.....	".....	203,000	41,000	3,500
" 7.....	Hand.....	".....	20,000	4,000	6,000
July 26.....	Hand.....	107.....	17,200	1,200	4,400
" 27.....	Machine.....	".....	1,208,000	39,600	31,400
" 30.....	Hand.....	".....	23,800	21,700	400
" 31.....	Hand.....	".....	3,200	400	300

\* Mixed milk of two cows.

In the next series of samples, the aim was to determine the effect of boiling the rubber parts and cover of the milker once a week. The results are shown in Table II.

Table II. The Effect upon the Bacterial Content of Machine-drawn Milk, of Boiling the Milker Once a Week. Bacteria per c.cm.

Date.	Cow.	Total bacteria.	Acid producing.	Liquefying.	Remarks.
August 10..	*78 and 90..	7,000	.....	6,000	Parts boiled 3 minutes.
" 10..	96.....	16,335	600	8,000	" " 3 "
" 17..	*78 and 90	96,000	.....	18,800	" " 3 "
" 17..	96.....	38,000	2,800	4,400	" " 3 "
" 23..	*78 and 90..	155,500	17,500	52,000	Parts not boiled since August 17th.
" 23..	96.....	141,500	8,500	16,000	Parts not boiled since August 17th.
" 24..	*78 and 90..	47,000	15,500	7,500	Parts boiled 2 minutes.
" 24..	96.....	15,806	6,000	4,000	" " 2 "
October 12..	*78 and 90..	15,600	.....	4,550	" " 2 "

\* Mixed milk of two cows.

A comparison of the bacterial content of the samples taken at the first milking after the parts of the machine were boiled with that of the samples taken when a week had elapsed after the parts were boiled, shows the futility of attempting to produce pure milk by relying upon a thorough cleaning of the milker only once a week.

An expert representing the manufacturers prepared the milker for the next samples, spending considerable time and care in getting every part of the machine thoroughly washed, boiled, and steamed. Only one cow was milked for each sample, and only the total number of bacteria present was determined. The sample from cow No. 90 showed 1,407 bacteria per c.cm., and from cow No. 78, 1,776 bacteria per c.cm. These results show that it is possible to secure milk having a very low bacterial content with the machine milker, but the time and care required to prepare the milker for producing such milk would make it impracticable for any but the large dairy farmer.

Wholesome milk can be secured and bacteria largely excluded by observing a few precautions to prevent bacterial contaminations. The source of these contaminations may be stated briefly as follows:—

*The Stable.* Manure teems with different kinds of micro-organisms, and if allowed to accumulate in the stable a part of it becomes dried, the bacteria contained are thrown into the air by movements of the animals and caretakers, and many of them settle into the pails during the milking. Straw and other litter used for bedding contribute a large number of bacteria to the air when stirred, as also does feed of any kind which makes dust in the stable. Bedding and feeding, therefore, should be done at least an hour before milking, or after milking. In short, the stable should be as free from dust as possible during milking, either by hand or machine.

*The Animal.* As hairs and particles of dirt from the animals carry many bacteria, the cows should be kept groomed, and the flanks and udder should be wiped with a damp cloth just before milking. This will keep much filth out of the pails. A few drops of milk remain in the teats after milking, and bacteria present or gaining access from around the opening of the teat may multiply here to many hundreds from one milking to another. If in milking the first few strippings are rejected, these bacteria will be eliminated.

*The Milker.* The milker should wear clean clothes, have clean hands, and should be a healthy individual. Many cases of typhoid fever and diphtheria have resulted from drinking milk handled by convalescents from these two diseases.

*Utensils.* All utensils should be first rinsed thoroughly in cool water, washed in hot water containing a little sal-soda, thoroughly scalded or boiled, and kept inverted until ready for use to prevent bacteria falling into them from the air.

All these precautions are equally important in producing pure milk, whether machine or hand milking is practised, and only by their observance can the farmer or dairyman produce pure milk. It remains, then, for each individual, who alone is the best judge of his own conditions, to determine whether he would be warranted in making the outlay of money necessary for the instalment of a machine milker.

#### SUMMARY.

1. It is possible and practicable for the general farmer as well as the dairy farmer to produce pure milk, either by hand or machine milking.
2. To produce pure milk, by hand or machine milking, scrupulous cleanliness must be maintained about the stable and animals, the person of the milker, and the utensils.
3. Strict sanitary precautions being observed, hand-drawn and machine-drawn milk in our test showed approximately the same average bacterial content.
4. The mere fact that milk is drawn by the Burrell-Lawrence-Kennedy milker is by no means a guarantee of its purity. It may contain many more bacteria than hand-drawn milk under similar conditions.
5. We would not advise the installation of a machine milker, unless the farmer or dairyman is prepared to fulfil the sanitary conditions essential to the production of pure milk.

