

University of Nebraska - Lincoln

DigitalCommons@University of Nebraska - Lincoln

Historical Research Bulletins of the Nebraska
Agricultural Experiment Station (1913-1993)

Agricultural Research Division of IANR

9-1931

The Influence of Number of Daily Milkings on the Production of Dairy Cows

R. F. Morgan

H. P. Davis

Follow this and additional works at: <http://digitalcommons.unl.edu/ardhistrb>



Part of the [Agriculture Commons](#), and the [Dairy Science Commons](#)

Morgan, R. F. and Davis, H. P., "The Influence of Number of Daily Milkings on the Production of Dairy Cows" (1931). *Historical Research Bulletins of the Nebraska Agricultural Experiment Station (1913-1993)*. 125.

<http://digitalcommons.unl.edu/ardhistrb/125>

This Article is brought to you for free and open access by the Agricultural Research Division of IANR at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Historical Research Bulletins of the Nebraska Agricultural Experiment Station (1913-1993) by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

COLLEGE OF AGRICULTURE UNIVERSITY OF NEBRASKA
AGRICULTURAL EXPERIMENT STATION
RESEARCH BULLETIN 59

The Influence of Number of Daily Milkings on the Production of Dairy Cows

R. F. MORGAN AND H. P. DAVIS
Department of Dairy Husbandry

LINCOLN, NEBRASKA
SEPTEMBER, 1931

COLLEGE OF AGRICULTURE UNIVERSITY OF NEBRASKA
AGRICULTURAL EXPERIMENT STATION
RESEARCH BULLETIN 59

The Influence of Number of Daily Milkings on the Production of Dairy Cows

R. F. MORGAN AND H. P. DAVIS
Department of Dairy Husbandry

LINCOLN, NEBRASKA
SEPTEMBER, 1931

SUMMARY

1. High-producing Holstein, Jersey, Ayrshire, and Guernsey cows of various ages milked three times daily produced from 39.69 to 52.26 per cent more fat and from 44.98 to 65.18 per cent more milk than cows milked twice daily.

2. When high-producing cows of all breeds milked four times daily were compared with cows milked twice daily, the fat production for the several age classes varied from 110.19 to 127.53 per cent and the milk production from 149.08 to 160.31 per cent greater for those milked four times.

3. Milking high-producing cows four times as compared with three times daily showed an increased fat production ranging from 44.70 to 59.81 per cent, while comparable increases for milk ranged from 51.99 to 71.79 per cent.

4. There was a slight tendency for additional daily milkings to increase the percentage of fat in the milk.

5. The influence of additional milkings was greatest when carried through the entire lactation period.

The Influence of Number of Daily Milkings on the Production of Dairy Cows

R. F. MORGAN AND H. P. DAVIS

Milking cows more frequently than twice a day has generally been considered as likely to increase their milk flow. The practice of so doing is a very old one in certain sections. An early writer (5) indicates that at the beginning of a lactation period many Dutch farmers milked their cows three times daily, although apparently this practice did not continue throughout the entire milking period. The fact that milking cows more than twice a day is likely to result in increased milk flow is recognized by several of the breed associations in the United States. For example, the Holstein-Friesian Association of America (16) has established separate classes in their Advanced Registry for cows milked twice daily as compared with those milked three or four times daily. The American Guernsey Cattle Club (1) recognizes a separate class for cows milked only twice a day, assuming apparently that other cows on Advanced Registry test are milked more frequently. The Register of Merit of the American Jersey Cattle Club lists the number of milkings used during the year together with the figures for milk and fat production, in order that readers may judge the influence of the number of milkings.

According to Eckles (8), "Heavy producing cows will increase their yield by an additional milking, while small or medium milkers show no appreciable increase. Few cows will produce over 50 or 60 pounds, at the most, with twice-a-day milking. For the Channel Island breeds (Guernseys and Jerseys) 35 to 45 pounds mark the same limits. With cows of this grade a third milking makes it possible not only to make use of the full capacity of the animal but also apparently to hold up the production to a higher level for a longer period. . . . Seventy or eighty pounds of milk daily for a Holstein or 50 for a Jersey is near the upper limit for three milkings daily. If the animal has a capacity above this, four milkings are necessary to obtain a maximum yield."

Riford (21) changed 50 cows averaging 45 pounds of milk daily from two- to three-time milking and stated that the average increase was four pounds of milk daily. He also compared a group of 25 cows milked three times daily with their past production when milked twice. The increase varied from 9.1 to 13.2 pounds of milk daily, the

largest increase being from fresh cows. He stated that milking three times added about 10 per cent to the production of cows giving between 40 and 60 pounds daily, while there was an increase of about 20 per cent from cows producing above 60 pounds of milk a day.

Woodward (28) reported that the increase in milk flow due to milking three times daily as compared with twice was about 12 per cent over a short period and for a longer period the increase varied up to 18 per cent. The change from three to four daily milkings increased production slightly more than 6 per cent.

Turner (26) reported that cows milked at eight-hour intervals and others milked at six-hour intervals produced respectively ten and sixteen per cent more milk than cows milked every twelve hours.

Dean (7) stated that during one month an Ayrshire and a Holstein cow were milked three times daily and during the following month they were milked twice daily. He concluded that, while three-time milking produced more milk, it did not pay in the case of cows producing 42 and 52 pounds of milk daily.

Brody (4) indicates that there is a marked difference in the production of cows milked twice, three times, and four times daily.

Atkeson (3) reported that three cows that had complete records under different systems of milkings showed 100 per cent milk production for four-time milking, 75 per cent for three-time milking, and 60 per cent for twice-a-day milking. Among thirteen cows that were milked both three and four times daily, the increased production due to the extra milking was 25 per cent. The peak of production for cows milked twice daily was reached before the end of the third week, while with three- and four-time milking, the peak of milk production was not reached until the end of the sixth week.

Dahlberg (6) reported that for a Jersey herd, the net result of three-time feeding and milking was 22.3 pounds of butterfat yearly for cows that produced about 375 pounds of fat yearly on twice-daily feeding and milking. There is a cumulative effect due to developing the producing ability of the cow that is brought about by the extra milking that may be important from the breeding standpoint. In this experiment the twice-a-day cows were milked only 10 months while the cows milked thrice a day were milked 12 months.

According to Huynen (17) the milking of cows three times as compared with twice daily showed an increase of 1 per cent

for cows milking 10 liters daily, and 10 per cent for those milking 30 liters daily, or an average for the herd of between 6 and 7 per cent.

Swett (24) demonstrated that pressure in the udder has an inhibiting effect upon milk secretion; consequently there is logical reason to believe that more frequent milking would result in increased production.

According to Smeyers (23) a trial with 34 cows whose production ranged from 8.5 to 17 kilograms of milk daily under twice-a-day milking showed an increase of 8 per cent in milk and 13 per cent in butterfat production when milked three times daily for a week.

Fleischmann (10) stated that three-time showed an increased yield over twice-a-day milking of between 6 and 7 per cent.

Woodward (27) in a later report showed that cows milked twice and three times daily for alternate 30-day periods, following 10-day transitional periods, produced 11 per cent more milk and almost 10 per cent more fat when milked three times daily. When longer periods, 217 to 365 days, were compared, the extra daily milking caused 20 per cent more milk and 21 per cent more fat production. Alternating periods of 30 days, with a 10-day transitional period, to compare three-time milking with four daily milkings showed an increased production for the latter system of 7 per cent more milk and 6 per cent more fat. Additional milkings over twice daily served to reduce the rate of decline of milk production, or, in other words, increased the persistency of lactation.

The effect of milking cows more than twice daily may be three-fold. It may increase the milk flow, it may have an effect upon the percentage of butterfat, and it may influence the persistency of lactation. Any of these effects may be measured by means of experimental trials or by the tabulation of past records. In an effort to determine the influence of the number of milkings daily, the available records of the dairy herd at the University of Nebraska were carefully tabulated and arranged by breeds and by ages. Only records that exceeded 304 days were included and all animals were excluded where abortion might have had an influence upon production (18).

In the University herd four breeds of dairy cattle have been kept, Holstein, Jersey, Ayrshire, and Guernsey. A larger number of records of the first-named breed were available for study, but all records for each breed have been presented where comparison was possible. Since it is a generally accepted fact that the production of dairy

cows is affected by their age, particularly when immature, it was necessary to group the data under different age classifications (1, 2, 11, 12, 13, 14, 15, 16, 18, 19, 25, 26). Consequently all animals calving between the ages of 24 and 35 months inclusive were grouped as two-year-olds (25); those calving at between 36 and 47 months inclusive were listed as three-year-olds; those calving at between 48 and 59 months were considered as four-year-olds; and all animals calving at 60 months or older were considered as belonging to the aged-cow group. Records of cows over 10 years of age were omitted in order that senility might not have an effect (11, 12, 15, 26). The tables include data on the following: the average age; the number of days that the animal was milked two, three, or four times daily; the pounds of milk; the pounds of fat; the percentage of fat; and the relation to maturity.

In Table 1, Holstein cows milked twice daily are listed by age groups. A total of 75 animals are included in the table. The relation of the production of the younger animals to the mature animals is approximately the accepted relationship as determined by various investigators (11, 12, 13, 14, 15, 16, 18, 19, 25). The production shows a regular progression from the younger to the older group. In making up this table, the range of milkings was as follows: for 305-day records, 610 to 792; for 365-day records, 612-912. It is believed that this is a fair range of milkings for the respective milking periods. The average age was 5 years and 1 month and the 75 cows were milked an average of 344 days.

Table 1 A is comparable to Table 1, except that it represents a tabulation of Holstein cows milked three times daily. Here again the production relationship of the immature animals to the mature is very close to the generally accepted relationship (25). The average age in this group was 4 years and 6 months and the average number of days in milk was 354. The number of milkings daily is listed together with the range. The difference of seven months in the average age of the cows milked three times daily as compared with those milked twice (shown in Table 1) does not have any effect upon the comparison of the tables.

In Table 1B, Holstein cows milked four times daily are compared in age groups. Here again the production according to age is approximately the accepted standard as shown in Table 7. The 109 cows averaged 5 years of age, were in milk 357 days, and had an average of 1,413 milk-

TABLE 1.—*Production of Holstein cows milked two times daily*

Range of milkings: for 305 days, 610-792; for 306-365 days, 612-912

Number of cows	Age groups Yrs.—Mos.	Days in milk	Days milked			Total milkings	Milk	Fat	Fat	Relation to maturity, based on fat
			Four times daily	Three times daily	Two times daily					
32	7-8	Av. no. 336.5	Av. no. 0.94	Av. no. 42.0	Av. no. 293.4	Av. no. 716.7	Av. lbs. 10585.7	Av. lbs. 356.04	Av. p. ct. 3.36	P. ct. 100.00
13	4-4	344.3	0.77	35.2	308.2	729.2	9622.3	332.25	3.45	93.31
12	3-3	354.3	...	...	354.3	708.5	8682.3	299.35	3.45	84.07
18	2-1	350.7	...	11.0	339.6	712.5	8292.8	273.33	3.29	76.76
Tot. 75	Av. 5-1	344.1	0.53	26.6	316.8	716.7	9563.8	323.07	3.37	.....

TABLE 1A.—*Production of Holstein cows milked three times daily*

Range of milkings: for 305 days, 853-1217; for 306-365 days, 913-1277

34	7-1	346.3	62.2	242.5	41.7	1059.7	15707.2	565.26	3.60	100.00
13	4-5	357.5	7.9	318.3	31.3	1049.2	15144.9	529.68	3.50	93.70
15	3-7	358.5	80.9	222.0	54.8	1099.7	14542.4	518.84	3.57	91.78
33	2-3	359.6	27.1	311.0	20.4	1084.3	12757.3	445.41	3.49	78.79
Tot. 95	Av. 4-6	354.4	57.7	273.4	34.9	1074.5	14421.6	511.43	3.55	.....

TABLE 1B.—*Production of Holstein cows milked four times daily*

Range of milkings: for 305 days, 1218-140; for 306-365 days, 1278-1460

51	7-1	356.4	344.3	9.8	0.25	1401.0	21972.5	788.97	3.59	100.00
15	4-7	360.0	350.6	8.4	0.93	1429.9	21495.8	783.92	3.65	99.35
15	3-5	349.0	339.8	10.1	3.00	1395.5	18001.8	690.41	3.83	87.50
28	2-4	351.1	354.4	6.8	1.96	1397.8	16642.1	606.63	3.44	76.88
Tot. 109	Av. 5-0	357.8	347.1	8.8	1.10	1413.0	20129.6	733.44	3.64	.....

ings. In Tables 1, 1A, and 1B, the greatest variation in days in milk was 13 days, and this did not have any appreciable effect upon the results. It is evident from studying Tables 1, 1A, and 1B, that there was a considerably larger production of milk and fat in the groups milked more than twice daily.

The average percentage of butterfat for the cows milked twice daily was 3.37, while for the Holstein cows milked three times daily it was 3.55 and for the cows milked four times daily, 3.64. It seems reasonable to conclude that the additional daily milkings added materially to the milk production, and there is an indication that the additional milkings increased the percentage of butterfat. It might be well to state that all the three- and four-time milking records were made under advanced registry conditions with the percentage of butterfat determined by samples tested for each milking for one or two days in the middle of the month. Part of these milking records were obtained by the testing of weekly composite samples of milk.

In Table 2, comparable to Table 1, data for Jersey cows are presented. The relation of production at younger ages to maturity is not according to the accepted scale as was the case with the Holsteins in Table 1. What this is due to is not entirely apparent. The three- and four-year-old groups deviate materially from the expected ratio, and in fact both groups exceed the mature production in fat. The effect of a higher fat percentage in the younger ages will account for part of the large fat production at the immature ages as compared with the production at maturity. If the cows at the different ages had produced milk containing the same percentage of fat that the mature cows produced, the two-year-old cows would have produced 301.10 pounds of butterfat or 88.91 per cent of the mature production. The three-year-old cows with the same percentage of butterfat would have produced 324.53 pounds of fat or 95.84 per cent of the mature production. The four-year-old Jersey cows with the same percentage of fat as the mature cows would have an average fat production of 341.23 pounds or 100.77 per cent of mature production. Even eliminating the factor for percentage of fat, the Jersey cows in this tabulation vary materially from the anticipated relationship between mature and immature cows. It will be noted that the number of milkings for each of the immature groups is larger than for the mature group.

TABLE 2.—*Production of Jersey cows milked two times daily*

Range of milkings: for 305 days, 610-792; for 306-365 days, 612-912.

Number of cows	Age groups Yrs.—Mos.	Days in milk	Days milked			Total milkings	Milk	Fat	Fat	Relation to maturity, based on fat
			Four times daily	Three times daily	Two times daily					
75	8-2	Av. no. 344.9	Av. no.	Av. no. 25.3	Av. no. 318.2	Av. no. 714.2	Av. lbs. 6714.7	Av. lbs. 338.61	Av. p. ct. 5.04	P. ct. 100.00
14	4-5	345.7	.....	40.3	304.5	731.0	6772.4	351.80	5.19	103.89
28	3-4	354.3	2.3	35.6	316.1	748.9	6439.1	343.15	5.33	101.34
47	2-2	354.1	11.0	19.8	323.5	751.6	5974.3	318.18	5.33	93.96
Tot. 164	Av. 5-3	349.2	3.5	26.8	318.2	732.2	6460.6	334.65	5.17	.....

TABLE 2A.—*Production of Jersey cows milked three times daily*

Range of milkings: for 305 days, 853-1217; for 306-265 days, 913-1277

17	6-8	358.2	20.1	271.0	67.0	1027.9	9566.7	517.51	5.41	100.00
10	4-5	361.5	33.7	219.7	107.1	1009.0	9033.9	491.49	5.44	94.97
8	3-5	357.3	59.9	200.2	97.2	1035.1	7653.8	435.97	5.70	84.24
9	2-2	333.0	33.1	291.3	8.5	1023.5	6992.5	394.30	5.64	76.19
Tot. 44	Av. 4-7	353.9	33.0	250.6	69.6	1024.0	8571.2	471.57	5.50	.....

TABLE 2B.—*Production of Jersey cows milked four times daily*

Range of milkings: for 305 days, 1218-1400; for 306-365 days, 1278-1460

4	9-0	365.0	329.5	34.5	0.75	1423.2	13186.2	725.56	5.50	100.00
2	4-5	364.5	361.0	.....	1.50	1448.5	10982.0	700.95	6.37	96.60
2	2-2	335.0	335.0	.....	.....	1340.0	9440.0	517.04	5.48	71.26
Tot. 8	Av. 6-2	357.3	338.7	17.2	0.63	1408.7	11698.6	668.53	5.71	.....

Jersey cows milked three times daily are tabulated in Table 2A according to age. This table is comparable to Table 1A for Holstein cows. While there is a variation in percentage of butterfat between the different age classes, the relationship between immature and mature production is reasonably close to the expected. There appears to be a wider range of butterfat percentage variations between various groups of Jersey cows than between corresponding groups of Holsteins. There was a uniform increase in production as compared with twice-a-day milking.

Table 2B shows the Jersey cows milked four times daily and is comparable to Table 1B for Holsteins. While only a few animals are presented, the table correlates well with other tables. Tables 2A and 2B show that cows milked three and four times daily produced materially more than those milked twice daily and that they averaged higher in butterfat.

Tables 3, 3A, and 3B present data regarding Ayrshire cows comparable with data presented in the previous tables for Holsteins and Jerseys. The small numbers represented do not permit the drawing of any conclusions but are presented for comparative study. Here, too, the cows milked three and four times daily produced more milk and fat than those milked twice a day, but showed no appreciable increase in the percentage of butterfat in the milk.

In Tables 4, 4A, and 4B figures for different age groups of Guernsey cows under different systems of milking are presented. Here again the numbers represented are too small to be significant. In Table 4 there is a very uniform progression in the age groups. Throughout all the tables the relationship of production at younger ages to mature production is quite uniform where there are sufficient numbers to be in any way significant. Since the progressive relationship is comparable to the figures presented by Turner and co-workers (25) on the relationship of immature production to mature production, it is believed that the data presented in Tables 1 to 4B are of significance. Cows milked three and four times daily had materially higher milk and fat production and in some cases a higher percentage of butterfat than cows milked twice a day.

It is obvious that in studying the influence of the number of daily milkings upon production the best comparison would be with the same cows. Since age is a factor influencing production, all animals would have to be mature if the comparisons were to be valuable unless corrections for age were used. Various factors have operated to pre-

TABLE 3.—*Production of Ayrshire cows milked two times daily*

Range of milkings: for 305 days, 610-792; for 306-365 days, 612-912

Number of cows	Age groups Yrs.—Mos.	Days in milk	Days milked			Total milkings	Milk	Fat	Fat	Relation to maturity, based on fat
			Four times daily	Three times daily	Two times daily					
		<i>Av. no.</i>	<i>Av. no.</i>	<i>Av. no.</i>	<i>Av. no.</i>	<i>Av. no.</i>	<i>Av. lbs.</i>	<i>Av. lbs.</i>	<i>Av. p. ct.</i>	<i>P. ct.</i>
17	9-9	342.0	1.3	61.5	278.4	747.4	9564.9	370.46	3.87	100.00
3	4-6	346.6	.....	98.6	248.0	792.0	8156.3	322.06	3.95	86.93
4	3-3	360.5	.....	18.5	342.0	739.5	7461.3	300.98	4.03	81.24
13	2-3	346.9	.....	40.1	305.7	733.0	6253.6	272.32	4.35	73.50
Tot. 37	Av. 6-0	346.1	0.6	52.4	292.4	745.1	8059.9	325.35	4.03	.....

TABLE 3A.—*Production of Ayrshire cows milked three times daily*

Range of milkings: for 305 days, 853-1217; for 306-365 days, 913-1277

12	6-6	354.0	.....	311.0	42.6	1018.6	11342.9	450.93	3.97	100.00
7	4-4	342.7	.....	270.2	72.4	955.7	9704.4	396.73	4.91	88.02
3	3-3	344.3	35.0	236.6	72.6	995.3	10990.0	404.48	3.68	89.69
7	2-3	356.5	.....	327.1	29.2	1040.0	7189.8	312.43	4.34	69.28
Tot. 29	Av. 4-7	350.8	3.6	297.3	49.9	1006.5	9942.2	399.58	4.01	.....

TABLE 3B.—*Production of Ayrshire cows milked four times daily*

Range of milkings: for 305 days, 1218-1400; for 306-365 days, 1278-1480

4	7-2	365.0	328.0	37.0	.....	1423.0	14683.2	600.33	4.08	100.00
Tot. 4	Av. 7-2	365.0	328.0	37.0	.....	1423.0	14683.2	600.33	4.08	.....

TABLE 4.—*Production of Guernsey cows milked two times daily*
 Range of milkings: for 305 days, 310-792; for 306-365 days, 612-912

Number of cows	Age groups Yrs.—Mos.	Days in milk	Days milked			Total milkings	Milk	Fat	Fat	Relation to maturity, based on fat	
			Four times daily	Three times daily	Two times daily						
		<i>Av. no.</i>	<i>Av. no.</i>	<i>Av. no.</i>	<i>Av. no.</i>	<i>Av. no.</i>	<i>Av. lbs.</i>	<i>Av. lbs.</i>	<i>Av. p. ct.</i>	<i>P. ct.</i>	
15	7-4	345.6	.....	34.8	309.6	725.0	7340.8	339.41	4.62	100.00
5	4-5	340.2	.....	87.2	250.0	764.6	6809.7	306.36	4.49	90.26
4	3-2	355.5	.....	68.2	287.2	779.2	6007.2	287.22	4.75	84.26
9	2-4	342.3	3.1	39.1	302.1	728.0	5570.4	253.84	4.55	74.78	
Tot.	33	Av. 5-1	345.1	0.8	47.4	295.8	738.3	6615.8	304.74	4.60

TABLE 4A.—*Production of Guernsey cows milked three times daily*
 Range of milkings: for 305 days, 853-1217; for 306-365 days, 913-1277

5	6-8	365.0	63.4	212.6	83.4	1058.2	10053.3	492.61	4.89	100.00	
3	4-5	359.3	73.0	189.6	96.6	1054.3	8483.2	408.04	4.80	83.03	
3	3-3	360.6	.....	301.6	59.0	1023.0	8447.3	424.35	5.02	86.14
4	2-1	320.5	.....	308.0	3.2	948.7	6566.5	359.26	5.47	72.90
Tot.	15	Av. 4-5	351.1	35.7	251.2	59.8	1021.2	8488.2	426.48	5.02

TABLE 4B.—*Production of Guernsey cows milked four times daily*
 Range of milkings: for 305 days, 1218-1400; for 306-365 days, 1278-1460

1	4-7	365.0	360.0	1.0	4.0	1451.0	12257.3	614.20	5.01	.....
1	3-3	365.0	347.0	18.0	.....	1442.0	13149.4	626.60	4.77	.....
Tot.	2	Av. 3-9	365.0	353.0	9.5	2.0	1446.5	12703.3	620.40	4.88

vent the actual accumulation of such data. For example, the general practice has been to milk cows four times daily only when their production was much above the average. Three-time milking has been practiced at times for all the herd, and at other times has been used only for exceptional cows. Records are available from eight mature Holstein cows under both twice-a-day and three-time milking. That each of these cows had the ability to produce much above the average is shown by the records. Table 5 shows the milk and fat production of each cow under each system of milking, together with the increased production that may be attributed to the extra milking. Where several records are available, all are given and the average used in determining the increase due to frequency of milking. While the numbers are very limited, this table confirms other tables in that there is a marked increase in production due to one extra milking each day. The average increase was 57.93 per cent in milk and 62.95 per cent in fat production. There is a very slight increase in the percentage of butterfat but it is not believed to be significant.

A similar comparison of individual cows when milked three and four times daily is given in Table 6. Only nine cows are included but a number of records are listed. Here again there was a uniform increase due to an extra milking, amounting to 38.76 per cent in milk and 34.88 per cent in fat. Not enough animals were available to justify a comparison of two-time with four-time milking. It should be noted that the animals listed in Tables 5 and 6 were high-producing cows. Whether comparable increases in production could have been obtained with cows of lower inherent producing ability is doubtful. Unfortunately there were only a very few cows of other breeds upon which like comparisons could have been made. Because of the limited numbers these were omitted.

The data presented in Tables 1, 1A, and 1B for Holstein cows have been rearranged and regrouped in Table 7. Here for comparison are advanced registry data tabulated by Turner (25). Since that work represents large populations it may presumably be considered as indicating the true relationship of fat production at immature ages to maturity, especially since it agrees with other material bearing on the subject (11, 12, 13, 15, 16, 18, 19, 26). Considering mature fat production as 100 per cent, then four-year-old cows produced 94.03 per cent of mature production, while three- and two-year-old cows produced respectively 87.15 per cent and 77.67 per cent. Nebraska records

TABLE 5.—*Influence of number of milkings upon production of mature individual Holstein cows—three vs. four times*

Name	Registry number	Milk records Milkings daily		Fat records Milkings daily		Increase in milk		Increase in fat		Fat percentage Daily milkings	
		Two	Three	Two	Three					Two	Three
Daisy Lincoln.....	72,992	<i>Lbs.</i> 7,477.7	<i>Lbs.</i> 14,283.6	<i>Lbs.</i> 251.50	<i>Lbs.</i> 531.77	<i>Lbs.</i> 7508.4	<i>P. ct.</i> 100.41	<i>Lbs.</i> 293.56	<i>P. ct.</i> 116.72	<i>P. ct.</i> 3.36	<i>P. ct.</i> 3.63
Kaan Marie Clothilde 2nd.....	49,529	9,844.9 8,026.6 11,889.5	13,526.1	315.62 260.52 390.82	426.95 558.36	3605.8	36.34	104.63	32.46	3.25	3.15
Roxanna Parthena.....	60,400	9,972.0 11,771.1 12,761.3	16,294.4 21,628.4 15,666.7	362.52 398.84 438.10	556.64 757.00 557.93	6361.7	55.31	224.04	56.03	3.47	3.49
Karen 2nd.....	55,815	11,663.8 13,608.8	17,810.9	374.25 461.02	601.87	5174.6	40.95	184.24	44.11	3.30	3.37
Katy Gerben.....	68,099	8,826.7 8,822.9 8,892.4	16,952.9 19,161.2 13,656.3	254.40 277.51 301.89	558.98 665.14 428.80	7742.8	87.51	273.04	98.24	3.14	3.38
Susanna Gerben.....	148,539	9,441.9 7,491.9 8,897.4 5,986.9	14,475.5	357.70 292.73 303.72 211.75	519.87	6521.0	81.97	228.40	78.36	3.66	3.59
Mesa Lincoln.....	126,168	13,174.3	12,037.5 12,971.3 17,001.4 13,350.2	460.58	428.21 527.68 644.29 472.85	665.8	5.05	57.70	12.52	3.49	3.74
Miss Gertrude Cornucopia DeKol....	181,981	11,027.7 8,674.0	15,863.4	395.43 297.29	554.14	6012.6	61.03	207.78	59.99	3.51	3.49
Average.....		9,907.9	15,648.0	337.16	549.43	5740.1	57.93	212.27	62.95	3.40	3.51

TABLE 6.—*Influence of number of milkings upon production of mature individual Holstein cows—two vs. three times*

Name	Registry number	Milk records Milkings daily		Fat records Milkings daily		Increase in milk		Increase in fat		Fat percentage Daily milkings	
		Three	Four	Three	Four					Three	Four
La Verna Lincoln	227,365	<i>Lbs.</i> 19,352.3	<i>Lbs.</i> 29,555.0	<i>Lbs.</i> 645.47	<i>Lbs.</i> 1048.50	<i>Lbs.</i> 7288.2	<i>P. ct.</i> 37.66	<i>Lbs.</i> 277.11	<i>P. ct.</i> 42.93	<i>P. ct.</i> 3.33	<i>P. ct.</i> 3.47
Eve Lincoln	262,516	13,985.3	19,699.2	452.35	611.16	6153.9	45.43	170.96	38.83	3.24	3.10
Allie Lincoln	178,368	13,105.3	17,070.2	428.05	692.12	2983.9	18.89	110.30	17.72	3.94	3.90
Quinet Lincoln	339,507	15,577.0	22,157.4	599.95	846.22	4323.8	29.69	151.92	27.13	3.84	3.76
Quality Lincoln	348,248	14,730.6	18,445.5	575.23	709.89	5978.2	31.77	227.16	35.99	3.35	3.46
Varsity Derby Esther	472,944	15,150.9	19,322.7	561.10	713.81	5794.2	39.45	222.76	43.35	3.49	3.59
Varsity Piebe Pontiac Karma	719,087	15,271.2	23,893.5	528.61	818.85	3534.1	21.34	126.25	20.03	3.80	3.76
Varsity Derby Georgia	475,484	13,259.0	23,294.1	631.15	801.18	3399.1	20.04	61.89	9.40	3.88	3.50
Varsity Derby Celia	381,325	18,813.1	27,668.0		963.01	6522.2	49.06	200.28	39.59	3.80	3.56
Average		17,040.4	24,309.8	513.85	752.02	6031.1	38.76	199.76	34.88	3.67	3.58
		16,957.4	20,356.5	658.05	719.94						
		13,294.3	21,959.5	505.81	782.58						
		17,673.6	21,588.9	772.03	629.60						

were tabulated according to age without reference to number of milkings daily. In this tabulation with the mature cows as 100 per cent, the four-year-olds produced 92.48 per cent, the three-year-olds 85.43 per cent, and the two-year-olds 76.80 per cent of mature fat production. The variation from advanced registry figures is 1.55 per cent for four-year-olds, 1.72 per cent for three-year-olds, and 0.87 per cent for two-year-olds, all of which indicates that the cows studied were normal as compared with the breed. When the cows milked twice a day were compared, the variations from advanced registry figures were as follows: for four-year-olds, 0.78 per cent; for three-year-olds, 3.12 per cent; and for two-year-olds, 0.94 per cent. In the comparison of cows milked three times daily with the advanced registry data, the variation is as follows: for four-year-olds, 0.33 per cent; for three-year-olds, 4.63 per cent; and for two-year-olds, 1.12 per cent. When the cows milked four times daily were compared with the advanced registry data, the differences were as follows: for four-year-olds, 5.32 per cent; for three-year-olds, 0.35 per cent; and for two-year-olds, 0.79 per cent. These comparisons have been presented in order to indicate that the cows whose records are presented were normal in the relation of their immature production to mature production and that age as a factor affecting milk and fat production had been eliminated. Table 7 shows that three-time as compared with twice-a-day milking showed differences in fat production varying from 58.68 per cent to 73.32 per cent, while for milk production the range is from 48.38 per cent to 67.49 per cent. The mature, four-year-old, and two-year-old cows showed a maximum variation of 4.32 per cent from the average, while the three-year-old cows showed a greater variation. Four-time milking when compared with twice-a-day milking (see Table 7) showed a fat production ranging from 121.48 to 135.97 per cent and milk production ranging from 100.03 to 123.39 per cent higher for the four times. When cows milked four times were compared with those milked three times, the fat ranged from 33.06 to 48.00 per cent higher, while the milk increase ranged from 23.78 per cent to 41.93 per cent. These data also indicate that a slightly higher percentage of butterfat accompanies the more frequent milking practice.

In Table 8 data comparable to Table 7 are presented for Jersey cows. When grouped together by ages, irrespective of number of milkings, the Nebraska cows do not agree

TABLE 7.—*Influence of number of milkings upon milk and fat production of dairy cows—Holsteins*

Age at calving	Item	Adv. Registry data, Holstein	Nebr. cows, all milkings	Nebraska cows milked daily			Relation to maturity					Increase due to milkings						
				Two	Three	Four times	Adv. Registry data	Nebr. cows, all milkings	Milked daily			Thrice over twice		Four times over twice		Four times over thrice		
									Two	Three	Four times	Lbs.	P. ct.	Lbs.	P. ct.	Lbs.	P. ct.	
Mature	Cows, No.	3390	117	32	34	51	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	Lbs.	P. ct.	Lbs.	P. ct.	Lbs.	P. ct.	
	Milk, Lbs.	17037.5	17037.5	10585.7	15707.2	21972.5	100	100	100	100	100	5121.5	48.38	11386.8	107.56	6265.3	39.88	
	Fat, P. ct.	...	3.55	3.36	3.60	3.59
	Fat, Lbs.	654	605.61	356.22	565.26	788.97	100	100	100	100	100	209.04	58.68	432.75	121.48	223.71	39.57	
Four years	Cows, No.	1238	41	13	13	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Milk, Lbs.	15717.4	15717.4	9622.3	15144.9	21495.8	.....	92.25	90.89	96.42	97.83	5522.6	57.39	11873.5	123.39	6350.9	41.93
	Fat, P. ct.	.....	3.56	3.45	3.50	3.65	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Fat, Lbs.	615	560.08	332.21	529.68	783.92	94.03	92.48	93.25	93.70	99.35	197.47	59.44	451.71	135.97	254.24	48.00	
Three years	Cows, No.	1523	42	12	15	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Milk, Lbs.	14103.6	14103.6	8682.3	14542.4	18001.8	.....	82.77	82.00	92.58	81.92	5860.1	67.49	9319.5	107.33	3459.4	23.78
	Fat, P. ct.	.....	3.67	3.45	3.57	3.83	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Fat, Lbs.	570	517.40	299.35	518.84	690.41	87.15	85.43	84.03	91.78	87.50	219.49	73.32	391.06	130.63	171.57	33.06	
Two years	Cows, No.	2454	80	18	33	29	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Milk, Lbs.	13141.6	13141.6	8292.8	12757.3	16588.5	.....	77.13	78.33	81.21	75.49	4464.5	53.83	8295.7	100.03	383.12	30.03
	Fat, P. ct.	.....	3.54	3.29	3.49	3.65	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Fat, Lbs.	508	465.14	273.33	445.41	606.63	77.67	76.80	76.73	78.79	76.88	172.08	63.00	333.30	121.94	161.22	36.19	

TABLE 8.—*Influence of number of milkings upon milk and fat production of dairy cows—Jersey*

Age at calving	Item	Adv. Registry data, Jersey	Nebr. cows, all milkings	Nebraska cows milked daily			Relation to maturity						Increase due to milkings					
				Two	Three	Four times	Adv. Registry data	Nebr. cows, all milkings	Milked daily			Thrice over twice		Four times over twice		Four times over thrice		
									P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.		
Mature	Cows, No.	4736	96	75	17	4	
	Milk, Lbs.	.....	7489.4	6714.7	9566.7	13186.2	100	100	100	100	2852.0	42.47	6471.5	96.37	3619.5	37.83	
	Fat, P. ct.	.....	5.15	5.04	5.41	5.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Fat, Lbs.	511	386.41	338.61	517.51	725.56	100	100	100	100	178.90	52.83	386.95	114.27	208.05	40.20		
Four years	Cows, No.	1687	26	14	10	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Milk, Lbs.	7966.0	6772.4	9033.9	10982.0	106.36	100.85	94.43	83.28	2261.5	33.39	4209.6	62.15	1948.1	21.56	
	Fat, P. ct.	.....	5.42	5.19	5.44	6.38	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Fat, Lbs.	486	432.38	351.80	491.49	700.95	95.10	111.89	103.89	94.97	96.60	139.69	39.77	349.15	99.24	209.46	42.61	
Three years	Cows, No.	2263	36	28	8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Milk, Lbs.	.....	6709.0	6439.1	7653.8	.....	.....	89.57	95.89	80.00	.....	1214.7	18.86	.....	.....	.....
	Fat, P. ct.	.....	5.42	5.33	5.70	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Fat, Lbs.	443	363.77	343.15	435.97	.....	86.69	94.14	101.34	84.24	.....	92.82	27.04	.....	.....	.....
Two years	Cows, No.	4090	58	47	9	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Milk, Lbs.	6251.8	5974.3	6992.5	9440.0	83.47	88.97	73.09	71.58	1018.2	17.04	3465.7	58.01	2447.5	35.00	
	Fat, P. ct.	.....	5.38	5.33	5.64	5.47	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Fat, Lbs.	383	336.84	318.18	394.30	517.04	74.95	87.17	93.96	76.19	71.26	76.12	23.92	198.86	62.49	122.74	31.13	

in all age classifications with the advanced registry data, the four-year-olds and the three-year-olds being above the mature cows in production (see Table 4). For Jersey cows, the percentage increase due to three-time milking over twice-a-day milking ranged from 23.92 to 52.83 for fat and from 17.04 to 42.47 for milk. When four-time milking was compared with twice-a-day milking, the increase in fat ranged from 62.49 per cent to 114.27 per cent, while the increase in milk ranged from 58.01 to 96.37 per cent. Four-time when compared with three-time milking showed an increase in percentage of fat production ranging from 31.13 to 42.61, while for milk the increase ranged from 21.56 to 37.83 per cent. As in Table 7, for Holsteins, this table shows that Jersey cows show materially higher milk and fat production when milked more frequently than twice daily. There appears to be also a higher percentage of butterfat from cows milked more frequently than twice daily. Additional milkings do not increase the production of milk and fat for Jersey cows as much as for Holstein cows, which may be due to the difference between the breeds, to the fact that the Jerseys were on the average lower in production than the Holsteins, or to both factors.

Table 9 presents figures for Ayrshire cows comparable to Table 7 for Holstein and Table 8 for Jersey cows. The Nebraska data are meagre but this table shows the same relationship that the others showed except that the additional milkings are not accompanied by the higher percentage of fat in the milk. The increased production due to the extra milking ranged slightly lower in percentage than was the case in the other breeds. This may have been due to the lower inherent producing ability of this group of cows.

Table 10, comparable to Tables 7, 8, and 9, shows the data for Guernsey cows. The paucity of the data precludes much discussion, but here as in every other case, the increased number of milkings materially increased the production. While not true in every case, the additional milkings tended slightly to increase the percentage of butterfat.

In Table 11 a recapitulation of previous tables is made so as to present a summary of all records of all breeds in one table. It is true that in such a tabulation the Holstein cows, being more numerous, naturally would have a greater effect upon the results, but since tables have been presented showing the separate breeds it is believed that a combination of all data is worth while. In the combined data there are enough numbers to smooth out individual inequalities

TABLE 10.—*Influence of number of milkings upon milk and fat production of dairy cows—Guernsey*

Age at calving	Item	Adv. Registry data, Guernsey	Nebr. cows, all milkings	Nebraska cows milked daily			Relation to maturity					Increase due to milkings					
				Two	Three	Four times	Adv. Registry data	Nebr. cows, all milkings	Milked daily			Thrice over twice		Four times over twice		Four times over thrice	
									Two	Three	Four times	Lbs.	P. ct.	Lbs.	P. ct.	Lbs.	P. ct.
Mature	Cows, No.	3457	20	15	5	.....	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	Lbs.	P. ct.	Lbs.	P. ct.	Lbs.	P. ct.
	Milk, Lbs.	....	8018.9	7340.8	10053.3	.....	100	100	100	100	100	2712.5	36.95	.....	.....	.....	.....
	Fat, P. ct.	....	4.71	4.62	4.89	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Fat, Lbs.	517	377.71	339.41	492.61	.....	100	100	100	100	100	153.20	45.13	.....	.....	.....	.....
Four years	Cows, No.	1977	9	5	3	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Milk, Lbs.	....	7972.8	6809.7	8483.2	12257.3	.....	99.42	92.76	84.38	.....	1673.5	24.57	5447.6	79.99	3774.1	44.48
	Fat, P. ct.	....	4.69	4.49	4.80	5.01	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Fat, Lbs.	492	374.47	306.36	408.04	614.20	95.16	99.14	90.26	82.83	.....	101.68	33.18	307.84	100.47	206.16	50.52
Three years	Cows, No.	2566	8	4	3	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Milk, Lbs.	....	7815.0	6007.2	8447.3	13149.4	.....	97.45	81.83	84.02	.....	2440.1	40.61	7142.2	118.89	4702.1	55.66
	Fat, P. ct.	....	4.87	4.78	5.02	4.77	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Fat, Lbs.	452	381.07	287.22	424.35	626.60	87.42	100.88	84.62	86.14	.....	137.13	47.74	339.38	118.16	202.25	47.66
Two years	Cows, No.	5554	13	9	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Milk, Lbs.	....	5876.9	5570.4	6566.5	.....	.....	73.28	75.88	65.31	.....	996.1	17.88	.....	.....	.....	.....
	Fat, P. ct.	....	4.87	4.55	5.47	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Fat, Lbs.	409	286.27	253.84	359.26	.....	79.11	75.79	74.78	72.92	.....	105.42	41.53	.....	.....	.....	.....

TABLE 11.—*Influence of number of milkings upon milk and fat production of dairy cows—combination of four breeds*

Age at calving	Item	Adv. Registry data, all breeds	Nebr. cows, all milkings	Nebraska cows milked daily			Relation to maturity					Increase due to milkings						
				Two	Three	Four times	Adv. Registry data	Nebr. cows, all milkings	Milked daily			Thrice over twice		Four times over twice		Four times over thrice		
									P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	Lbs.	P. ct.	Lbs.	P. ct.	Lbs.	P. ct.
Mature	Cows, No.	14747	266	139	68	59	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Milk, Lbs.	.....	12147.3	8022.0	13000.9	20882.6	.....	100	100	100	100	4978.9	62.06	12860.6	160.31	7881.7	60.62	.....
	Fat, P. ct.	.....	4.01	4.32	4.05	3.69	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Four years	Cows, No.	6224	86	35	33	18	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Milk, Lbs.	.....	11810.3	7954.9	11533.4	19814.2	.....	97.22	99.16	88.71	94.88	3578.5	44.98	11859.3	149.08	8280.8	71.79	.....
	Fat, P. ct.	.....	4.08	4.22	4.15	3.86	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Three years	Cows, No.	8017	93	48	29	16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Milk, Lbs.	.....	10314.1	7049.1	11644.1	17698.6	.....	84.90	87.87	89.56	84.75	4595.0	65.18	10649.5	151.07	6054.5	51.99	.....
	Fat, P. ct.	.....	4.20	4.59	4.07	3.87	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Two years	Cows, No.	16005	170	87	53	30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Milk, Lbs.	.....	9540.8	6453.9	10575.4	16664.9	.....	78.54	80.45	81.34	79.80	4121.5	63.86	10211.0	158.21	6089.5	57.58	.....
	Fat, P. ct.	.....	4.08	4.57	3.90	3.72	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Fat, Lbs.	408	389.39	295.39	412.64	620.88	75.55	79.91	85.21	78.18	80.43	117.25	39.69	325.49	110.19	208.24	50.46	.....

so that when compared under two-, three-, and four-time milking under the different age groups the variation from the advanced registry data is slight in any particular case, which indicates that the Nebraska cows are a normal group. When three-time milking is compared with twice-a-day milking, the increase in fat ranges from 39.69 to 52.26 per cent, while in milk production the increase ranges from 44.98 to 65.18 per cent. In the comparison of four-time milking with twice-a-day milking, the fat increase ranges from 110.19 to 127.53 per cent. The milk increase ranges from 149.08 to 160.31 per cent. When four-time milking is compared with three-time milking, the increases in fat range from 44.70 to 59.81 per cent while the milk increases vary from 51.99 to 71.79 per cent. It is not fair to draw any conclusions from this table with reference to the percentage of fat, since high and low testing breeds are represented and are not in equal proportions.

From the data presented the influence of more frequent milking daily upon yearly milk and butterfat production appears to be greater than most writers have stated, at least when cows of potential high production are considered. There is some evidence that more frequent milkings tend to increase the average percentage of fat in the milk. Whether the increased milk flow is due to a larger production of milk evenly distributed throughout the lactation period or whether added milkings daily tend to maintain milk flow at a higher level for a longer period has not been determined.

LITERATURE CITED

1. American Guernsey Cattle Club.
1930. RULES AND REQUIREMENTS OF THE ADVANCED REGISTRY OF GUERNSEY CATTLE. Peterboro, N. H.
2. American Jersey Cattle Club.
1923. REGISTER OF MERIT, consolidated. New York.
3. Atkeson, F. W.
1929. DAIRY HUSBANDRY. Idaho Agr. Exp. Sta. Ann. Rept., Bul. 164.
4. Brody, Samuel, Turner, C. W., and Ragsdale, A. C.
1924. THE RELATION BETWEEN THE INITIAL RISE AND THE SUBSEQUENT DECLINE OF MILK SECRETION FOLLOWING PARTURITION. Jour. of Gen. Physiol. 6:541-545.
5. Colman, Henry.
1848. EUROPEAN AGRICULTURE, quoted in HOLSTEIN HERD BOOK, 1:9.
6. Dahlberg, A. C.
1924. NEW YORK EXPERIMENT STATION, JERSEYS. TWO VERSUS THREE MILKINGS. Hoard's Dairyman 68:436.
7. Dean, H. H.
1898. ANNUAL REPORT, Dept. of Agr., Ontario, Canada.
8. Eckles, C. H.
1929. DAIRY CATTLE AND MILK PRODUCTION, rev. ed., Macmillan, New York.
9. ———, and Palmer, L. S.
1917. INFLUENCE OF AGE OF THE COW ON THE COMPOSITION AND PROPERTIES OF MILK AND MILK FAT. Jour. Agr. Research, 11:645-658.
10. Fleischmann, W.
1920. LEHRBUCH DER MILCHWIRTSCHAFT. Aufl. 6, Neubearb., p. 633, Berlin.
11. Gowen, John W.
1920. STUDIES IN MILK SECRETION V. ON THE VARIATION AND CORRELATION OF MILK SECRETION WITH AGE. Genetics 5:111-189.
12. ———
1920. STUDIES IN MILK SECRETION VIII. INFLUENCE OF AGE IN MILK AND BUTTERFAT YIELD IN HOLSTEIN-FRIESIAN CATTLE. Maine Agr. Exp. Sta. Bul. 293.
13. ———
1920. THE CORRELATION BETWEEN THE BUTTERFAT PERCENTAGE OF ONE LACTATION AND THE BUTTERFAT PERCENTAGE OF SUCCEEDING LACTATIONS IN JERSEY CATTLE. Maine Agr. Exp. Sta. Bul. 291.
14. ———
1923. STUDIES IN MILK SECRETION XIV. THE EFFECT OF AGE ON MILK YIELD AND BUTTERFAT PERCENTAGE OF GUERNSEY ADVANCED REGISTRY CATTLE. Maine Agr. Exp. Sta. Bul. 311.
15. Graves, R. R., and Fohrman, M. H.
1925. EFFECT OF AGE AND DEVELOPMENT OF BUTTERFAT PRODUCTION OF REGISTER OF MERIT JERSEY AND ADVANCED REGISTRY GUERNSEY CATTLE. U. S. Dept. of Agr. Bul. 1352.
16. Holstein-Friesian Advanced Registry Year Book.
1924. Vol. 35.

17. Huynen, E.
1923. CONTRIBUTION A L'ETUDE DES VARIATIONS DE LA COMPOSITION DU LAIT. World's Dairy Congress, Syracuse, N. Y., Proc. 2:1067.
18. Morgan, R. F.
1929. SOME ECONOMIC PHASES OF ABORTION IN DAIRY CATTLE. Thesis presented for partial fulfillment of the Master of Science Degree, University of Nebraska.
19. Pearl, Raymond.
1914. ON THE LAW RELATING MILK FLOW TO AGE IN DAIRY CATTLE. Proc. Soc. Exp. Biol. and Med. 12:18-19.
20. ———, and Miner, J. R.
1919. VARIATION OF AYRSHIRE COWS IN QUANTITY AND FAT CONTENT OF THEIR MILK. Maine Agr. Exp. Sta. Bul. 279.
21. Riford, L. S.
1922. DOES IT PAY TO MILK THREE TIMES A DAY? Hoard's Dairyman 63:661.
22. Roberts, Elmer.
1918. CORRELATION BETWEEN THE PERCENTAGE OF FAT IN COW'S MILK AND THE YIELD. Jour. Agr. Research 14:67-96.
23. Smeyers, F.
1909. L'INFLUENCE DU NOMBRE DES TRAITES SUR LA PRODUCTION DU LAIT ET DU BEURRE. Laiterie 19:58.
24. Swett, W. W.
1927. RELATION OF CONFORMATION AND ANATOMY OF THE DAIRY COW TO THE MILK AND BUTTERFAT PRODUCING CAPACITY. UDDER CAPACITY AND MILK SECRETION. Jour. Dairy Sci. 10:1.
25. Turner, C. W., Ragsdale, A. C., and Brody, S.
1924. THE RELATION BETWEEN AGE AND FAT PRODUCTION IN DAIRY COWS. Mo. Agr. Exp. Sta. Bul. 221.
26. ———
1928. FACTORS AFFECTING THE PERCENTAGE OF FAT IN COW'S MILK. Mo. Agr. Exp. Sta. Bul. 222.
27. Woodward, T. E.
1931. THE PRODUCTION OF DAIRY COWS AS AFFECTED BY FREQUENCY AND REGULARITY OF MILKING AND FEEDING. U. S. Dept. of Agr. Circular 180.
28. ———, and Dawson, J. R.
1926. CARE AND MANAGEMENT OF DAIRY COWS. U. S. Dept. of Agr. Farmer's Bul. 1470.

