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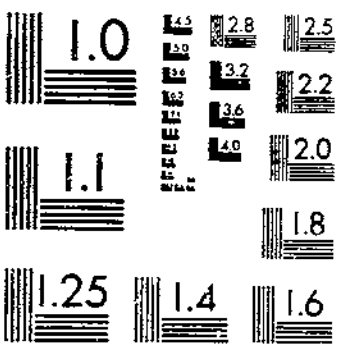

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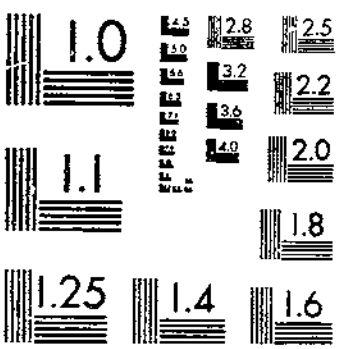

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DAIRY WORK AT THE HUNTLEY FIELD STATION, HUNTLEY, MONT., 1918–1927

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INTRODUCTION

Dairy work at the Huntley Field Station [1] (fig. 1) was begun by the Bureau of Dairy Industry in 1918 as the result of a special appropriation made in August, 1916, by Congress for dairy demonstration work to be carried on in the semiarid and irrigated districts of western United States. This station is located on the Huntley Reclamation Project in the Yellowstone Valley of Montana and was established in 1910 by the Bureau of Plant Industry. Land for buildings, corrals, and irrigated pastures to be used in the dairy work was furnished by the Bureau of Plant Industry. Building operations were started in May, 1917, when dairy barns, silos, and a house for the man in charge were erected. A herd of purebred Holstein-Friesian cattle was established in May, 1918.

The purpose of this dairy station is to investigate problems encountered in dairying in the irrigated districts, particularly the effective utilization of home-grown forage and grain crops. The station also

[1] Dan Hansen has served as superintendent of the Huntley Field Station since its establishment in 1910. L. J. Ridings had charge of the herd from May, 1918, to March, 1919. He was succeeded by J. B. Shepherd, who served until July, 1921, when T. W. Moseley was appointed.

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serves as a demonstration of modern dairy methods in a district where dairying is just becoming established.

The investigational work is conducted along the following lines: (1) Pasture experiments, (2) feeding experiments, (3) factors influencing variation in weight of dairy cows and calves, and (4) breeding experiments.

The milking cows were fed individually, each cow receiving all the roughage feeds and pasture she could eat and grain mixture according to the quantity of milk she produced. The grain mixture generally used was as follows: Ground corn, 2 parts by weight; ground oats, 2 parts; mill feed, 2 parts; and linseed meal, 1 part. This mixture contained 12.9 per cent digestible protein and 74.8 per cent total digestible nutrients. Other mixtures have been used from time to time, but they furnished practically the same percentages of digestible nutrients. The roughage was composed of alfalfa hay, corn silage, and sugar beets. Dried beet pulp was fed when fresh beets were not available. Cows on semiofficial test were milked three times per day; those under herd conditions were milked only twice daily.

FIGURE 1.—Huntley Field Station, Huntley, Mont.

Except for this difference the test cows were handled in the same manner as the herd cows. During the summer the cows were placed on irrigated mixed-grass pasture.

Until they were from 6 to 10 months of age, the heifer calves were fed skim milk, alfalfa hay, and small quantities of grain. After the skim-milk period they received only alfalfa hay, corn silage, and a limited quantity of pasture. During the latter period the alfalfa hay fed the heifers consisted of the hay left by the milking cows and a small quantity of good-quality hay. All heifers that had been weaned from skim milk were kept on pasture day and night, when it was available. Pasturage for the herd was limited and was usually available for the heifers only during June and part of July. When on pasture the heifers received no additional feeds. They were bred to freshen at 26 to 28 months of age. When possible all heifers were placed on semiofficial test during their first lactation period.

PASTURE EXPERIMENTS

Pasture experiments with dairy cows were conducted to determine: (1) The grass mixture most suitable for irrigated pastures; (2) the greatest carrying capacity of irrigated grass and sweet-clover pastures; (3) the value of a top-dressing of cow manure in increasing the carry-

ing capacity of irrigated grass pastures; (4) the length of time the cows grazed daily; and (5) the effect of pasture on breeding efficiency, body weight, and milk flow.

MEASURING RESULTS

The following method devised by the Bureau of Dairy Industry was used to determine the value of the pastures in the various experiments:

A calculation was made of the quantity of digestible protein and total digestible nutrients necessary to maintain the cow at constant body weight and to furnish the nutrients required for gain in weight and milk and butterfat production. (Savage standard.) From the required nutrients thus calculated were deducted the nutrients in the hay fed while the cows were on pasture. The difference was taken as the quantity of nutrients that may be credited to the pasture. By converting this quantity of nutrients into its equivalent of alfalfa hay and corn silage and by finding their value at local prices, the value of the pasture was obtained. In other words, the monetary value of the pasture was figured in terms of the monetary value of alfalfa hay and corn silage that would be required to furnish a quantity of nutrients equal to that furnished by the pasture. Corn silage was figured at $5 per ton and alfalfa hay at $10 per ton.

In calculating the quantity of nutrients required for gain in weight, it was assumed that the nutrients required for a pound of gain in the dairy cow would be the same as those required for a pound of gain in the beef steer. The average quantities of total digestible nutrients required for a pound of gain in steers weighing 1,020, 1,140, and 1,260 pounds, as given in Henry and Morrison's Feeds and Feeding,[2] averaged 4.3 pounds more than the quantity required for maintenance. This is the figure that has been used in the calculations. It is probable that the quantity of nutrients required for a pound of gain in a dairy cow in milk will vary widely with the individual and her condition of flesh.

MANAGEMENT OF COWS ON PASTURE

Holstein cows were used in these experiments, and they were divided into two groups as nearly alike as possible in production, weight, stage of lactation, and period of gestation. From the middle of May, the beginning of the pasture season, until the end of August the cows were on pasture day and night and received no supplemental feeds. In September they were on pasture only during the day. Each evening when they were removed from the pasture they were given a light feeding of alfalfa hay. On stormy days it was sometimes necessary to keep the cows off pasture. At such times they were fed alfalfa hay.

All cows on semiofficial test, when on pasture, received a light feeding of alfalfa hay during July and August after the flush-grass season, and during the latter part of August and September they received corn silage. No grain was fed to the cows while they were on pasture.

MANAGEMENT OF PASTURES

Each pasture was divided into two equal parts to permit alternate grazing and irrigation. Each half was grazed in periods of from one to two weeks, depending upon conditions of growth and irrigation

[2] HENRY, W. A., and MORRISON, F. B. FEEDS AND FEEDING; A HANDBOOK FOR THE STUDENT AND STOCKMAN. Ed. 18, 770 p., illus. Madison. 1923.

requirements. The lot that had been pastured was irrigated as soon as the cows were removed to the other lot. From five to eight irrigations were required during the season. As the growth of the pastures increased during the early part of the season, it was necessary to place additional cows on them. As the season advanced and the growth of grasses decreased, the number of cows on the various pastures was decreased. All pastures were harrowed in the spring to distribute evenly the manure that had been spread in the fall. The pastures that received no manure were also harrowed so that this practice would be uniform on all pastures.

DAMAGE TO PASTURE BY GRASSHOPPERS

Each season from 1921 to 1923 it was necessary to remove the cows from the pasture for a few days to apply arsenic-bran mash as a control measure. Although this practice helped to destroy many grasshoppers, the damage done by them decreased the carrying capacity of the pastures. The poison was spread after the cows were removed, and the pastures were irrigated before the cows were returned.

FINDING A GRASS MIXTURE FOR IRRIGATED PASTURES

In finding a grass mixture that would be most suitable for permanent irrigated pastures in regions having climatic conditions similar to those that prevail at the Huntley station, three grass mixtures were used [3] as shown in Table 1.

TABLE 1.—*Pasture grass mixtures used, 1918–1920*

Kind of seed used	Rate of seeding per acre of—		
	Mixture 1	Mixture 2	Mixture 3
	Pounds	*Pounds*	*Pounds*
Awnless brome grass	2	2	
Orchard grass	5	5	5
Tall fescue	3	3	3
Perennial ryegrass	3	3	
Kentucky bluegrass	4	4	4
White clover	2		2
Alsike clover	2		2
Total	21	17	16

The results obtained in this pasture experiment, 1918 to 1920, inclusive, are given in Table 2. The average length of the grazing season on mixtures 1 and 3 was 141 days, whereas on mixture 2 it was only 137 days. The average carrying capacity of mixtures 1 and 2 was at the rate of 1.75 cows per acre, and that of mixture 3 at the rate of 1.84 cows per acre. Although the average number of cows per acre did not vary greatly, the net returns showed that those pastures containing clover gave the largest income per acre. The average net returns for mixture 1, which included five grasses and two clovers, was $50.84 per acre. Mixture 2, which contained no clover, had a value of $41.58 per acre. Mixture 3, which contained the clovers but no brome grass nor perennial ryegrass, made a net

[3] This experiment was started by Dan Hansen, superintendent of the Huntley station, in 1916, and the results are given in the following publication: HANSEN, D. IRRIGATED PASTURES. Mont. Agr. Expt. Sta. Bul. 166, 26 p., illus. 1924.

return of $46.56 per acre. This experiment indicated that mixture 1 was most suitable for permanent irrigated pastures at the Huntley Field Station.

TABLE 2.—*Average yearly carrying capacity of three pasture grass mixtures, 1918–1920*

Items of comparison	Pasture grass mixture		
	No. 1	No. 2	No. 3
Length of grazing season—days	141	137	141
Total number cow days per acre—do	248	239	260
Average daily number of cows per acre	1.75	1.75	1.84
Quantity of alfalfa hay fed cows on pasture—pounds	620	628	698
Average live weight of cows—do	1,148	1,050	1,070
Total gain in weight of cows per acre—do	296	160	316
Average milk production per acre—do	3,578	3,426	2,715
Quantity milk produced per cow day per acre—do	14.4	14.3	10.4
Average per cent of butterfat in milk	3.59	3.55	3.29
Quantity feed required to furnish nutrients necessary for body maintenance, gain in weight, and milk production:			
Alfalfa hay—pounds	4,712	3,585	4,100
Corn silage—do	12,152	10,516	11,700
Total value of hay and silage per acre—dollars	53.94	44.22	50.05
Value of hay fed on pasture—do	3.10	2.64	3.49
Net value of pasture per acre—do	50.84	41.58	46.56

MAXIMUM CARRYING CAPACITY OF AN ACRE OF IRRIGATED GRASS PASTURE

In order to determine the greatest possible carrying capacity of an acre of irrigated grass pasture receiving heavy annual applications of cow manure, an experiment was started in 1919 with a 1.11-acre

FIGURE 2.—Cows on irrigated pasture at Huntley Field Station, with buildings in background

pasture that had been seeded in 1916 with mixture 1, described in Table 1. Every fall since 1917 this pasture has received a top-dressing of cow manure at the rate of 15 tons per acre. It was observed that as the season advanced the pasture growth decreased, although presumably irrigation furnished plenty of moisture at all times for growth. The pastures provided feed for more cows in June than in any other month. The increased growth of the grasses at this time may probably have been due to the cooler temperatures which then prevailed, an abundance of moisture, and sunshine. (Fig. 2.)

The pasture season of 1927 was much cooler than usual, and there was an uncommonly large amount of rainfall. These atmospheric conditions, together with supplemental irrigation, undoubtedly played a large part in the increased carrying capacity obtained during 1927.

The results of this experiment obtained during the nine years 1919 to 1927, are given in Table 3, which shows the average carrying capacity of this pasture to be 2.22 cows per acre for a pasture season of 138 days. During the nine years the carrying capacity increased from 1.98 cows per acre to 2.73 cows per acre, which represents an increase of 37.8 per cent.

The average production per acre per pasture season for the nine years was 7,041 pounds of milk containing 268.7 pounds of butterfat, and at the values given in Table 3 the net returns per acre were $59.58.

TABLE 3.—*Maximum carrying capacity of an acre of irrigated pasture, 1919–1927*

Items of comparison	1919	1920	1921	1922	1923
Length of grazing season—days	143	137	135	136	136
Cows on pasture—do	136	134	123	133	131
Cows off pasture—do	7	3	12	3	5
Total number cow-days per acre—do	283	282	270	290	329
Grazing period of cows on outside pasture—do		3	7		
Average daily number of cows per acre	1.98	2.06	2.00	2.13	2.47
Green corn fed cows on pasture—pounds			1,850		
Alfalfa hay fed cows on pasture—do	352	751	952	1,578	1,193
Alfalfa hay fed cows off pasture—do	416		270	228	269
Average weight per cow—do	1,170	1,117	1,185	1,265	1,124
Average gain or loss in weight per cow—do	59	83	60	−20	−9
Average gain or loss in weight per acre—do	118	172	181	−43	−22
Average milk production per acre—do	5,592	6,345	8,438	8,225	6,588
Average butterfat production per acre—do	191.1	304.7	330.9	307.5	265.1
Quantity of milk produced per cow-day—do	19.8	22.5	31.2	28.4	20.0
Quantity of feed necessary to furnish nutrients for body maintenance, milk production, and gain in weight:					
Alfalfa hay—pounds	4,528	5,640	5,130	5,510	4,935
Corn silage—do	13,867	14,946	14,040	13,920	14,147
Value of alfalfa hay and corn silage per acre—dollars	57.31	65.57	60.75	62.35	60.04
Value of hay fed cows on pasture—do	1.76	3.75	[1] 6.61	7.89	5.96
Net value of pasture per acre—do	55.55	61.82	54.14	54.46	54.08

Items of comparison	1924	1925	1926	1927	Average
Length of grazing season—days	139	135	143	138	138.0
Cows on pasture—do	138	135	143	138	134.5
Cows off pasture—do	1	0	0	0	3.4
Total number cow-days per acre—do	298	308	314	377	305.6
Grazing period of cows on outside pasture—do					
Average daily number of cows per acre	2.16	2.28	2.19	2.73	2.22
Green corn fed cows on pasture—pounds					
Alfalfa hay fed cows on pasture—do	1,013	834	608	801	808
Alfalfa hay fed cows off pasture—do	77	30			143.3
Average weight per cow—do	1,230	1,181	1,330	1,388	1,221
Average gain or loss in weight per cow—do	100	38	−14	82	43.2
Average gain or loss in weight per acre—do	216	41	−31	223	95.0
Average milk production per acre—do	9,736	5,384	6,885	6,180	7,041
Average butterfat production per acre—do	343.6	208.6	234.4	232.7	268.7
Quantity of milk produced per cow-day—do	32.6	17.5	21.9	10.4	23.0
Quantity of feed necessary to furnish nutrients for body maintenance, milk production, and gain in weight:					
Alfalfa hay—pounds	7,301	4,774	5,024	6,409	5,472
Corn silage—do	16,688	12,936	13,502	18,850	14,760
Value of alfalfa hay and corn silage per acre—dollars	78.22	56.21	58.87	79.16	64.27
Value of hay fed cows on pasture—do	5.06	4.17	3.04	4.00	[1] 4.69
Net value of pasture per acre—do	73.16	52.04	55.83	75.16	59.58

[1] Includes value of green corn fed cows on pasture.

MAXIMUM CARRYING CAPACITY OF AN ACRE OF IRRIGATED SWEET-CLOVER PASTURE

Sweet clover usually furnishes an abundance of pasturage during the latter half of the year it is seeded and good pasturage during the first half of the following year. In the middle of the summer of the second year the clover matures and makes seed.

To obtain information on the carrying capacity of irrigated sweet-clover pasture, in the spring of 1926 a 2.19-acre field was seeded with oats and white-flowered sweet clover. The oats were seeded at the rate of 1½ bushels per acre and the sweet clover at the rate of 16 pounds per acre. A good stand of sweet clover was obtained, but the pasture was not utilized during the fall of 1926. It was not ready any earlier the next spring than was the grass pasture. The cows were kept on the sweet clover from May 19 to September 6, except on rainy days. When they were first placed on it they did not eat the sweet clover readily nor did they prefer it to the grasses. The results obtained from this experiment are shown in Table 4.

TABLE 4.—*Maximum carrying capacity of an acre of irrigated sweet-clover pasture, 1927*

Items of comparison		1927
Length of grazing season	days	111
Cows on pasture	do	96
Cows off pasture	do	15
Total number of cow-days per acre	do	174.4
Average daily number of cows per acre		1.57
Grazing period of cows on outside pasture	days	12
Quantity alfalfa hay fed cows on pasture	pounds	94.5
Quantity alfalfa hay fed cows off pasture	do	208.2
Average weight per cow	do	1,354
Average loss in weight per cow	do	68.9
Average loss in weight per acre	do	108.2
Average milk production per acre	do	4,942.3
Average butterfat production per acre	do	197.8
Milk production per day per cow	do	28.3
Quantity feed required to furnish nutrients necessary for body maintenance, gain in weight, and milk production:		
Alfalfa hay	pounds	2,964
Corn silage	do	8,371
Total value of hay and silage per acre	dollars	35.75
Value of hay fed on pasture	do	.47
Net value of pasture per acre	do	35.28

Pasture for an average of 1.57 cows per acre was furnished for 111 days. The average weight of the cows during this time was 1,354 pounds. During the season the cows lost an average of 108.2 pounds in weight per acre. They produced during the 96 days on pasture 4,942.3 pounds of milk, containing 197.8 pounds butterfat, and at the values given in Table 4 the net returns per acre were $35.28. Neither the carrying capacity nor the returns of the sweet-clover pasture, for its second year, compare favorably with that of the grass pastures. The experiment, however, has been carried on for only a short period. Additional data may change the results given.

EFFECT OF COW MANURE AS A TOP-DRESSING FOR IRRIGATED GRASS PASTURES

In earlier experiments with pasture grasses at this station it was found that the application of manure as a top-dressing for grass pastures was very effective in increasing production. In order to determine the value of cow manure in maintaining or improving production of old pastures, a more extensive experiment was begun in 1921. The 6-acre plot used for this purpose was seeded in 1916. It

was divided into two 3-acre fields, designated as pastures A and B. These two pastures were handled in an identical manner, except that pasture A received a top-dressing of 12 tons of manure per acre, whereas pasture B received no manure. The results obtained from these two pastures are given in Table 5.

TABLE 5.—*Comparison of pastures receiving a top-dressing of manure with those receiving no manure, 1921–1926*

Items of comparison	Pasture A, manured						
	1921	1922	1923	1924	1925	1926	Average
Length of grazing season.....days	135	136	136	139	129	136	135.1
Cows on pasture.....do	130	117	124	132	129	133	127.5
Cows off pasture.....do	5	19	12	7	3	7.6	
Total number of cow-days per acre.....do	147	259	232	251	276	294	243.1
Average daily number of cows per acre.....	1.09	1.91	1.70	1.80	2.14	2.16	1.8
Alfalfa hay fed cows on pasture.....pounds	415	462	857	662	589	442	571.1
Alfalfa hay fed cows off pasture.....do	176	623	596	355	10	293.3	
Average weight per cow.....do	1,149	1,197	1,217	1,306	1,125	1,111	1,184
Average gain or loss in weight per cow.....do	65	43	−56	−28	94	108	37
Average gain or loss in weight per acre.....do	71	83	−95	−50	201	234	74
Average production of milk per acre.....do	3,109	4,558	5,356	4,307	1,472	2,606	3,568
Average production of butterfat per acre.....do	117.5	158.6	200.5	170.7	52.3	97.7	132.9
Milk production per cow-day.....do	21.1	17.6	23.1	17.2	5.3	8.9	14.7
Quantity of feed required to furnish nutrients necessary for body maintenance, milk production, and gain or loss in weight:							
Alfalfa hay.....pounds	2,369	3,755	3,828	3,263	3,583	4,263	3,513
Corn silage.....do	7,644	12,173	10,904	9,280	9,936	12,054	10,332
Value of hay and silage per acre.....dollars	30.05	49.20	46.40	39.51	42.75	51.44	43.39
Value of hay fed cows on pasture.....do	2.07	2.31	4.28	3.31	2.95	2.21	2.85
Net value of pasture per acre.....do	27.98	46.89	42.12	36.20	39.80	49.23	40.54

Items of comparison	Pasture B, not manured						
	1921	1922	1923	1924	1925	1926	Average
Length of grazing season.....days	135	136	136	139	129	136	135.1
Cows on pasture.....do	130	117	124	132	129	133	127.5
Cows off pasture.....do	5	19	12	7	3	7.6	
Total number of cow-days per acre.....do	131	225	202	189	196	215	193.0
Average daily number of cows per acre.....	0.97	1.66	1.48	1.36	1.52	1.58	1.43
Alfalfa hay fed cows on pasture.....pounds	418	345	706	436	342	318	427.5
Alfalfa hay fed cows off pasture.....do	178	519	555	247	4	250.5	
Average weight per cow.....do	1,158	1,269	1,169	1,335	1,222	1,199	1,225
Average gain or loss in weight per cow.....do	68	−71	−90	−27	85	106	12
Average gain or loss in weight per acre.....do	66	−118	−114	−36	130	168	16
Average production of milk per acre.....do	3,528	4,080	3,924	3,451	640	1,675	2,883
Average production of butterfat per acre.....do	122.9	150.2	143.9	115.8	23.6	59.8	104.2
Milk production per cow-day.....do	26.9	18.1	19.4	18.3	3.3	7.8	14.9
Quantity of feed required to furnish nutrients necessary for body maintenance, milk production, and gain or loss in weight:							
Alfalfa hay.....pounds	2,020	2,925	2,626	2,646	2,352	2,795	2,061
Corn silage.....do	6,812	8,325	6,918	7,560	7,056	9,675	7,724
Value of hay and silage per acre.....dollars	30.13	35.43	30.32	32.13	29.40	38.16	32.64
Value of hay fed cows on pasture.....do	2.09	1.73	3.53	2.18	1.71	1.59	2.14
Net value of pasture per acre.....do	28.04	33.70	26.79	29.95	27.69	36.57	30.50

During the six years of this experiment, pasture A had an average carrying capacity of 1.8 cows per acre for a grazing season of 135.1 days. The average weight of the cows was 1,184 pounds. Pasture B carried an average of 1.43 cows per acre for a grazing season of 135.1 days. The average weight of the cows on this pasture was 1,225 pounds. Pasture A, therefore, had a 25.9 per cent greater carrying capacity than pasture B. This increased carrying capacity amounted to $10.46 per acre in favor of pasture A.

Pasture A increased its capacity at a rapid and constant rate, so that by 1926 it carried an average of 2.16 cows per acre. Pasture B, although it increased its carrying capacity to some extent after 1921, carried only 1.58 cows per acre in 1926. Pasture A, therefore, had a 36.7 per cent greater carrying capacity in 1926 than pasture B. When calculated in terms of hay and silage required to provide an equivalent quantity of nutrients, the net value of pasture A in 1926 was $12.66 greater per acre than that of pasture B. On an average the cows on both pastures increased slightly in weight during the season, although the gain in weight made by the cows on pasture B was less than the gains made by the cows on pasture A.

LENGTH OF TIME THE COWS GRAZED DAILY

During the pasture season of 1927, observations were made of the number of hours that cows graze when receiving pasture alone and when receiving other feeds in addition to pasture. The observations covered two days in June and two days in August. The cows were removed from pasture each morning at 4 a. m. None of the cows were grazing at that time. They were returned to the pastures about 5 a. m., and a record was made of the time they grazed throughout the day. No record of the grazing time was made after 9 p. m. The results of these observations are shown in Table 6.

TABLE 6.—*Length of grazing time per day on different rations*

Kind of ration	Grazing period per day in—		
	June	August	Average
	Hours	*Hours*	*Hours*
Pasture alone	8.97	9.35	9.16
Pasture and alfalfa hay	6.98	6.05	6.51
Pasture and a limited grain ration	5.05	6.15	5.60
Pasture and a full grain ration	5.06	5.60	5.33

The cows on pasture alone grazed an average of 9.16 hours per day. Those receiving alfalfa in addition to the pasture grazed 29 per cent less time than the cows on pasture alone. When cows were fed pasture and a limited grain ration, consisting of 1 pound of grain for each 6 pounds of milk produced, they grazed 39 per cent less time than those on pasture alone. Cows receiving pasture and a full grain ration, consisting of 1 pound of grain to each 3 pounds of milk produced, grazed 42 per cent less time than those on pasture alone. Cows on pasture and a limited grain ration grazed 14 per cent less time than the cows on pasture and alfalfa hay, whereas the cows on pasture and a full grain ration grazed 18 per cent less time. These observations indicate that the more supplemental feeds a cow receives, the shorter will be the average grazing period per day.

EFFECT OF PASTURE ON THE BREEDING EFFICIENCY OF DAIRY COWS

A general opinion exists that cows on pasture average fewer services per conception than cows on a nonpasture ration. Conceptions at the Huntley herd have been studied to determine whether this is the case. One difficulty in obtaining conclusive results is the fact

that practically all the cows in the Huntley herd are on pasture every year. A beneficial effect from the pasture season may extend through the intervening nonpasture period to the next pasture season. To determine the possible carry-over effect of the grass, the breeding efficiency of cattle kept off pasture for a number of years should be compared with that of animals on the same feeds with pasture in addition. Unfortunately such data are not available for study at this time. In making this study, the nonpasture period was divided into two parts: The two months immediately following pasturing and the remainder of the period. Service dates of the same animals were obtained for several years. This study represents 120 conceptions that required 204 services, an average of 1.7 services per conception.

Two methods of analyzing the data obtained have been employed. One method is to consider the percentage of animals that conceived on the first service after being placed on pasture or after being removed from pasture, regardless of whether they had had previous ineffective services. The second method is to consider the percentage of animals that conceived on the first actual service while they were on pasture and after they were removed from the pasture. The two methods give different results.

Table 7 shows the number of animals and the per cent of the total number bred that conceived on the first, second, third, and fourth services in each period of feeding. Prior services under another period of feeding are not taken into consideration.

TABLE 7.—*Services required per conception in three different periods of feeding*

Period of feeding	Total number of cows	Cows conceiving at—							
		First service		Second service		Third service		Fourth service	
		Number	Per cent of total bred	Number	Per cent of total bred	Number	Per cent of total bred	Number	Per cent of total bred
Cows off pasture more than 2 months	51	30	58.8	11	21.6	8	15.7	2	3.9
Cows on pasture	40	30	75.0	7	17.5	3	7.5		
Cows off pasture 2 months or less	29	26	89.7	3	10.3				

According to Table 7, after the cows had been removed from pasture not more than two months, 89.7 per cent conceived on the first service; only 10.3 per cent required a second service; and none required a third or fourth service. Seventy-five per cent of the animals conceived on the first service after being placed on pasture, and only 58.8 per cent conceived on the first service after having been removed from pasture more than two months.

The data showed that 74 conceptions were obtained in the last six months of the year as compared with 47 in the first six months. However, there were more first services in the last half of the year than in the first half—70 as compared to 51. It was thought that possibly fresh green grass contains a vitamin that stimulates ovula-

tion in cows and that cows in need of this vitamin would not react to the feed containing it until they had been on pasture a month or six weeks; also, that the cumulative effect of such feed might continue about two months after the removal of the cows from pasture. If such were the case, it might furnish an explanation for the fact that more conceptions occurred during the last six months of the year than during the first six months. The difference, however, between the number of first services and conceptions for the latter six-month period was only 3 per cent. Apparently the majority of the animals in the herd were calving at such a time as to be bred during this period.

Table 8 shows the number of animals and the percentage of the number bred that conceived on the actual first service in each period of feeding.

TABLE 8.—*Number and percentage of cows conceiving on actual first service in different periods of feeding*

Period of feeding	First actual service	
	Number of cows	Per cent of total number bred
Cows off pasture more than 2 months	30	58.8
Cows on pasture	23	57.5
Cows off pasture 2 months or less	18	62.0

When considered on this basis, the average number of cows that conceived on first service was so close for each of the three periods of feeding as to indicate that little difference existed in the breeding efficiency of cows during the different periods of feeding. However, it is possible, as stated before, that pasturing had a beneficial effect throughout the year, since the breeding efficiency of the entire herd was good.

Of the cows with the least breeding efficiency, one cow required 6 services, of which 4 occurred before the pasture season and 2 after the season started; one cow required 5 services, 4 before the pasture season; 5 cows required 4 services, 2 having the 4 services after the pasture season ended, 2 having 1 service each before pasture, and 1 having 2 services before pasture started. Eighteen cows required 3 services before conception; of these 9 had all 3 services when off pasture. The reason for this might be the fact that the pasture season at Huntley extends over only about four and one-half months of the year. Of the remaining 9 animals, 4 had 2 services before the pasture season and conceived on the first service after pasture started; 1 had 1 service before the pasture season; 2 had 2 services during the pasture season and conceived on the first service after pasture ended; and 2 had 1 service during the pasture season and conceived on the second service after pasture ended.

Although the evidence is not conclusive, it indicates that for those cows requiring three or more services per conception pasture was beneficial.

The detailed service dates for the different periods of feeding are given in Tables 9, 10, and 11.

Of the 51 conceptions listed in Table 9, 30 occurred on the first service; 11 on the second service; 8 on the third service; and 2 on the fourth service.

TABLE 9.—*Service dates for 51 conceptions by cows that were bred and conceived more than two months after the pasture season ended*

Cow	Date removed from pasture	Service dates			
		First	Second	Third	Fourth
H-1	Oct. 3, 1919	Nov. 20, 1919	Feb. 6, 1920		
H-1	Sept. 27, 1920	Mar. 28, 1921	Apr. 23, 1921		
H-1	Sept. 30, 1921	Apr. 27, 1922			
H-2	do	Jan. 24, 1923			
H-2	Sept. 6, 1922	Feb. 28, 1923			
H-2	Sept. 30, 1925	Nov. 25, 1925	Mar. 6, 1926	May 15, 1926	
H-3	June 6, 1921	Dec. 6, 1921			
H-3	Oct. 3, 1922	Dec. 31, 1922	Mar. 27, 1923		
H-3	Sept. 30, 1924	Oct. 24, 1924	Dec. 12, 1924		
H-6	Sept. 29, 1920	Dec. 15, 1920			
H-6	Aug. 30, 1921	Feb. 4, 1922			
H-6	Sept. 30, 1922	Apr. 9, 1923			
H-6	Sept. 26, 1923	May 14, 1924			
H-9	Sept. 29, 1920	Jan. 7, 1921			
H-9	Aug. 31, 1921	Mar. 4, 1922			
H-11	None	Mar. 23, 1920			
H-12	None	Nov. 25, 1920			
H-12	June 20, 1921	May 2, 1922			
H-13	Sept. 30, 1924	Jan. 2, 1925			
H-13	Sept. 30, 1925	Mar. 11, 1926			
H-14	None.	Jan. 8, 1922	Apr. 14, 1922	Apr. 27, 1922	
H-16	Sept. 30, 1924	Mar. 12, 1925			
H-16	Sept. 16, 1925	Feb. 16, 1926			
H-17	Sept. 26, 1923	Nov. 1, 1923	Nov. 22, 1923	Jan. 26, 1924	
H-19	Sept. 30, 1925	Dec. 15, 1925			
H-19	Sept. 22, 1926	Mar. 18, 1927			
H-26	July 13, 1923	July 19, 1923	Nov. 20, 1923		
H-26	Sept. 30, 1924	Feb. 9, 1925	Mar. 16, 1925	May 11, 1925	
H-29	Sept. 30, 1925	Jan. 2, 1926			
H-31	Sept. 22, 1926	Dec. 16, 1926			
H-32	July 16, 1924	July 30, 1924	Sept. 10, 1924	Jan. 22, 1925	Feb. 12, 1925
H-33	do	Jan. 2, 1925	Feb. 2, 1925	Mar. 14, 1925	Apr. 30, 1925
H-34	do	Jan. 30, 1925			
H-36	do	Nov. 20, 1924	Jan. 21, 1925	Feb. 10, 1925	
H-37	Sept. 21, 1927	Nov. 29, 1927	Dec. 21, 1927	Jan. 31, 1928	
H-38	Sept. 22, 1926	Nov. 12, 1926	Jan. 28, 1927		
H-40	July 16, 1925	May 11, 1925	Sept. 23, 1925	Jan. 9, 1926	
H-41	do	Aug. 25, 1925	Jan. 3, 1926		
H-47	Aug. 12, 1925	Feb. 8, 1926			
H-47	Oct. 13, 1926	Apr. 12, 1927			
H-62	Aug. 21, 1927	Dec. 7, 1927			
H-208	Sept. 30, 1921	Apr. 28, 1922	May 21, 1922		
H-218	do	Jan. 22, 1922	Feb. 13, 1922		
H-218	Sept. 6, 1922	May 5, 1923			
H-59	Aug. 21, 1927	Sept. 4, 1927	Oct. 21, 1927	Dec. 24, 1927	
H-15	Sept. 26, 1923	Dec. 24, 1923			
H-16	Sept. 14, 1923	Nov. 24, 1923			
H-17	July 6, 1922	July 18, 1922	Oct. 1, 1922		
H-22	July 13, 1923	Nov. 22, 1923			
H-29	July 16, 1924	Aug. 1, 1924	Nov. 5, 1924		
H-46	May 16, 1927	Dec. 9, 1927			

TABLE 10.—*Service dates for 40 conceptions by cows that conceived while on pasture*

Cow	Pasture period		Service date	
	Beginning	Ending	Before pasture season	During pasture season
H-2	May 15, 1924	Sept. 30, 1924		May 29, 1924
				Aug. 11, 1924
				Sept. 5, 1924
H-3	May 8, 1919	Oct. 3, 1919		May 20, 1919
				July 6, 1919
H-3	May 15, 1924	Sept. 30, 1924		May 23, 1924
H-4	May 18, 1922	Oct. 3, 1924		June 6, 1922
H-4	May 14, 1923	Sept. 26, 1923		Sept. 3, 1923
H-4	May 15, 1924	Sept. 30, 1924		Sept. 1, 1924
H-9	May 10, 1923	Sept. 26, 1923		July 23, 1923
H-10	May 18, 1922	Sept. 24, 1922		July 10, 1922
H-13	do	Oct. 3, 1922		Sept. 3, 1922
H-13	May 10, 1927	Oct. 5, 1927		July 27, 1927
				Aug. 29, 1927
H-15	June 4, 1922	July 6, 1922	Feb. 2, 1922	
			Mar. 24, 1922	June 17, 1922
H-17	May 10, 1925	Sept. 30, 1925		June 8, 1925
H-17	May 3, 1926	Sept. 22, 1926		June 18, 1923
H-19	May 24, 1923	July 13, 1923	Jan. 2, 1923	
			Jan. 31, 1923	
			Feb. 22, 1923	
			Apr. 28, 1923	June 29, 1923
H-19	May 15, 1924	Sept. 30, 1924		Sept. 14, 1924
H-21	June 28, 1923	July 13, 1923	Mar. 15, 1923	
			do	July 13, 1923
H-21	May 15, 1924	Sept. 30, 1924		Sept. 23, 1924
H-23	June 30, 1923	July 13, 1923		July 7, 1923
H-23	May 15, 1924	Sept. 30, 1924		Sept. 16, 1924
H-30	May 3, 1926	Sept. 22, 1926		July 15, 1926
H-32	do	do	Apr. 6, 1926	May 17, 1926
				June 10, 1926
				Aug. 15, 1926
H-32	May 16, 1927	Sept. 21, 1927		Sept. 2, 1927
H-33	May 3, 1926	Sept. 22, 1926		July 3, 1926
				Aug. 20, 1926
H-33	May 16, 1927	Sept. 30, 1927		Aug. 27, 1927
H-34	May 3, 1926	Sept. 22, 1926	Apr. 11, 1926	May 23, 1926
				June 9, 1926
H-38	May 21, 1925	Sept. 30, 1925	Feb. 1, 1925	
			Apr. 28, 1925	Sept. 15, 1925
H-39	May 21, 1925	Aug. 17, 1925	Mar. 20, 1925	July 26, 1925
H-40	May 10, 1926	Oct. 13, 1926	Dec. 20, 1925	
			Jan. 10, 1926	
			Feb. 20, 1926	
			Mar. 13, 1926	May 16, 1926
				June 29, 1926
H-48	May 10, 1926	Oct. 13, 1926	Feb. 16, 1926	
			Mar. 9, 1926	May 28, 1926
				June 21, 1926
H-49	May 10, 1926	Oct. 13, 1926	Apr. 29, 1926	June 5, 1926
				June 24, 1926
				Aug. 20, 1926
H-52	May 10, 1926	Aug. 18, 1926		July 25, 1926
H-53	do	do		Aug. 12, 1926
H-54	May 21, 1927	Sept. 7, 1927	Mar. 1, 1927	
			Mar. 22, 1927	June 20, 1927
H-56	May 21, 1927	Sept. 7, 1927		June 3, 1927
				June 27, 1927
H-57	May 21, 1927	Sept. 7, 1927		July 31, 1927
H-204	May 18, 1922	Sept. 30, 1922	May 18, 1922	Sept. 15, 1922
H-208	May 14, 1923	Sept. 12, 1923		July 8, 1923
H-215	May 20, 1922	Sept. 30, 1922		Aug. 22, 1922
H-215	May 14, 1923	Aug. 19, 1923		July 19, 1923
H-218	May 15, 1924	Sept. 30, 1924		July 20, 1924

In Table 10, 12 of the 40 conceptions occurred while the cows were on pasture. These cows had been bred prior to the pasture season. Of these, 7 conceptions occurred on the first service after the pasture season started, 3 on the second service, and 2 on the third service. Twenty-three of the 40 conceptions occurred on the first service while the cows were on pasture, 4 occurred on the second service, and 1 required a third service.

TABLE 11.—*Service dates for 29 conceptions by cows that were bred and conceived during the first and second months after being removed from pasture*

Cow	Date removed from pasture	Service dates		
		During pasture season	After pasture season	
			First service	Second service
H-1	Sept. 26, 1923	June 30, 1923		
		Aug. 10, 1922	Oct. 25, 1923	
H-1	Sept. 22, 1924	Aug. 30, 1924	Oct. 26, 1924	
H-3	Sept. 29, 1920	Aug. 21, 1920	Nov. 1, 1920	
H-4	Sept. 30, 1925		Nov. 4, 1925	
H-9	Oct. 3, 1919	June 15, 1919		
		July 7, 1919	Nov. 23, 1919	
H-10	June 20, 1921	June 20, 1921	July 26, 1921	
H-13	Sept. 9, 1923		Nov. 22, 1923	
H-16	July 6, 1922	June 12, 1922	July 16, 1922	
H-16	July 26, 1926		Sept. 14, 1926	
H-16	Sept. 21, 1927		Oct. 27, 1927	
H-21	Sept. 27, 1925		Oct. 9, 1925	
H-22	Sept. 30, 1924	Sept. 19, 1924	Nov. 1, 1924	Nov. 22, 1924
H-23	Sept. 27, 1925		Nov. 19, 1925	
H-27	July 10, 1924		Aug. 2, 1924	
H-27	Sept. 30, 1925		Oct. 8, 1925	
H-31	July 16, 1924		Sept. 1, 1924	
H-31	Sept. 30, 1925		Nov. 16, 1925	
H-37	Aug. 16, 1925		Aug. 29, 1925	
H-37	Sept. 22, 1926		Nov. 4, 1926	
H-39	do		Oct. 23, 1926	
H-39	Sept. 21, 1927		Nov. 5, 1927	
H-49	Oct. 5, 1927		Oct. 29, 1927	
H-52	do		Oct. 23, 1927	
H-53	do		Nov. 18, 1927	
H-55	Sept. 7, 1927	June 22, 1927	Sept. 19, 1927	
H-48	Oct. 5, 1927		Oct. 9, 1927	
H-58	Sept. 7, 1927	July 27, 1927	Sept. 13, 1927	
H-218	Sept. 30, 1925	Sept. 10, 1925	Oct. 6, 1925	Nov. 19, 1925
H-218	Sept. 10, 1926		Oct. 13, 1926	Nov. 5, 1926

In 10 of the 29 conceptions listed in Table 11 the cows were first bred while still on pasture. Eighteen conceptions occurred on first service, and only three cows required a second service after being removed from pasture.

EFFECT OF PASTURE ALONE ON MAINTENANCE OF BODY WEIGHT AND MILK FLOW

To determine the effect of pasture alone on body weight and milk flow, a tabulation was made of the weights of 23 cows and the milk flow of 18 cows, kept on pasture from May 15 to September 1, a period of 16 weeks. These cows received no supplemental feeds while on pasture. Table 12 shows the average weights and milk production during this period.

TABLE 12.—*Average weights of 23 cows and average milk production of 18 cows on pasture 16 weeks*

Period	Average weight	Average milk production	Period	Average weight	Average milk production
	Pounds	*Pounds*		*Pounds*	*Pounds*
Before pasture	1,091		Ninth week	1,122	157
First week	1,096	206	Tenth week	1,113	156
Second week	1,108	211	Eleventh week	1,131	163
Third week	1,124	201	Twelfth week	1,121	165
Fourth week	1,132	196	Thirteenth week	1,134	152
Fifth week	1,134	189	Fourteenth week	1,121	141
Sixth week	1,132	181	Fifteenth week	1,133	144
Seventh week	1,131	175	Sixteenth week	1,148	137
Eighth week	1,131	165			

Table 12 shows that the 23 cows maintained a remarkably uniform weight throughout the 16 weeks. In the case of the 18 cows, the decline in milk flow up to the twelfth week was perhaps no more rapid than was to be expected with an advance of 12 weeks in lactation. The production of the twelfth week was 80 per cent of that of the first week. During the last four weeks, however, the decline in milk flow was more rapid, probably due to a large extent to the slower growth of the grass as shown by the weight of grass clipped at regular intervals throughout the season from a fenced area of the pasture. Heat and flies and the fact that some of these cows were far advanced in their lactation period probably were contributing causes.

FEEDING EXPERIMENTS

The following feeding experiments have been conducted: (1) The effect of three planes of feeding on milk production; (2) the effect of sunflower silage on milk production; and (3) the effect of sprouted oats on breeding troubles.

THREE PLANES OF FEEDING

The following experiment was conducted to compare the effect of three planes of feeding on milk production and on the economy of production: (1) Cows were fed roughage, consisting of alfalfa hay, corn silage, roots, and irrigated tame-grass pasture, and 1 pound of a standard grain mixture for each 3 pounds of milk produced daily (full grain ration); (2) the same cows were fed the same kinds of roughages with 1 pound of grain mixture to each 6 pounds of milk produced (limited grain ration); and (3) the same cows were fed the above roughages but received no grain (roughage ration). The records were for 365 days and were all made under the semiofficial test regulations of the Holstein-Friesian Association of America. Ten cows have completed yearly records on the three rations.

The records in this experiment were not made concurrently. When a cow freshened she was started on one of the rations. If she had completed a year's record on limited grain, at the next freshening she was put on the full grain or on the roughage ration, and so on until she had completed records on the three different planes of feeding.

In conformity with the plan followed in the breeding projects of this bureau, all cows are given an official test on a full grain ration and milked three times a day throughout the year. The production record thus made is used in the inheritance studies as the animal's producing capacity. In the field station herds this record is obtained when possible when the animal is 2 years old, in order to make more certain the obtaining of the record while the animal is physically sound. Then, too, if the record is delayed it may not be obtained at all on account of death or injury to the animal. This record has been used in the three planes of feeding experiment as the full-grain phase.

In view of the above practice the record on full grain was usually obtained before the records on roughage and limited grain. Since the record on full grain was made by cows milked three times a day, the cows making records on limited grain and roughage were also milked three times a day in order to make all the records comparable.

Table 13 gives the production records, the feed consumption, and other data for the 10 cows on each of the three phases of the experiment.

TABLE 13.—*Comparison of the effect of three planes of feeding on 10 cows*

ROUGHAGE

Cow	Milk production	Butterfat production		Grain	Alfalfa hay	Silage	Beet pulp	Beets	Pasture	Age		Average weight	Gain or loss in weight	Dry period prior to test	Grain fed while dry	Period carrying calf	Cost of feed exclusive of pasture [1]	Cost of feed including pasture [2]	Value of butterfat and skimmilk	Returns over cost of feed
		Per cent	Pounds							Years	Months									
	Pounds			*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Days*			*Lbs.*	*Lbs.*	*Days*	*Lbs.*	*Days*				
H–1	12,401.4	3.92	486.26	.....	7,615	7,798	.....	2,745	128	6	8	1,317.5	1	218	None.	233	$85.79	$91.39	$257.95	$166.56
H–2	14,949.2	3.34	499.24	.....	6,165	9,735	.....	1,010	138	5	4	1,112.5	6	25	34	96	58.20	85.80	273.75	187.95
H–3	13,037.3	3.87	388.43	.....	5,012	12,413	.....	660	139	6	7	1,165.0	89	86	56	178	58.09	85.89	206.62	120.73
H–4	9,320.4	3.88	362.45	.....	5,037	13,099	.....	395	137	4	2	1,252.8	95	18	None.	194	59.11	85.11	192.66	107.55
H–6	10,094.9	4.54	459.10	.....	4,784	12,147	320	1,970	132½	4	5	1,022.6	−52	36	344	231	65.50	92.30	237.13	144.83
H–9	11,066.4	3.58	396.48	.....	4,904	11,252	320	1,970	132½	4	7	1,243.7	24	84	45	229	64.46	90.96	214.18	123.22
H–13	15,380.8	3.15	484.34	.....	6,058	10,590	.....	1,590	140	7	9	1,265.8	37	52	None.	119	61.56	89.56	269.09	179.53
H–19	10,755.1	3.28	549.40	.....	6,792	10,582	.....	1,085	140	5	1	1,291.7	102	54	None.	202	63.66	91.66	302.47	210.81
H–211	15,122.1	3.23	488.51	.....	8,715	10,956	8	2,030	123	7	0	1,233.3	−12	148	840	239	77.20	101.80	269.85	168.05
H–218	17,815.3	2.95	526.83	.....	8,616	13,764	.....	.....	115	11	6	1,497.7	12	57	None.	30	77.49	100.49	297.04	196.55
Average (actual)	13,295.2	3.49	464.11	.....	6,376	11,234	65	1,345	132	6	4	1,240.2	30	78	132	175	65.13	91.49	252.07	160.58
Average (calculated to maturity)	13,656.5	.....	478.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

LIMITED GRAIN

H–1	17,031.2	3.67	626.06	2,794	5,993	12,692	.....	780	124½	8	11	1,466.9	64	54	168	112	$108.73	$128.63	$336.43	$207.80
H–2	18,146.0	3.29	596.89	2,945	6,601	10,536	.....	.....	149	6	11	1,198.0	43	64	188	46	106.46	130.30	329.19	198.89
H–3	14,762.0	3.97	586.05	2,399	5,076	13,541	.....	1,010	138	7	11	1,288.9	51	98	56	148	100.64	122.72	310.21	187.49
H–4	14,887.6	3.57	531.30	2,419	6,931	9,866	.....	.....	151	6	5	1,411.6	60	50	None.	222	98.03	122.19	287.25	165.06
H–6	13,324.2	4.38	584.60	2,138	4,918	12,753	.....	750	125½	5	7	1,070.6	180	46	None.	226	92.93	113.01	303.83	190.82
H–9	12,950.8	3.64	471.88	2,117	5,064	12,717	.....	750	125½	5	9	1,357.3	152	49	194	152	93.23	113.31	254.06	140.75
H–13	16,486.0	3.78	623.27	3,035	7,683	10,804	.....	.....	143	6	7	1,315.8	91	41	52	223	113.99	136.87	333.06	196.19
H–19	17,754.6	3.15	559.18	2,877	6,804	10,330	.....	.....	151	3	10	1,308.7	170	51	140	205	105.87	130.03	310.67	180.64
H–211	17,831.2	3.13	558.27	2,880	5,204	13,369	20	750	135½	8	2	1,284.0	135	38	None.	.....	108.12	129.80	310.57	180.77
H–218	20,892.4	3.00	627.08	3,495	5,511	14,160	.....	1,230	138	10	3	1,604.7	132	58	310	211	122.57	144.65	352.32	207.67
Average (actual)	16,407.2	3.51	576.45	2,710	5,978	12,076	2	527	138	7	0	1,330.6	108	55	111	155	105.06	127.15	312.76	185.61
Average (calculated to maturity)	16,648.6	.....	584.1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

FULL GRAIN

H-1	15,120.2	3.45	523.23	5,830	9,509	6,205	.....	4,905	70	5	1	1,457.1	205	43	None.	55	$171.49	$179.19	$284.75	$105.56
H-2	14,877.1	3.31	496.82	4,874	4,325	8,857	327	1,070	132½	3	1	1,054.5	82	.....	.....	221	133.37	147.94	272.43	124.49
H-3	14,110.9	3.90	550.68	5,140	8,708	7,031	.....	2,885	130	4	2	1,172.3	183	87	502	171	153.90	168.20	292.45	124.19
H-4	12,895.9	3.68	471.59	4,884	4,694	8,281	782	.....	135	3	1	1,236.0	204	.....	.....	204	135.99	156.84	253.33	102.49
H-6	12,721.7	4.17	530.60	4,613	7,589	6,832	.....	2,905	97	3	4	1,045.9	140	146	302	238	137.55	148.22	278.28	130.06
H-9	12,873.6	3.71	477.92	4,529	8,629	6,937	348	2,870	125	3	5	1,304.0	333	161	168	236	147.04	161.39	256.32	94.93
H-13	14,863.8	3.32	493.91	5,274	4,676	8,321	862	160	135½	2	9	1,119.1	189	.....	.....	169	144.13	159.03	263.13	104.10
H-19	16,887.8	3.24	547.18	4,566	4,923	10,158	.....	660	138	2	5	1,199.8	117	.....	.....	214	125.03	140.21	302.06	161.85
H-211	20,345.9	3.14	638.53	6,261	10,414	7,915	.....	4,625	109	5	6	1,235.3	89	60	104	105	185.91	197.90	355.03	157.13
H-218	23,317.0	3.06	713.82	6,985	4,203	13,870	122	1,598	125½	9	1	1,552.6	169	65	696	211	169.58	183.38	399.19	215.81
Average (actual)	15,793.3	3.45	544.43	5,266	6,782	8,501	241	2,258	120	4	2	1,237.7	189	56	186	188	150.46	163.64	295.70	132.06
Average (calculated to maturity)	17,851.5	.....	619.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[1] Computed on the following values per ton: Grain $32; alfalfa hay $10; silage $5; dried beet pulp $35; beets $6.
[2] Cost of pasture: On roughage alone 20 cents per day; on limited grain, 16 cents; on full grain, 11 cents.
[3] Computed on the following values: Butterfat, at 44 cents per pound; skim milk, 40 cents per 100 pounds.

40460°—29——3

Table 13 shows that good results were obtained from the feeding of roughage alone. Two cows produced more than 500 pounds of butterfat each without receiving any grain throughout the year. The cows on the limited grain ration also gave good returns, averaging 16,407 pounds of milk and 576 pounds of butterfat.

In considering these results, three possible sources of error should be taken into account. One is that largely because of the need of obtaining records under the most favorable conditions for the hereditary studies, most of the first records were made on the full-grain ration, only three of the animals being mature when these records were made. No attempt was made to correct the records for age because of the impossibility of making the same correction for feed consumption with any degree of accuracy. Consequently, the records made of animals on roughage and limited grain have the advantage of the greater age of the animals and of any development that may have taken place. Then, too, there is the possibility of a carry-over effect from the full grain ration on the records made when the animals were on roughage.

To determine the extent of the error, the records of the cows lately started on this experiment are made in a different order. One heifer 2 years 7 months of age at the beginning of the experiment recently finished her first lactation year on a limited grain ration. She consumed 2,345 pounds of grain mixture, 5,896 pounds of alfalfa hay, 9,794 pounds of corn silage, and was on pasture 136 days. Her average weight for the year was 1,153 pounds. She produced 14,711 pounds of milk and 477.54 pounds of butterfat, the equivalent of 596 pounds of butterfat when correction was made for age. This record compares favorably with the average of 576 pounds of butterfat made by the 10 mature cows on the limited grain ration.

The second source of error is the possibility of a carry-over effect from the full-grain ration on the records made when the animals were on roughage. To determine the extent of this error, a study was made of the records of three cows on the roughage ration that either preceded a full grain ration or followed a limited grain ration. The results are shown in Table 14.

TABLE 14.—*Production and feed consumption of three cows on a roughage ration which either preceded a full grain ration or followed a limited grain ration*

Cow	Ration	Age		Weight	Production		Feed consumption				
		Years	Months		Milk	Butterfat	Pasture	Grain	Hay	Silage	Beets
				Pounds	*Pounds*	*Pounds*	*Days*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
H-19	Full grain	2	5	1,200	16,887	547	138	4,566	4,923	10,158	660
	Limited grain	3	10	1,309	17,754	559	151	2,877	6,804	10,330	
	Roughage	5	1	1,292	16,755	540	149		6,790	10,439	1,035
218	do	7	7	1,410	14,926	453	127		5,028	14,271	1,984
	Full grain	9	1	1,552	23,717	713	125	6,657	4,203	13,585	1,593
	Limited grain	10	3	1,604	20,802	627	135	3,384	5,752	14,825	1,230
	Roughage	11	5	1,498	17,815	526	115		8,616	13,764	
204	do	8	3	1,236	14,210	470	140		9,078	8,085	
	Full grain	9	11	1,424	25,409	823	130	7,725	10,068	8,535	4,725

It will be noted that the record made by cow H–19 while on roughage was practically the same as her record made when 2 years of age on full grain. She had an average weight of 1,200 pounds during her first lactation period; this is somewhat greater than the average of 2-year-olds. Her average weight at 5 years of age, when on the roughage ration, was only 92 pounds greater than her average weight as a 2-year-old. This represents an increase of only 8 per cent, which is considerably less than the usual increase in body weight between these two ages. Her average weight when 5 years of age was practically the same as it was when she was on the limited grain ration, which was started when she was 3 years 10 months old. Evidently she was just about able to maintain her weight on roughage and probably did not make the usual gain on limited grain.

The records of cow 218 are of exceptional interest because 2 were made on roughage, 1 prior to a record on full grain and 1 following a record on limited grain, and because all 4 records were made after the age of 7 years 7 months. The last record of this cow is the second largest record made on roughage at Huntley.

Although cow H–19 consumed approximately the same quantity of hay and silage on limited grain and roughage rations, cow 218 consumed 2,864 pounds more alfalfa hay on the roughage ration than on the limited grain ration. This difference partially made up for the loss of the 3,364 pounds of grain and the 1,230 pounds of beets she had had on the previous limited grain ration. Her last record made on roughage is the more remarkable because she was 11 years 5 months of age when the record started. During the period of these four records she was quite a regular breeder. She was not bred at any time until five months after freshening in order to give her time for a dry period after the year's record was completed. Cow H–19 made the largest butterfat record on roughage that has been made at Huntley, and that record was made following a record on limited grain.

Cow 204 had no limited grain ration; her first record was made on the roughage ration.

From the fact that the two highest records on roughage alone were made following records on a limited grain ration, it is probable that the carry-over effect of a prior full grain ration was not the cause for the good showing of the group while on the roughage ration.

The third possible source of error in interpreting the data in Table 14 is that the nutrients obtained from pasture are not included. There is no accurate method of determining the quantity of grass that an individual cow will consume. The report given on page 9 shows that the cows on limited grain and on full grain grazed from 14 to 18 per cent less time than did those receiving only roughage. In order to determine whether the cows on the roughage ration obtained more nutrients from pasture than did the cows on the other rations, a compilation was made of the milk and butterfat production and the feed consumption of the 10 cows on the different rations during the months in which they received no pasture. These data are given in Table 15.

TABLE 15.—*Production and feed consumption of 10 cows on three planes of feeding when not on pasture*

ROUGHAGE RATION

Cow	Days on ration	Production		Grain mixture	Alfalfa hay	Corn silage	Dried beet pulp	Beets	Average weight	Gain or loss in weight	Total digestible nutrients			
		Milk	Butterfat								Consumed	Required	Excess or deficiency	
	No.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*P. ct.*
H–1	212	7,472	313.5	None.	5,362	6,840		2,745	1,323	−217	4,619	4,728	−109	−2.3
H–2	212	8,998	302.3	None.	4,800	8,001		1,010	1,101	−62	4,034	4,560	−526	−11.5
H–3	152	5,206	194.1	None.	3,283	9,030		660	1,167	108	3,544	3,330	214	6.4
H–4	212	4,791	178.8	None.	3,676	11,531		395	1,300	111	3,993	3,596	397	11.0
H–6	212	6,637	300.2	None.	3,718	9,972	252	1,970	1,008	−70	4,139	4,211	−72	−1.7
H–9	192	7,067	262.3	None.	3,505	9,251	252	1,970	1,207	−175	3,902	4,122	−220	−5.3
H–13	159	7,300	231.1	None.	3,279	5,736		705	1,265	−46	2,806	3,579	−773	−21.5
H–19	212	10,807	353.6	None.	5,347	8,067		1,035	1,208	42	4,338	5,241	−903	−17.2
H–21	212	8,545	286.2	None.	4,741	9,842	8	2,030	1,274	−68	4,476	4,605	−129	−2.8
H–18	212	8,639	246.5	None.	5,949	9,505			1,482	153	4,752	4,585	167	3.6
Average	201	7,600	266.9		4,416	8,867	51	1,257	1,240	−22	4,060	4,255	−195	−4.6

LIMITED GRAIN RATION

H–1	212	9,197	348.9	1,515	4,145	11,032		780	1,476	57	5,333	5,270	57	1.1
H–2	212	9,765	319.0	1,625	4,747	7,254			1,203	60	4,048	4,868	80	1.6
H–3	212	8,358	342.6	1,349	4,036	9,771		1,010	1,280	38	4,902	4,955	7	.14
H–4	212	7,810	271.3	1,273	5,373	6,360			1,408	165	4,850	4,588	262	5.7
H–6	212	7,938	369.4	1,274	3,476	11,181		750	1,072	97	4,830	4,829	1	.02
H–9	212	7,612	294.3	1,234	3,554	11,175		750	1,302	159	4,839	4,653	186	4.0
H–13	192	10,960	302.8	1,804	5,285	6,780			1,295	−42	5,276	5,149	127	2.5
H–19	212	9,826	312.3	1,615	5,101	7,168			1,206	120	5,098	4,913	185	3.8
H–21	188	7,482	259.0	1,259	3,420	9,990	14	750	1,325	116	4,590	4,195	395	9.4
H–18	212	10,935	334.3	1,841	4,261	8,235		1,230	1,607	120	5,382	5,475	−93	−1.7
Average	207	9,028	321.4	1,479	4,340	8,989	1.4	527	1,333	90	5,011	4,809	121	2.4
Average[1]	201	8,708	312.1	1,436	4,214	8,728	1.3	512	1,333	87	4,866	4,748	117	

FULL GRAIN RATION

H–1	212	7,661	270.9	2,968	5,954	5,080		3,810	1,500	95	6,725	4,660	2,065	44.3
H–2	212	9,225	306.8	3,606	3,082	7,207	223	1,970	1,041	4	5,617	4,549	1,068	23.4
H–3	212	7,267	305.6	2,615	5,043	6,566		2,905	1,208	−14	6,127	4,533	1,594	35.1
H–4	181	5,475	208.3	2,124	3,164	5,370	576		1,203	181	4,252	3,548	704	19.8
H–6	212	8,724	305.2	2,981	5,119	6,707		2,905	1,027	107	6,481	4,834	1,647	34.1
H–9	212	8,463	312.5	2,981	5,521	6,602		2,870	1,202	201	6,664	4,770	1,894	39.7
H–13	153	6,650	231.9	2,282	2,778	4,870	598	160	1,122	134	4,452	3,503	949	27.1
H–19	212	9,117	295.4	2,621	3,696	7,214		660	1,226	97	5,236	4,682	554	11.8
H–21	182	10,308	336.3	3,192	5,535	6,215		3,530	1,237	46	6,838	4,775	2,063	43.2
H–18	212	14,091	455.8	4,578	3,009	12,256	80	1,598	1,535	210	7,431	6,461	970	15.0
Average	201	8,686	308.8	2,943	4,290	6,826	148	2,041	1,246	106	5,982	4,631	1,351	29.2

[1] This average, calculated to a 201-day basis from the actual average for the 207 days, is inserted to show a direct comparison of the results obtained from all 3 rations on a 201-day basis.

Table 15 brings out some very interesting points. When on a roughage ration with no pasture, the 10 cows failed by a small margin to consume sufficient nutrients to meet their requirements. They also lost in weight an average of 23 pounds. Only 4 of the 10 cows gained in weight. It is rather remarkable that the quantity of milk and butterfat produced, the loss or gain in body weight, and the excess or deficiency in total digestible nutrients over the requirements do not bear a closer relationship. For example, cow H–19, the largest butterfat producer on the roughage ration, gained 42 pounds in weight and failed by 17.2 per cent to consume sufficient nutrients to meet her requirements; whereas cow H–1, the second-highest

producer, lost 217 pounds and failed by only 2.3 per cent to consume sufficient nutrients.

The cows on the limited grain ration gained an average weight of 90 pounds and consumed an average excess of only 2 4 per cent of nutrients over requirements. Only 1 cow, H–13, lost in weight, and this cow consumed an excess of nutrients over her requirements. Only 1 cow of the 10 failed to consume sufficient nutrients. The cows on this ration appear to have consumed sufficient nutrients to gain a little weight and to produce well up toward their capacity.

The cows on the full grain ration did not make much larger gains in body weight than did the cows on the limited grain ration. It appears that they wasted feed, the excess of nutrients consumed over their requirements for body maintenance and milk production amounting to 29 per cent.

The total digestible nutrients consumed over maintenance by the three groups in the 201 days per 1,000 pounds of milk, are as follows: Full grain ration, 476 pounds; limited grain ration, 335 pounds; and roughage ration, 292 pounds. The income per cow over cost of feed was $72.77 for the full grain; $101.38 for the limited grain; and $95.90 for the roughage ration. The amount of dry matter consumed per pound of butterfat produced was as follows: Full grain, 28.4 pounds; limited grain, 24.1 pounds; and roughage, 24.6 pounds.

The production of these 10 cows on the three different planes of feeding in the months in which they received no pasture was nearly the same as it was in the remainder of the year, when pasturage made up the greater part of their roughage. The number of days in the months in which they received no pasturage averaged 201, which is 55 per cent of the entire year. During these nonpasture months the cows when on full grain produced 56 per cent of their total yield for the entire year; on the limited grain they produced 54 per cent; and on the roughage ration they produced 57 per cent. This indicates that on the average the cows when on the three different planes of feeding produced at about the same rate on pasture as on hay and silage. When the cost of feeds and the returns for butterfat and skim milk were calculated at the Huntley prices, the cows were the most profitable when on the limited grain ration. However, there was only a narrow margin of profit between the limited grain ration and the ration of roughage alone. The cows on full grain were the least profitable. In localities where high prices are received for whole milk and sweet cream, the same ratio of profit between the three rations would probably not prevail.

The important point brought out by this investigation is that where roughages of the right quality are available, cows of more than average producing ability have sufficient capacity to consume enough nutrients from roughage alone to meet their requirements; and where cows are allowed all the roughage they will consume and grain at the rate of 1 pound to each 3 pounds of milk produced, nutrients greatly in excess of their requirements will be consumed and wasted.

The criticism may be made that the data given are obtained from too small a number of cows to make them significant. Table 16 gives the average production of all cows at Huntley that have completed one or more records on these three planes of feeding. The last column shows the butterfat production calculated to maturity.

TABLE 16.—*Average production of cows that have completed records on one or more planes of feeding*

Cows	Ration	Milk production	Butterfat production	Age		Butterfat production calculated to maturity
				Years	Months	
Number		*Pounds*	*Pounds*			*Pounds*
42	Full grain	14,868.1	519.08	3	8	613.4
13	Limited grain	16,200.5	556.66	6	1	588.9
15	Roughage	13,032.8	452.88	6	5	465.3

The averages for all cows that have completed records on one or more planes are somewhat lower than those of the 10 cows that have completed records on all three planes of feeding. (Table 13.) On the full grain ration the difference between the average butterfat production of the 42 cows and that of the 10 cows is 25 pounds; on the limited grain ration the difference between the butterfat production of the 13 cows and the 10 cows is 9.6 pounds; and on the roughage ration the difference between the average butterfat production of the 15 cows and the 10 cows is 11 pounds. The averages for the larger number of cows are somewhat more favorable to the limited grain and roughage rations than are the averages for the 10 cows.

SUNFLOWER-SILAGE EXPERIMENT

The Montana Agricultural Experiment Station at Bozeman, Mont., found in 1916–17 that 3.75 pounds of sunflower silage was equal in feeding value to 1 pound of choice alfalfa hay. In 1917–18 it found that 2.83 pounds of sunflower silage was equal in feeding value to 1 pound of alfalfa hay when fed to cows receiving grain and a limited hay ration.

An experiment was started at the Huntley Field Station to determine the relative feeding value of sunflower silage and corn silage for milk and butterfat production. This experiment was conducted with eight cows. These cows were divided into two groups as nearly alike as possible in age, milk production, and stage of lactation. Over three periods of 40 days each, they were fed approximately 2 pounds of hay for each 100 pounds of live weight and as much sunflower silage during one period and corn silage during the next period as they would consume and still clean up practically all the hay fed to them, the two groups being alternately fed the sunflower silage.

The hay was of good-quality alfalfa of second and third cutting. The corn silage was of good quality, made from corn that produced 50 bushels of grain per acre. The sunflowers were harvested when one-fourth to one-half in bloom, with a few mature heads, and having a green weight of 29 tons per acre. This silage was of a dark color and of a rather strong odor and flavor, rendering it very unpalatable. Chemical analysis made by the Montana station showed that the sunflowers grown at the Huntley station were lower in sugar and of a higher protein content than sunflowers grown at Bozeman. This difference in composition permitted a putrefactive protein decomposition and the formation of large quantities of butyric acid. Because of the unpalatable nature of the sunflower silage the cows would not eat it readily, the average consumption being 13.4 pounds per cow per day less than that of the corn silage.

During each period of sunflower feeding the cows consumed an average of 1,640.4 pounds sunflower silage and 1,839.2 pounds alfalfa hay. They produced 1,635.4 pounds milk containing 60.9 pounds butterfat. They lost on an average 73.4 pounds. When the same cows were fed corn silage and alfalfa hay they consumed 2,845.8 pounds corn silage and 1,829.2 pounds alfalfa hay and produced 2,187.8 pounds milk containing 75.06 pounds butterfat. They gained on an average 31 pounds. The cows consumed 1,205.4 pounds more corn silage than sunflower silage. When fed corn silage they consumed 10 pounds less hay but produced 552.4 pounds more milk and 14.16 pounds more butterfat.

The results of this experiment indicate that for milk and butterfat production corn silage is superior to the sunflower silage produced at the Huntley Field Station. This may be due partly to a difference in composition of the locally grown sunflowers and those grown elsewhere, resulting in a less palatable silage.

EFFECT OF FEEDING SPROUTED OATS ON BREEDING TROUBLES

Some difficulty has been experienced at the Huntley station in getting first-calf heifers to conceive. These heifers had been on pasture only about two months during their first two years, though this may not have been the cause of their difficulty in breeding. On account of favorable results obtained in experiments conducted by the bureau at its Beltsville station in the feeding of sprouted oats to overcome some forms of sterility, germinated or sprouted oats were fed to the Huntley heifers. Tables 17, 18, and 19 give data that have been obtained on three heifers and on two cows in regard to overcoming difficulty in breeding.

TABLE 17.—*Results of feeding sprouted oats to three heifers with breeding difficulty*

Item of comparison	Heifer		
	43	44	51
Number services before sprouted-oats feeding	5	9	4
Number months from first to last service	11	12	10
Age when first served, months	20	20	20
Number days sprouted oats were fed before conception	15	19	37
Number services after sprouted-oats feeding	1	1	1

TABLE 18.—*Results of feeding sprouted oats to two cows with breeding difficulty*

Item of comparison	Cow	
	20	34
Number calves prior to sprouted-oats feeding	2	2
Number services since last calf	3	2
Number months since last calf	10	5
Number days sprouted oats were fed before conception	23	24
Number services after sprouted-oats feeding	1	1

It will be noted that the three heifers conceived on the first service following sprouted-oats feeding after having been previously bred from four to nine times without success. Table 19 shows the date of first service, the date that feeding of oats was started, and the date of conception for the three heifers and two cows.

TABLE 19.—*Dates of first service, start of sprouted oats feeding, and conception of three heifers and two cows*

Animal	Date of first service	Date of start of sprouted oats feeding	Date of conception
Heifer:			
H–43	Dec. 30, 1925	Nov. 2, 1926	Nov. 17, 1926
H–44	Jan. 3, 1926	Dec. 20, 1926	Jan. 7, 1927
H–51	May 24, 1926	Feb. 27, 1927	Apr. 5, 1927
Cow:			
H–34	July 14, 1927	Aug. 7, 1927	Aug. 30, 1927
H–26 [1]	Aug. 14, 1926	Dec. 23, 1926	Jan. 14, 1927

[1] This cow was in heat more or less continuously until December 22, 1926.

Several of the farmers that are cooperating with the Huntley station have been successful in overcoming sterility in cows in their herds by feeding sprouted oats.

FACTORS INFLUENCING VARIATION IN WEIGHT OF DAIRY COWS AND CALVES

Studies have been made at this station of the changes in weight of dairy cows during pregnancy, during the three months following calving, and immediately preceding and immediately following calving; the relation between size and age of dam and size of calf; and growth of Holstein-Friesian heifers from birth to 2 years of age.

CHANGES IN WEIGHT OF COWS DURING PREGNANCY

To determine the influence of pregnancy upon the weight of cows in the Huntley herd, 53 cows were weighed on the date of service and for two consecutive days of each month after conception until the calf was dropped. They were also weighed for seven days previous to calving, on the day of calving, and on the day after calving.

Table 20 gives the average weights of the cows at different periods. The average age of these cows was 5 years 3 months. The average weight of the calves at birth was 97 pounds.

TABLE 20.—*Average weight of 53 cows during pregnancy*

Item	Weight on date of service	Weight at stated months during pregnancy—									Weight at time of calving	Weight one day after calving
		1	2	3	4	5	6	7	8	9		
Average weight, pounds	1,150	1,162	1,177	1,201	1,224	1,263	1,295	1,335	1,381	1,423	1,435	1,280
Average increase over weight at time of service, pounds		12	27	51	74	113	145	185	231	273	285	
Per cent increase over weight at time of service		1.04	2.34	4.43	6.43	9.83	12.61	16.08	20.08	23.73	24.78	
Per cent increase over previous month			1.29	2.04	1.91	3.18	2.53	3.09	3.44	3.04		

The total average increase in weight from the date of service to the date of calving was 285 pounds, of which 130 pounds was due to the increase in body weight as indicated by the difference in the average weight on the date after calving and the weight on the date of service. The difference between 285 pounds and 130 pounds, or 155 pounds, covers the weight of the calf, the placental membranes, and the amniotic fluids. Since the average weight of the calves was 97 pounds, the weight of the placenta and amniotic fluid was 58 pounds. In

the case of a Jersey cow slaughtered by Eckles [4] just previous to parturition, the amniotic fluid weighed 32.7 pounds and the placenta 18.3 pounds, a total of 51 pounds. The calculated weight of 58 pounds as the average weight of placenta and amniotic fluid from the 53 Holstein-Friesian cows in this study agrees quite closely with the actual weight obtained by Eckles when the difference in size of the two breeds is considered.

With 58 pounds as the weight of the amniotic fluid and placenta and 97 pounds as the average weight of the calves, the ratio of the weight of the amniotic fluid and placenta to the weight of the fetus at the end of gestation is 1 to 1.67.

Table 20 shows the average increase in weights of these 53 cows during each month of pregnancy. It would be interesting to know what part of this increase in weight is due at the various stages of pregnancy to the weight of the fetus, the placenta, and the amniotic fluid.

Zangemeister [5] has compiled the actual weights of the human fetus for each month of its prenatal growth. Assuming that since the period of gestation for persons and cattle is the same the relative rate of growth of the human fetus and the bovine fetus would be the same, Hervey,[6] by the use of Zangemeister's figures, has calculated the weight of the bovine fetus by months from the average birth weight of the various breeds. His weights for the fetus of the Holstein-Friesian breed are given in Table 21.

TABLE 21.—*Weight of Holstein-Friesian fetus, by months*

Month	Weight	Month	Weight	Month	Weight
	Pounds		*Pounds*		*Pounds*
1	0.041	4	4.783	7	42.612
2	.136	5	16.208	8	64.238
3	1.117	6	29.666	9	97.201

If these figures are correct, 70 per cent of the total growth of the fetus, as expressed by weight, is attained in the last one-third of the gestation period. A few actual weights of fetuses have been obtained at the Beltsville station, and although they are too few in number to offer any conclusive evidence, those for the early months of gestation are even less than the weights given in Table 21.

It is probable that in the early months of gestation the amniotic fluid is heavier than the fetus. Weights of the amniotic fluid have been obtained in two cases at the Beltsville station. In the first case a Jersey cow was killed on the ninety-second day after conception, and the following weights were obtained:

Fetus	pounds	0.31
Fetal membranes	do	0.31
Amniotic fluid	do	2.19

In the second case a Holstein-Friesian cow was killed seven and one-half months after conception. The fetus was malformed and probably had not attained a normal growth. The weight of the fetus was 28.75 pounds and that of the amniotic fluid 27.25 pounds.

[4] ECKLES, C. H. THE NORMAL GROWTH OF DAIRY CATTLE. Mo. Agr. Exp. Sta. Research Bul. 36, 20 p., illus. 1920.

[5] ZANGEMEISTER, W. DIE ALTERSBESTIMMUNG DES FÖTUS NACHGRAPHISCHER METHODE. Ztschr. Geburtsh. u. Gynaekol. 69: 1-40. 1911.

[6] HERVEY, G. W. GROWTH IN DAIRY CATTLE. (Unpublished manuscript.)

These figures indicate that in these 53 cows very little of the increase in weight in the first half of the gestation period was due to the weight of the fetus, fetal membrane, and amniotic fluid.

CHANGES IN WEIGHT DURING THE FIRST THREE MONTHS AFTER CALVING

To determine the changes in weight for the first three months after calving, 59 cows were weighed two days each week for 13 weeks. The results are shown in Table 22.

TABLE 22.—*Changes in weight of cows during the first three months after calving*

Period	Average weight	Increase or decrease	Period	Average weight	Increase or decrease
	Pounds	*Pounds*		*Pounds*	*Pounds*
Weight before calving	1,438		Seventh week	1,210	+2
Weight first day after calving [1]	1,278		Eighth week	1,214	+4
First week	1,241	−37	Ninth week	1,212	−2
Second week	1,221	−20	Tenth week	1,218	+6
Third week	1,211	−20	Eleventh week	1,220	+2
Fourth week	1,216	+5	Twelfth week	1,219	−1
Fifth week	1,205	−11	Thirteenth week	1,222	+3
Sixth week	1,208	+3			

[1] The average weight of the 59 calves at birth was 95.2 pounds.

These data show that the cows lost body weight until the end of the fifth week after calving. After that time there was very little change in body weight. The greatest loss in weight occurred during the first week after calving.

CHANGES IN WEIGHT OF COWS IMMEDIATELY BEFORE AND AFTER CALVING, AND RELATION OF SIZE OF DAMS TO WEIGHT OF CALVES

The changes in weights, immediately preceding and immediately following calving, of 79 cows grouped according to their ages are shown in Table 23. The average weights of the calves for each group are also shown.

TABLE 23.—*Changes in weight immediately before and after calving of cows grouped according to age, also the average weights of calves from these groups*

Item	Days	Average weight of cows of stated ages					
		2 years	3 years	4 years	5 years	6 years and over	Average
		Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Before calving	10	1,341.2	1,385.1	1,452.4	1,490.7	1,546.4	1,444.8
	9	1,339.7	1,389.8	1,459.0	1,493.7	1,553.9	1,447.6
	8	1,342.6	1,383.4	1,456.9	1,489.7	1,550.0	1,445.7
	7	1,342.6	1,393.0	1,462.1	1,488.0	1,555.5	1,447.9
	6	1,349.2	1,394.4	1,458.1	1,492.0	1,560.8	1,449.6
	5	1,349.7	1,392.2	1,456.6	1,494.1	1,560.9	1,449.6
	4	1,349.2	1,397.0	1,460.1	1,495.1	1,561.1	1,450.9
	3	1,354.0	1,399.6	1,466.1	1,487.8	1,548.6	1,452.1
	2	1,357.6	1,402.3	1,463.9	1,493.4	1,549.2	1,452.7
	1	1,360.0	1,402.7	1,476.1	1,503.8	1,555.9	1,460.3
After calving	1	1,199.6	1,251.5	1,302.3	1,361.1	1,399.6	1,301.6
	2	1,198.6	1,224.5	1,298.2	1,345.6	1,385.1	1,290.0
	3	1,185.8	1,219.1	1,289.4	1,317.9	1,379.0	1,280.6
	4	1,187.4	1,218.1	1,281.8	1,323.0	1,375.0	1,278.5
	5	1,174.3	1,213.3	1,276.1	1,328.2	1,368.1	1,271.7
	6	1,168.7	1,206.4	1,268.9	1,326.4	1,362.5	1,266.1
	7	1,165.1	1,209.4	1,262.0	1,321.6	1,353.0	1,261.0
Differences between first day before calving and first day after calving		160.4	151.2	173.8	142.7	156.3	158.7
Average birth weight of calf [1]		92.0	93.0	97.9	95.3	96.2	94.8
Number in each group		22	11	14	9	23	79

[1] 41 heifer calves averaged 91.1 pounds at birth, and 38 bull calves averaged 98.7 pounds.

The increase in weight from the tenth to the first day immediately preceding calving was fairly uniform throughout the age groups, the average increase being 16 pounds. There was a greater uniformity, however, in the decrease in weight from the first to the seventh day immediately following calving, the average decrease being 40 pounds for the different age groups.

There appears to be no relationship between the loss of body weight of the dams or the size of the calves at birth and the age of the dams. The weights of the calves of the 4-year-old dams are somewhat higher than those of dams at other ages; but this is due in part, at least, to the fact that of the 14 calves in this group 8 were bulls, with an average weight of 102.4 pounds, and only 6 were heifers, with an average weight of 92 pounds. The average weights of the calves from dams of all other ages are remarkably uniform.

RELATION OF SIZE OF DAM TO SIZE OF CALF AT BIRTH

The average birth weights of 89 calves, 47 of which were heifers and 42 were bulls, are given in Table 24.

TABLE 24.—*Relation of size of dam to size of calf at birth*

Weight group of dams	Heifer calves		Bull calves	
	Number in group	Average birth weight	Number in group	Average birth weight
Pounds		*Pounds*		*Pounds*
900 to 999	1	85	3	89
1,000 to 1,099	7	83	6	91
1,100 to 1,199	6	89	7	93
1,200 to 1,299	13	92	8	96
1,300 to 1,399	10	93	9	101
1,400 to 1,499	6	94	5	103
1,500 to 1,599	4	89	4	99

The average birth weight of all the heifer calves was 90.2 pounds and of all the bull calves 97.8.

In Table 24 the dams are grouped according to weights without regard to their ages. Although the numbers in some of the groups are so small as to make the results of doubtful value, there appears to be a gradual increase in the size of both heifer and bull calves as the dams increase in size up to 1,500 pounds. In the group of dams weighing more than 1,500 pounds there is a decrease in size of both heifer and bull calves; however, the number in this group is so small that the decrease shown may not be significant.

GROWTH OF HOLSTEIN-FRIESIAN HEIFERS FROM BIRTH TO 2 YEARS OF AGE

The average weights of Holstein-Friesian heifers at the Huntley station, by months, from birth to 2 years of age are shown in Table 25. For comparison, average weights are shown of animals grown at the Bureau of Dairy Industry Experiment Stations at Ardmore, S. Dak., and at Beltsville, Md., and of heifers grown at the University of Missouri.

TABLE 25.—*Average weights of Holstein-Friesian heifers at the Huntley station by months from birth to 2 years of age, compared with average weights of Holstein-Friesian heifers at the Ardmore, S. Dak., and Beltsville, Md., stations and at the University of Missouri*

Age	Huntley, Mont., 10 animals [1]	Ardmore, S. Dak.,[2] 17 animals	Beltsville, Md.,[2] 27 animals	University of Missouri [3] (normal ration), 23 animals
	Pounds	*Pounds*	*Pounds*	*Pounds*
Birth	86.8	90	97.2	90
1 month	126.0	132	121.3	121
2 months	174.4	184	154.6	157
3 months	230.5	238	197.2	200
4 months	293.5	294	252.8	249
5 months	361.1	342	302.8	302
6 months	424.9	403	360.2	349
7 months	487.5	449	406.5	389
8 months	543.5	485	460.2	425
9 months	594.2	515	506.5	456
10 months	633.6	537	552.8	501
11 months	680.2	560	586.1	520
12 months	721.2	590	626.9	558
13 months	749.7	628	662.0	574
14 months	786.0	659	708.3	596
15 months	807.4	689	745.4	612
16 months	841.6	707	776.9	643
17 months	869.5	730	812.0	660
18 months	904.7	752	839.8	686
19 months	936.0	787	880.6	715
20 months	969.3	824	912.0	740
21 months	989.6	860	943.5	774
22 months	1,016.3	894	982.4	798
23 months	1,049.5	934	1,015.7	824
24 months	1,070.8	973	1,056.5	841

[1] Only 9 animals were used from the nineteenth to the twenty-fourth month.

[2] Weights for Ardmore, S. Dak., and Beltsville, Md., from the following publication: COLE, J. S., KELSO, F. L., RUSSELL, E. Z., SHEPHERD, J. B., STUART, D., and GRAVES, R. R. WORK OF THE UNITED STATES DRY-LAND FIELD STATION, ARDMORE, S. DAK., 1912 TO 1925. U. S. Dept. Agr. Tech. Bul. 17, 68 p., illus. 1927.

[3] Missouri weights from ECKLES, C. H. Op. cit. (The Missouri normal is the average of both light and liberal rations.)

The animals at Huntley were grown under different feeding conditions from those at the other stations. They were fed skim milk until 9 months of age, and during that period they received grain and alfalfa hay. After the ninth month they received only alfalfa hay and corn silage. They were also on pasture about two months during their second year. There was not sufficient pasture for the entire herd except during the flush period in the early part of the pasture season. The heifers at the Ardmore and Beltsville stations were taken off skim milk at the end of the sixth month but received grain, alfalfa hay, and corn silage until they were 2 years old.

It will be noted that at 24 months of age the Huntley heifers weighed 14.3 pounds more than the Beltsville heifers and 97.8 pounds more than the Ardmore heifers.

The net gains of the heifers at the Ardmore, Beltsville, and Huntley stations, by 6-month periods, are shown in Table 26. The second 6-month period, during which the feeding at Huntley was changed, is divided into two periods of three months each.

TABLE 26.—*Net gains of heifers by 6-month periods at the Ardmore, Beltsville, and Huntley stations*

Period	Ardmore	Beltsville	Huntley
	Pounds	*Pounds*	*Pounds*
First six months	313	263	338
Second six months, 7 to 9 months	112	146	169
Second six months, 10 to 12 months	75	120	127
Third six months	102	213	184
Fourth six months	221	217	166

For some unknown reason, during the first six months the Huntley heifers made the largest gains of any of the heifers. During the first half of the second six months, when the Huntley heifers were still receiving skim milk, they continued to make the largest gains and even continued to do so during the latter half of this period, after both skim milk and grain had been removed from their ration. During the third and fourth 6-month period their gains fell somewhat behind those of the Beltsville heifers, and in the last period they were gaining less rapidly than the Ardmore heifers.

The data indicate that if alfalfa hay and corn silage of good quality are available, heifers can make satisfactory gains after the ninth month without grain.

Some heifers at the Huntley station are receiving skim milk until 2 years of age, to determine whether the rapidity of gain obtained in the first six months can be continued to 2 years of age. Four heifers on the continued skim-milk ration have reached the nineteenth month with an average of 985 pounds, which is an increase of 49 pounds over the average for all heifers at Huntley at that age.

BREEDING EXPERIMENTS

The breeding experiment at the Huntley station is the same as that carried on at the other field stations of the bureau, namely, the building up of a herd that will be homozygous or pure in its inheritance for high milk and butterfat production. It is expected that this will be accomplished by the continued use, for generation after generation, of sires that have proved through their daughters that they have the inheritance that will enable them to transmit high producing ability to all their offspring. This project was outlined on the theory that sires whose daughters are uniformly high producers and have greater producing capacity than their dams are homozygous for the hereditary factors that determine high-producing capacity, and that if such sires were used for five or six generations a herd would be obtained which would be pure in its inheritance for this character. After this time, as long as proved sires are used every son and every daughter may be depended upon to transmit uniformly high production, and in addition, in the case of the females, become high producers themselves.

THE FOUNDATION HERD

The foundation herd of registered Holstein-Friesian cattle was established at Huntley in the spring of 1918, when a carload of females was shipped from the Beltsville (Md.) Experiment Farm. Most of the animals were daughters and granddaughters of the two good sires Johan Woodcrest Lad 52145 and his son, Johan Woodcrest Lad 11th 103987. Two very high producing cows, however, were not

related to these sires. One, a Maryland-bred cow, named Korndyke Sadie Vale Rag Apple 244732, a granddaughter of King of the Pontiacs, made the three following high production records at Huntley: 486 pounds of butterfat on roughage alone at 5 years 8 months, 523 pounds of butterfat on a full grain ration at 5 years, and 626 pounds of butterfat on a limited grain ration at 8 years 11 months of age. Her picture may be seen among the dams mated to Mapleside King Paul (Fig. 6). At 14 years of age this cow is still breeding and producing well.

The other high-producing cow was Pledge Pietje De Kol 250627, a Michigan-bred great-granddaughter of De Kol 2d's Butter Boy 3d. As cow 218, her production records are discussed in some detail in connection with Table 14. This cow dropped a heifer calf in August, 1927, and was slaughtered January, 1928, at a little more than 14 years of age. She was the only positive reactor to the agglutination test for abortion in the Huntley herd. In November, 1927, the month in which she became 14 years of age, she was producing from 45 to 50 pounds of milk per day. Her total production for that month was 1,448 pounds of milk and 42.73 pounds of butterfat. She aborted calves in 1919 and 1920 after going to the Huntley station, but thereafter was a regular breeder.

Another high-producing cow included in the shipment from Beltsville was Helen Uilkje Calamity 145857, a daughter of Johan Woodcrest Lad. At the age of 8 years 3 months she made a record of 470 pounds of butterfat on roughage alone. At 9 years 11 months she made a record of 25,499 pounds of milk and 823 pounds of butterfat on a full grain ration. She dropped her last calf when just past her fifteenth birthday and produced during the following year 13,622 pounds of milk and 429.8 pounds of butterfat. Her picture is shown in Figure 8.

In 1920 a few granddaughters of King Segis Pontiac Count and a granddaughter of Sir Pietertje Ormsby Mercedes were added to the foundation herd.

SIRES USED IN THE HUNTLEY BREEDING PROJECT

At the time the project was started no money was available for the purchase of a proved sire. About two years prior to this time the Holstein cow Calamity Wayne Pauline 2d 137625 had been purchased and put on official test at the Beltsville station. She made a yearly record of 22,547 pounds of milk and 855 pounds of butterfat. The dam of this cow made a yearly record of 723 pounds of butterfat. In view of these good records, it was decided to purchase the son of Calamity Wayne Pauline 2d. This bull, Mapleside King Paul, was then in service in a small herd in Michigan. At that time his daughters were not more than 5 or 6 months old. Before being brought to Huntley this bull had sired one or two red and white calves and therefore carried the recessive factor for red and white. Apparently the Huntley foundation females to which he was mated were fairly pure for black and white, since only one red and white calf has been sired by him at Huntley. However a part of his offspring must have received the hereditary factor for red and white. Evidently Friend Ona Hartog Korndyke 277648, the sire that was used for some time on the daughters of Mapleside King Paul, did not carry the factor for red and white, since no red and white animals resulted from these matings. The next sire used, Pride of the Bess Burkes, apparently

carried the factor for red and white because one of the twin heifer calves sired by him was red and white and the other black and white. The dam of these twins was Duchess Korndyke Corby (fig. 3), a daughter of Mapleside King Paul. Here are unlike twins, no more closely related than ordinary full sisters would be. The red and white twin received the inheritance for red and white from both of its black and white parents. The black and white twin may be pure in its inheritance for black and white, or it may be heterozygous (mixed) and transmit red to half of its offspring.

Although the transmitting ability for milk and butterfat production of Mapleside King Paul was unknown when he was first used at Huntley, the production records of his daughters, made under conditions comparable with those of their dams, have shown that this

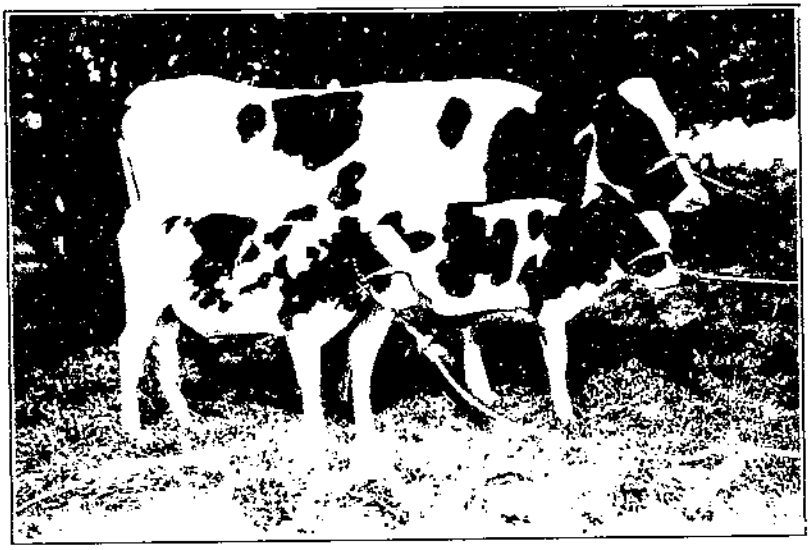

FIG. 3.—Duchess Korndyke Corby 555823, a daughter of Mapleside King Paul, with twin heifer calves sired by Pride of the Bess Burkes. The heifer at the left is red and white, the one at the right is black and white

bull is very nearly pure in his inheritance for the factors governing a fairly high level of production.

In all the herds operated by the Bureau of Dairy Industry in its breeding investigational work, each generation of animals is tested for producing capacity. Every effort is made to keep the conditions under which the tests are made as nearly identical as possible. At Huntley, the test cows are milked three times a day, are kept in stanchions, and during the pasture season are pastured with the rest of the herd. In spite of the efforts to make all conditions of the tests comparable, some inequalities, such as temporary indisposition of the animal, arise. In the case of Mapleside King Paul's three daughters that fell below their dams in production when compared on a mature basis, one had trouble with her teeth during the test, one, an inbred daughter, was slow in developing, and one was not in good health. It is thought that all three are capable of larger production than was shown in their first test.

The complete records of the 17 daughters of Mapleside King Paul and of their dams are shown in Table 27.

TABLE 27.—*Production records of registered daughters and of dams of daughters of Mapleside King Paul 181023*

[Sire, Johanna Korndyke of Mapleside 143930. Dam, Calamity Wayne Pauline 2d 137625 (22,547 pounds of milk; 855.4 pounds of butterfat at 8 years)]

No.	Daughters						Dams					
	Age		Milk	Butterfat			Age		Milk	Butterfat		
	Years	Months		Per cent	Actual	Calculated to maturity	Years	Months		Per cent	Actual	Calculated to maturity
			Pounds		*Pounds*	*Pounds*			*Pounds*		*Pounds*	*Pounds*
1	4	0	16,202	3.21	521.6	573.3	4	1	15,946	3.25	518.6	570.0
2	4	2	19,050	3.11	591.6	650.2	4	5	7,301	3.16	230.8	253.6
3	2	8	16,887	3.24	547.2	684.0	6	11	18,146	3.20	590.8	596.8
4	3	2	13,155	3.81	501.3	589.5	1	9	13,838	3.52	487.0	695.5
5	2	7	15,121	3.43	518.7	648.4	3	4	12,721	4.17	530.0	623.3
6	2	6	16,517	3.24	535.5	669.5	3	0	15,486	3.61	559.0	657.4
7	2	4	13,781	3.62	498.3	664.2	5	4	14,154	3.04	430.5	443.8
8	2	8	16,378	3.83	626.9	783.7	8	11	17,031	3.68	626.0	626.0
9	3	2	13,592	3.87	525.9	618.4	3	1	12,805	3.68	471.6	554.6
10	3	4	16,641	3.49	581.4	683.7	4	2	14,110	3.90	550.6	605.2
11	2	7	14,712	3.25	477.5	596.9	6	11	18,146	3.29	596.8	596.8
12	2	9	14,546	4.02	584.4	730.5	8	11	17,031	3.68	626.0	626.0
13	2	11	11,171	3.44	384.7	480.9	5	4	14,154	3.04	430.4	443.8
14	2	7	14,238	3.69	526.2	657.7	3	1	12,805	3.68	471.6	554.6
15	3	0	14,689	4.11	603.4	709.6	2	10	14,863	3.45	493.9	617.4
16	3	0	15,067	3.33	501.0	589.2	9	11	25,499	3.23	823.1	823.1
17	2	9	11,587	3.81	441.8	552.3	4	2	19,030	3.11	591.6	650.2
Average [1]						640.1						584.6
Increase of daughters over dams						55.5						
Per cent increase						9.5						

[1] 13 daughters exceeded dams in quantity of butterfat calculated to maturity, and 1 produced practically the same.

Table 27 shows that the daughters average 55.5 pounds more butterfat than their dams. Ten show an increase in per cent of butterfat over that of their dams, and seven show a decrease. The average increase, however, is less than 0.2 per cent. This is a good illustration of the fallacy of attempting to increase materially the percentage of butterfat of a breed, which by inheritance is fixed at a fairly constant point, by the selection of a bull from a dam that has a high per cent of butterfat. It would appear that the only method of fixing the inheritance for a high per cent of butterfat is to use for several generations sires that have inherited a high per cent of butterfat from both their sires and their dams, or in other words, sires that are pure or homozygous for a high per cent of butterfat.

The dam of Mapleside King Paul (Calamity Wayne Pauline 2d) made an official record of a little less than 3.8 per cent of butterfat. Her dam had a record of 4.48 per cent of butterfat. It is not known, however, that 4.48 per cent was the inherited per cent of butterfat that Calamity Wayne Pauline 2d received from her dam, nor is the per cent of butterfat known that Mapleside King Paul inherited through his sire. Then, too, the dams to which Mapleside King Paul was mated had an inheritance for per cent of butterfat to pass on to their daughters in addition to the inheritance which they received from the sire. When it is considered that the great majority of the animals of the Holstein-Friesian breed have an inheritance for less

than 3.5 per cent of butterfat; the influence on their granddaughters of one of two animals with a high test is likely to be slight.

A comparison of the photographs of the daughters of Mapleside King Paul with those of their dams (figs. 4 to 8) show that he was dominant in transmitting color markings. The broad band of white the entire length of the head shows in all but two of the daughters. These two daughters are the only ones that do not show an increase in the area of white as compared with their dams. The sire himself was mostly white, as were also his dam and his full sister. His daughters for the most part have udders that are held up more closely to the body than the udders of the dams, though this may be due in part to the difference in age. As heifers, many of his daughters were sloping in the rump, but as they grew older most of them became more nearly straight. His daughters show quite a marked resemblance to one another, though all but one are classed as outbred, none of them having any common ancestry through the sire and the dam in the first four ancestral generations. Double Duchess Hetty Walker (fig. 8) is an inbred, the result of a daughter being bred back to her sire.

Mapleside King Paul is almost 13 years old and at this age is still in active service at the Ardmore (S. Dak.) Field Station.

The sire selected to use on the daughters of Mapleside King Paul was Friend Ona Hartog Korndyke 277648, bred by the Bureau of Dairy Industry at the Ardmore Field Station. His sire was Meadow Holm Ona Pontiac Hartog 189413, and his dam was Sadie Korndyke Albino 270937, with a production of 16,929 pounds of milk and 528 pounds of butterfat at 7 years of age. This bull as a yearling was placed with a dairyman on the Huntley project to be tested out in a grade herd. Table 28 shows the comparative records of his first 11 grade daughters and their dams.

TABLE 28.—*Production records of grade daughters and of dams of daughters of Friend Ona Hartog Korndyke 277648, tested under farm conditions; records calculated to maturity*

No.	Daughters				Dams			
	Yearly records	Milk	Butterfat		Yearly records	Milk	Butterfat	
			Per cent	Pounds			Per cent	Pounds
	Number	*Pounds*			*Number*	*Pounds*		
1	2	12,575.5	3.93	492.02	5	10,932.3	3.79	414.46
2	2	12,196.7	3.73	454.50	5	10,932.3	3.79	414.46
3	4	11,484.5	3.53	405.18	3	11,558.2	3.36	388.54
4	1	9,233.2	3.83	353.79	4	12,485.5	3.10	387.45
5	4	15,125.6	3.46	523.78	3	14,467.6	3.18	460.80
6	1	14,240.8	3.72	530.66	2	7,066.4	3.68	282.13
7	1	9,822.5	3.74	367.11	4	8,511.0	3.86	329.00
8	3	10,010.5	3.78	376.89	3	9,319.9	3.54	330.02
9	1	12,442.0	3.70	460.66	3	9,714.1	3.82	371.24
10	1	11,835.5	3.64	430.80	4	11,541.6	3.69	425.63
11	2	10,093.8	3.49	352.65	1	9,368.6	3.48	326.41
Average		11,732.7	3.68	431.72		10,590.6	3.54	375.53
Increase or decrease of daughters over dams [1]		1,142.1	.14	56.19				
Per cent increase or decrease		10.78	3.95	14.96				

[1] 9 daughters exceeded dams in milk, 10 daughters exceeded dams in butterfat, and 8 daughters exceeded dams in per cent of butterfat.

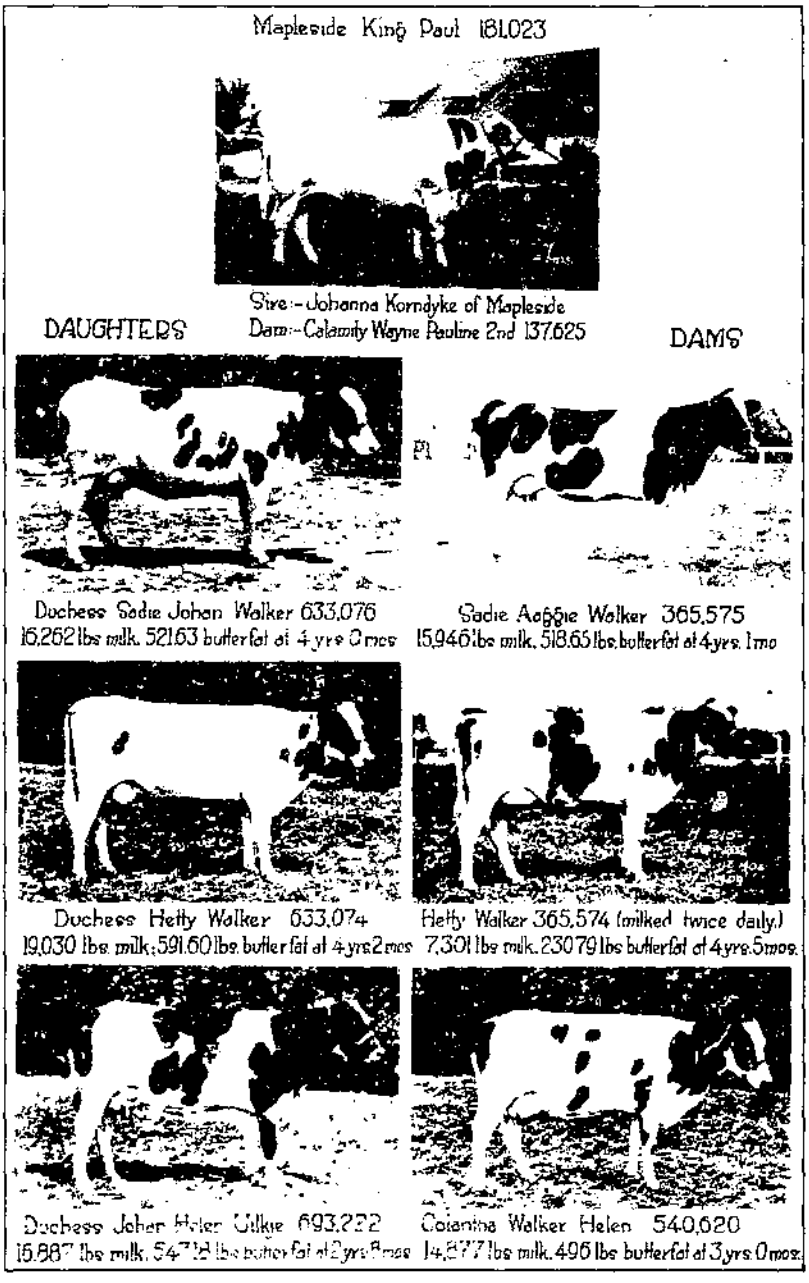

FIGURE 4.—Mapleside King Paul and three of his daughters with their dams

FIGURE 5.—Four daughters of Mapleside King Paul with their dams

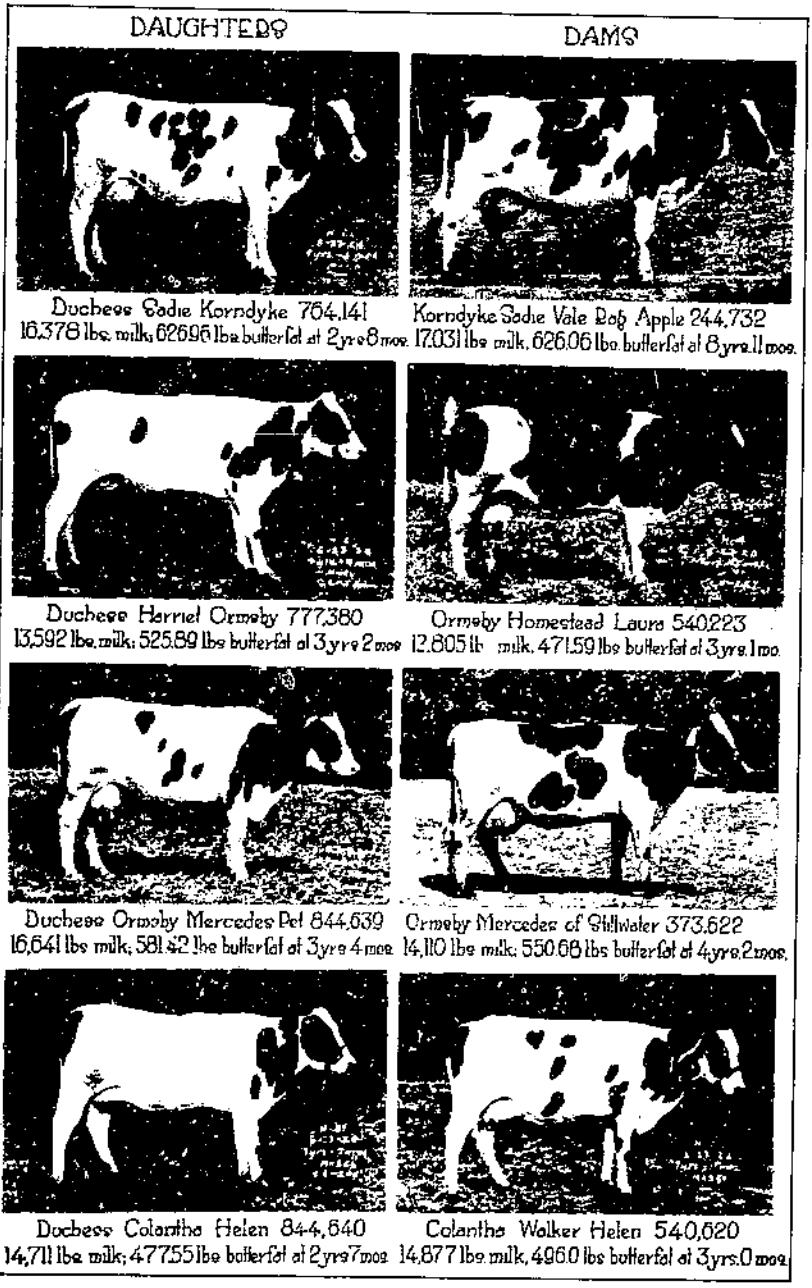

FIGURE 6.—Four daughters of Mapleside King Paul with their dams

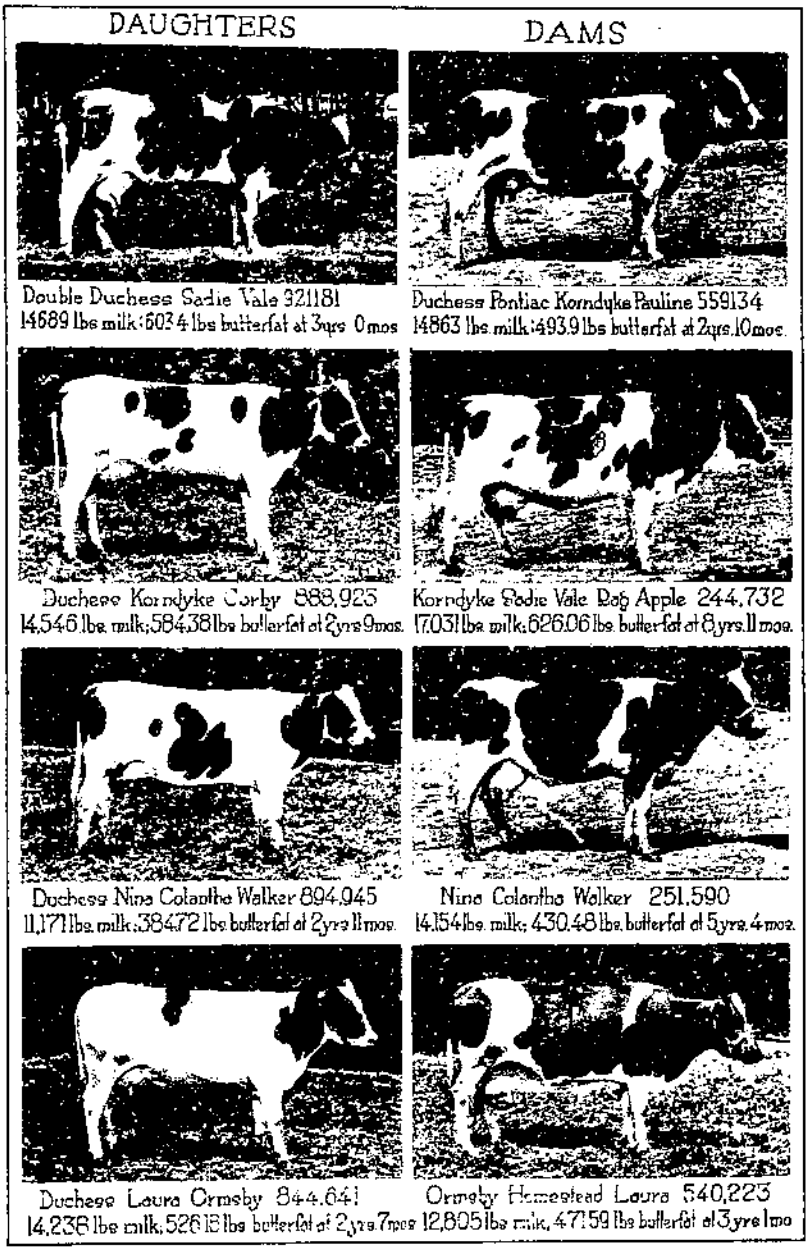

FIGURE 7.—Four daughters of Mapleside King Paul with their dams

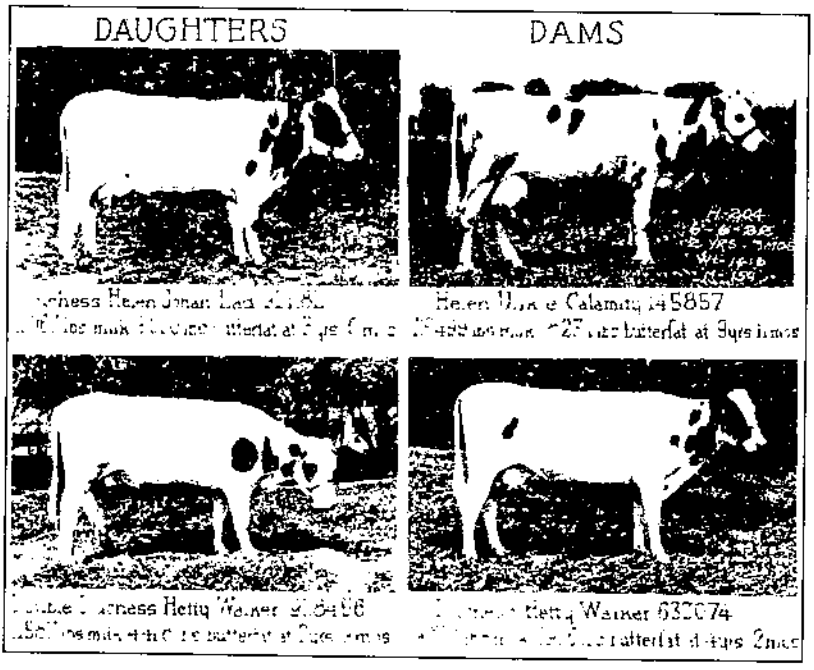

FIGURE 8.—Two daughters of Mapleside King Paul with their dams

These grade daughters of Friend Ona Hartog Korndyke averaged 11,733 pounds of milk and 432 pounds of butterfat in one year, an increase of 1,142 pounds of milk and 56 pounds of butterfat over the production of their dams. There is always some difficulty in judging the transmitting ability of a sire from the records of his daughters in a grade herd when these records are made under farm conditions. The general practice of farmers in the Huntley district is to feed alfalfa hay during the winter and pasture in the summer. Very few feed silage or grain. It is a question whether a sire whose daughters average 57 pounds more butterfat than their dams, which average 375 pounds, under the feeding conditions described above and on twice-a-day milking, will have the capacity to increase the production records of dams averaging 640 pounds of butterfat, when fed a good grain ration in addition to alfalfa hay and silage and milked three times a day. It has been assumed, in this breeding work, that when a sire's grade daughters were outstandingly better than their dams it showed clearly that he had an inheritance for transmitting high production, and when mated with dams with higher records would sire daughters better than their dams. Of course, this is somewhat problematical.

Friend Ona Hartog Korndyke now has five daughters that are out of dams in the Huntley herd, tested under the conditions previously described. The records of these daughters and those of their dams are given in Table 29. It will be noted that four daughters are higher than their dams in per cent of butterfat, and that when the records are calculated to maturity four daughters are better than their dams in butterfat production.

TABLE 29.—*Production records of registered daughters and of dams of daughters of Friend Ona Hartog Korndyke*

No.	Daughters						Dams					
	Age		Milk	Butterfat			Age		Milk	Butterfat		
	Years	Months		Per cent	Actual	Calculated to maturity	Years	Months		Per cent	Actual	Calculated to maturity
			Pounds		*Pounds*	*Pounds*			*Pounds*		*Pounds*	*Pounds*
1	2	5	12,320	3.76	462.9	617.1	3	1	12,806	3.69	471.6	554.6
2	2	8	14,155	3.72	526.1	657.7	8	11	17,031	3.68	626.0	628.0
3	2	9	11,633	3.58	416.2	[1] 520.2	2	10	14,863	3.32	493.9	617.4
4	2	5	15,305	3.45	530.6	707.4	4	2	19,030	3.11	591.6	650.2
5	2	6	13,939	3.78	526.7	658.4	3	2	13,155	3.81	501.3	589.5
Average						632.2						607.5

[1] It is believed that this is not a fair test of this cow's producing ability because she was not in good health during the time the record was made.

The five grade daughters shown in Figures 9 and 10 are similar in appearance to their dams, though the daughters have better-shaped udders. Attention should be called to the fact that all of these grade daughters are outbred. This is also true of the five purebred daughters shown in Figures 11 and 12 though one of these has some common ancestry through both sire and dam in the fifth ancestral generation.

The third sire is Pride of the Bess Burkes 294574 (fig. 13), sired by Pietertje Ormsby Mercedes 41st 132723 and out of Bess Ormsby Fytje 276357, with a production of 14,597 pounds of milk and 511 pounds of butterfat at 4 years 10 months of age. This sire has 21 daughters which average yearly 669 pounds of butterfat when the records are calculated to maturity. Seventeen of these daughters are out of dams with yearly records. The 17 daughters average 689.2 pounds of butterfat, calculated to a mature basis, and their dams average 592.3 pounds of butterfat. These records were made in the herd of the South Dakota State School and Home, Redfield, where Pride of the Bess Burkes was in service until taken to Huntley. He was in service at Huntley a little less than a year, when it was decided to move him to the Beltsville (Md.) Experiment Farm.

The fourth sire, Varsity Derby Allen 256012 (fig. 14), a 9-year-old bull, was bred by the University of Nebraska and used for a number of years at the Valentine Experiment Station of that State. He was sired by King Derby Lincoln 153017, a sire that has nine daughters with yearly records averaging 23,142 pounds of milk and 814 pounds of butterfat. The dam of Varsity Derby Lincoln was Allie Lincoln 178368, with a yearly record of 22,160 pounds of milk and 846 pounds of butterfat.

The records of 15 daughters sired by Varsity Derby Allen in the Valentine station herd average 10,578 pounds of milk and 405 pounds of butterfat per year. These daughters were milked twice a day and fed grain at the rate of 1 pound to 3½ pounds of milk in addition to alfalfa hay and corn silage, and pasture in the summer. The records of the dams average 8,176 pounds of milk and 287 pounds of butterfat per year. This is an increase for the daughters of 2,402 pounds of

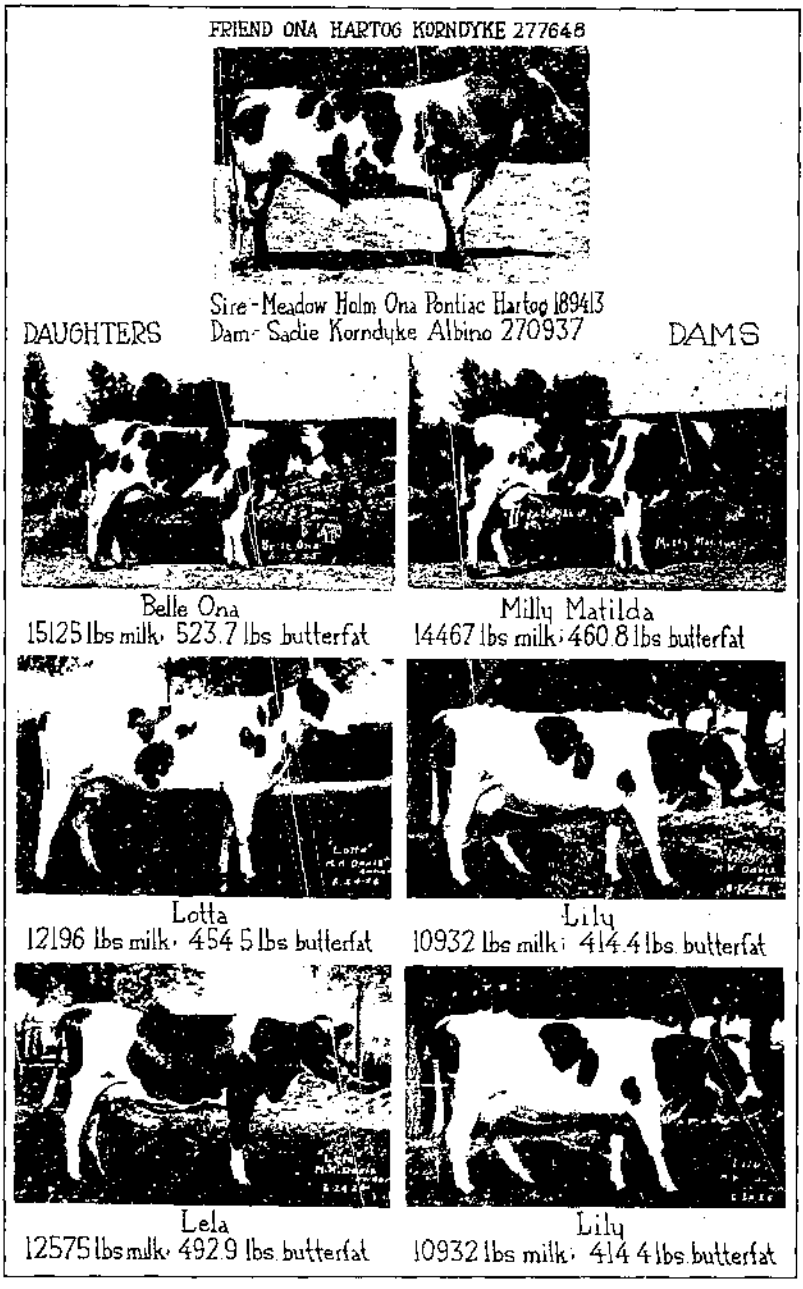

FIGURE 9.—Friend Ona Hartog Korndyke 277648 and three grade daughters with their dams

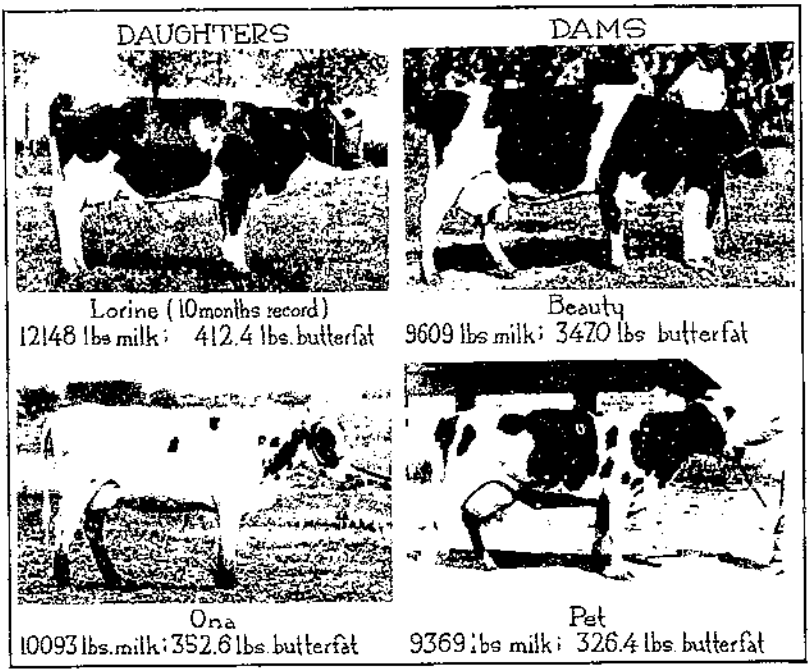

FIGURE 10.—Two grade daughters of Friend Ona Hartog Korndyke with their dams

milk and 118 pounds of butterfat. All but one of the 15 daughters are better than their dams, and in this one case the dam has only a slightly better record than her daughter. When the records of daughters and dams are calculated to a mature basis, the average yearly butterfat production of the daughters is 473.8 pounds and that of the dams 328.6 pounds, an average increase of 145.2 pounds.

Here again, as in the case of the grade daughters of Friend Ona Hartog Korndyke, the question may be raised as to what this sire will do when mated to dams with higher records in a herd where the cows are kept under more favorable conditions. It is believed that the marked increase in production of the daughters of Varsity Derby Allen over that of their dams indicated that daughters sired by him in the Huntley herd will be fully up to the production level of their dams. Even though the hereditary level for producing capacity which this bull transmits should prove to be not quite so high as that of Mapleside King Paul and Pride of the Bess Burkes, the performance of his daughters shows that he can not greatly lower the hereditary level of the offspring that he will sire in the Huntley herd. Thus the object of the breeding project—the breeding of a herd that will be pure in its inheritance for a high level of production—can not be greatly impaired by his use.

PROVING OF YOUNG BULLS

To prove the transmitting ability for high milk and butterfat production, the bulls born in the Huntley herd are placed with dairy farmers on the Huntley Reclamation Project and in near-by territory.

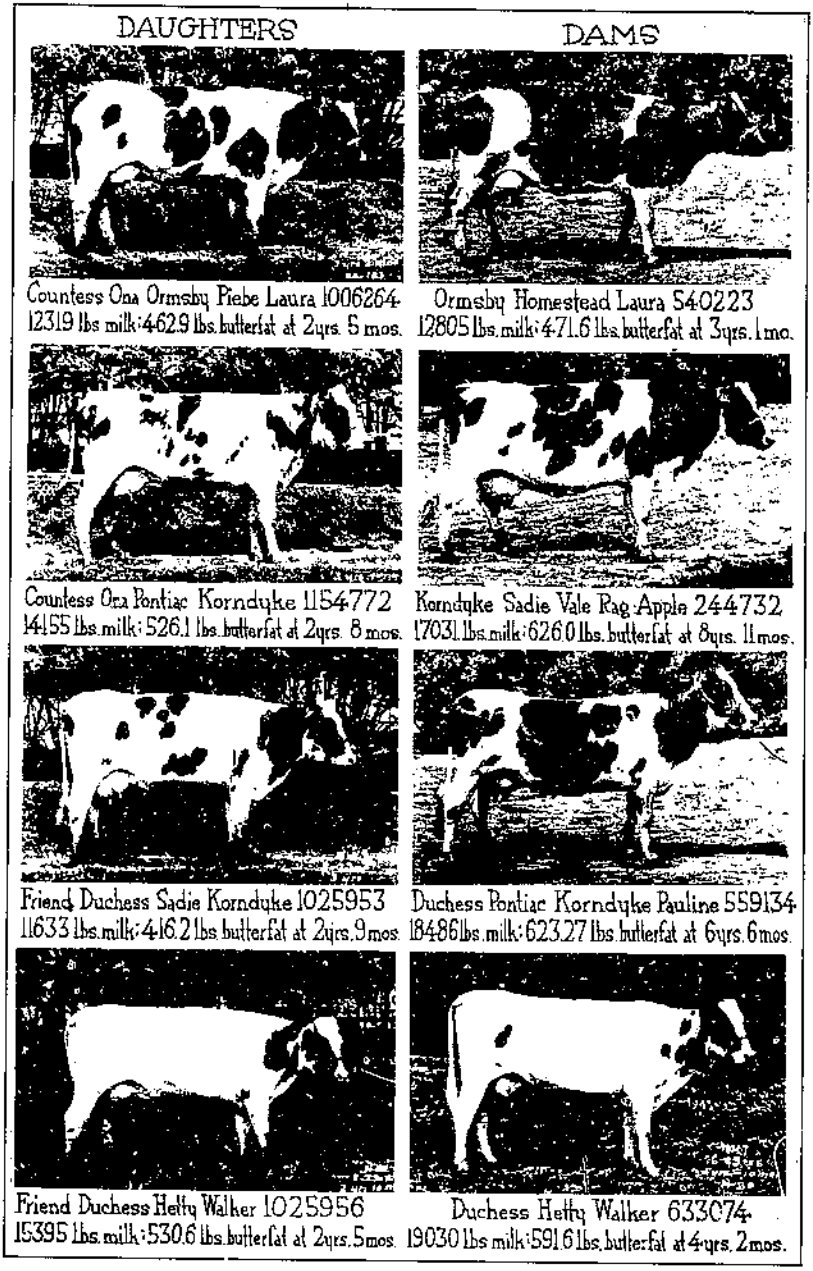

FIGURE 11.—Four purebred daughters of Friend Ona Hartog Korndyke with their dams

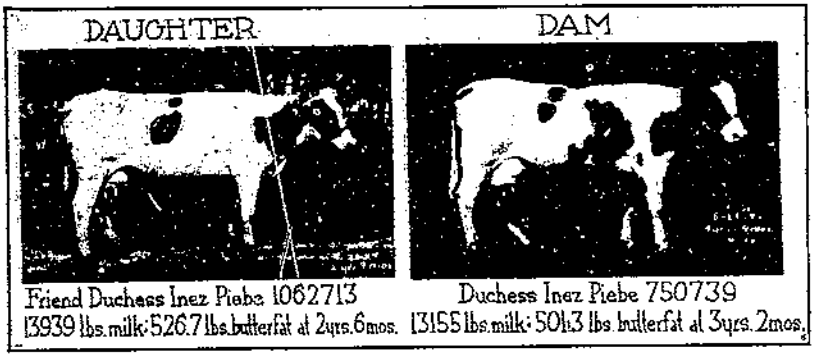

FIGURE 12.—One purebred daughter of Friend Ona Hartog Korndyke and her dam

The farmers agree to keep records of the production of the daughters of these bulls and of the production of the dams of these daughters. It is intended, in this work, to remove all sires as soon as they have been proved. Bulls that prove to be exceptionally prepotent for high production are used in the experimental breeding work or by State agricultural colleges that cooperate with the Bureau of Dairy Industry in dairy-cattle breeding projects. Bulls proving to be poor or only moderately good are slaughtered.

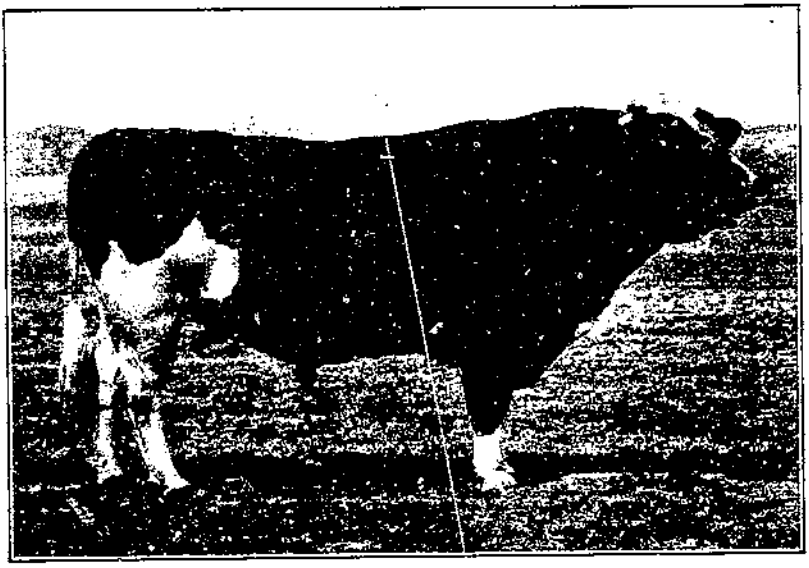

FIGURE 13.—Pride of the Bess Burkes 294574

Thirty-six bulls from the Huntley station are in the process of being proved. They are being used in the herds belonging to 61 farmers, totaling 691 cows. These bulls have sired 423 daughters, 130 of which are being tested, and 293 will be tested when they come into milk. The great majority of these animals are being tested through dairy-

herd-improvement associations. These farms are personally visited several times a year and observations made on the development of the animals.

When the work was started several years ago many of these herds consisted of common scrub cows of no particular breed. All the herds now have the appearance of high-grade Holstein-Friesians. In addition to providing valuable experimental data for the breeding project, this work has been the means of greatly improving the producing capacity of the cooperators' herds.

Sixteen sires born at the Huntley station now have one or more daughters that have completed one lactation period in farmers' herds. These daughters total 94. Their average yearly production when calculated to a mature basis is 10,565 pounds of milk and 385.09 pounds of butterfat, as compared with 8,871 pounds of milk and 318.25 pounds

FIGURE 14.—Varsity Derby Allen 256012

of butterfat for their dams, an average increase of 1,694 pounds of milk and 66.8 pounds of butterfat. At 44 cents per pound for butterfat and 40 cents per hundred pounds for skim milk, the value for the increased product in one year would be $35.43 per cow.

The average production records of the daughters and the dams of these daughters of all sires having one or more daughters with a completed lactation period are shown in Table 30. Attention is again called to the fact that these records were made almost entirely on pasture and alfalfa hay. Very few of the farmers have silos or feed grain. Six of the bulls listed have been slaughtered because of physical defects or because their daughters were not making sufficient increases to warrant their use in breeding experiments. It will be noted that only 2 of these 16 sires have daughters that show a decrease in their average butterfat production over that of their dams. Sires H–107, H–109, H–111, H–112, H–113, H–114, H–115, H–117, and H–120 are all sons of Mapleside King Paul, whose breeding, and the production records of whose daughters, have already been discussed.

TABLE 30.—*Average production records of daughters and of dams of daughters of all sires having one or more first-generation daughters*

Sire No.	Cows	Daughters				Dams				Increase or decrease of daughters over dams	
		Yearly records [1]	Milk	Butterfat		Yearly records [1]	Milk	Butterfat		Milk	Butterfat
				Per cent	Pounds			Per cent	Pounds		
	No.	*No.*	*Pounds*			*No.*	*Pounds*			*Pounds*	*Pounds*
H–105	5	5	11,279.8	3.56	402.10	9	9,737.8	3.73	363.11	1,542.0	38.99
H–107	6	12	10,373.5	3.94	408.34	15	9,433.8	3.55	334.71	939.7	73.63
H–109	11	14	10,223.7	3.63	370.91	14	6,918.2	3.82	264.03	3,305.5	106.88
H–111	6	8	9,721.9	3.87	375.99	15	8,263.8	3.59	296.97	1,458.1	79.02
H–112	14	16	12,861.4	3.64	468.03	26	9,407.6	3.60	338.38	3,453.8	129.65
H–113	2	2	9,199.9	3.53	324.53	5	10,013.1	3.33	333.15	−813.2	−8.62
H–114	3	3	9,413.4	3.83	360.79	10	7,554.8	3.53	266.56	1,858.6	94.23
H–115	1	1	12,525.5	3.60	450.90	2	8,149.9	3.96	322.84	4,375.6	127.06
H–117	1	1	10,478.0	3.75	393.37	4	10,611.8	3.25	345.11	−133.8	48.26
H–120	2	2	12,727.4	3.37	429.58	4	6,617.6	3.65	241.74	6,109.8	187.84
H–257	14	22	9,776.2	3.54	345.84	36	8,659.0	3.51	303.95	1,117.2	41.89
A–104	2	2	10,052.3	3.70	371.04	8	8,967.6	4.20	339.26	1,084.7	32.08
A–105	11	22	11,732.7	3.68	431.72	37	10,590.6	3.54	375.53	1,142.1	56.19
A–107	4	5	8,309.0	3.80	315.61	6	7,568.7	4.06	307.57	731.3	8.04
A–108	6	10	8,666.3	3.36	291.06	14	9,484.4	3.24	307.26	−818.1	−15.60
A–109	6	10	9,562.9	3.61	344.66	11	9,241.3	3.45	318.68	311.6	25.98

[1] All production records have been calculated to maturity. The number of yearly records vary from the number of cows because of the fact that when an animal had more than one record, all of her records were averaged and the average was used for comparison. This method was used in order to offset any abnormal feed conditions that might exist in any one year. The management of the cattle was usually the same over a period of years.

Tables 31 to 38 show the production records of the daughters and dams of daughters of all sires having five or more daughters with completed records.

TABLE 31.—*Production records of the daughters and dams of daughters of sire H–105; all records calculated to a mature basis*

No.	Daughters				Dams			
	Yearly records	Milk	Butterfat		Yearly records	Milk	Butterfat	
			Per cent	Pounds			Per cent	Pounds
	Number	*Pounds*			*Number*	*Pounds*		
1	1	11,897.2	3.59	431.44	1	9,133.3	4.24	387.18
2	1	10,488.0	3.41	357.64	2	12,102.9	3.66	445.16
3	1	11,063.2	3.46	382.89	2	11,119.2	3.21	357.13
4	1	12,431.2	3.61	448.38	1	5,159.4	4.04	208.47
5	1	10,412.7	3.74	390.18	3	11,114.3	3.76	417.65
Average		11,279.8	3.56	402.10		9,737.8	3.73	363.11
Increase or decrease of daughters over dams [1]		1,542.0	−.17	38.99				
Per cent increase or decrease		15.83	−4.56	10.74				

[1] 2 daughters exceeded their dams in milk, 3 daughters exceeded dams in butterfat, and 1 daughter exceeded dam in per cent of butterfat.

TABLE 32.—*Production records of the daughters and dams of daughters of sire H–107; all records calculated to a mature basis*

No.	Daughters				Dams			
	Yearly records	Milk	Butterfat		Yearly records	Milk	Butterfat	
			Per cent	Pounds			Per cent	Pounds
	Number	*Pounds*			*Number*	*Pounds*		
1	2	10,536.1	4.22	444.48	2	9,043.6	4.03	364.10
2	1	12,091.6	4.39	557.80	3	8,024.6	3.63	324.17
3	2	10,212.4	3.37	345.04	2	9,221.1	3.51	323.99
4	2	8,907.5	3.47	309.55	3	10,049.8	3.11	313.37
5	2	10,319.4	3.68	380.75	3	11,275.9	3.34	376.52
6	3	9,573.9	4.31	412.45	2	8,688.1	3.78	306.09
Average		10,373.5	3.94	408.34		9,433.8	3.55	334.71
Increase or decrease of daughters over dams [1]		939.7	.39	73.63				
Per cent increase or decrease		9.96	10.98	21.99				

[1] 4 daughters exceeded their dams in milk, 5 daughters exceeded their dams in butterfat, and 5 daughters exceeded their dams in per cent of butterfat.

TABLE 33.—*Production records of the daughters and dams of daughters of sire H–109; all records calculated to a mature basis*

No.	Daughters				Dams			
	Yearly records	Milk	Butterfat		Yearly records	Milk	Butterfat	
			Per cent	Pounds			Per cent	Pounds
	Number	*Pounds*			*Number*	*Pounds*		
1	1	8,622.7	3.91	337.90	2	5,979.2	3.54	211.50
2	1	10,845.3	3.55	385.11	1	5,267.4	4.42	233.32
3	1	11,686.7	3.71	433.52	1	8,228.6	3.56	293.11
4	1	11,120.0	3.37	374.97	1	8,248.6	3.56	293.11
5	1	10,175.2	3.81	388.45	1	5,314.4	3.71	197.35
6	1	10,161.2	3.95	401.18	1	7,046.1	3.45	242.97
7	2	10,449.3	3.67	383.74	1	7,271.8	4.41	320.74
8	1	10,097.7	3.33	336.46	2	5,979.2	3.54	211.50
9	1	10,930.9	3.50	382.53	1	8,257.0	3.63	300.37
10	2	9,592.1	3.50	336.28	2	7,256.0	3.85	279.62
11	2	8,779.7	3.64	319.89	1	7,271.8	4.41	320.74
Average		10,223.7	3.63	370.91		6,918.2	3.82	264.03
Increase or decrease of daughters over dams [1]		3,305.5	−.19	106.88				
Per cent increase or decrease		47.78	−4.97	40.48				

[1] 11 daughters exceeded dams in milk, 10 daughters exceeded dams in butterfat, and 4 daughters exceeded dams in per cent of butterfat.

TABLE 34.—*Production records of the daughters and dams of daughters of sire H–111; all records calculated to a mature basis*

No.	Daughters				Dams			
	Yearly records	Milk	Butterfat		Yearly records	Milk	Butterfat	
			Per cent	Pounds			Per cent	Pounds
	Number	*Pounds*			*Number*	*Pounds*		
1	1	6,576.4	3.99	262.76	3	7,751.8	3.53	273.49
2	2	10,686.8	3.36	359.11	1	5,507.2	3.34	184.04
3	2	9,990.5	4.09	408.25	2	8,926.1	3.54	316.40
4	1	11,016.8	4.25	467.77	2	8,284.6	3.91	323.98
5	1	10,419.6	3.67	382.67	4	9,843.9	3.50	344.76
6	1	9,641.6	3.89	375.41	3	9,267.5	3.66	339.15
Average		9,721.9	3.87	375.99		8,263.8	3.59	296.97
Increase or decrease of daughters over dams [1]		1,458.1	.28	79.02				
Per cent increase or decrease		17.64	7.79	26.61				

[1] 5 daughters exceeded dams in milk, 5 daughters exceeded dams in butterfat, and 6 daughters exceeded dams in per cent of butterfat.

TABLE 35.—*Production records of the daughters and dams of daughters of sire H–112; all records calculated to a mature basis*

No.	Daughters				Dams			
	Yearly records	Milk	Butterfat		Yearly records	Milk	Butterfat	
			Per cent	Pounds			Per cent	Pounds
	Number	*Pounds*			*Number*	*Pounds*		
1	1	15,246.6	3.10	473.91	3	8,549.6	3.32	284.04
2	1	14,495.0	3.32	481.85	1	13,003.1	3.32	432.59
3	1	10,811.1	3.99	430.87	2	9,233.1	3.85	355.22
4	1	15,489.8	3.94	611.11	2	12,802.5	3.44	442.82
5	1	12,440.3	3.59	447.71	1	8,611.8	4.69	403.72
6	1	15,643.7	3.78	592.37	1	6,481.0	3.65	236.72
7	2	12,215.7	3.24	395.44	2	12,008.5	3.35	402.08
8	1	10,398.0	3.99	415.52	2	8,769.9	3.61	316.84
9	2	12,025.4	3.70	444.77	3	8,549.6	3.32	284.04
10	1	10,613.2	3.93	416.97	1	7,424.8	3.30	246.60
11	1	12,213.0	3.38	412.92	2	8,566.1	3.52	302.16
12	1	13,443.3	3.86	518.95	3	10,922.9	3.74	408.98
13	1	12,814.4	3.25	417.20	3	8,549.6	3.32	284.04
14	1	12,210.4	4.03	492.76	2	8,174.2	4.13	337.52
Average		12,861.4	3.64	468.03		9,407.6	3.60	338.38
Increase or decrease of daughters over dams[1]		3,453.8	.04	129.65				
Per cent increase or decrease		36.71	1.11	38.31				

[1] 14 daughters exceeded dams in milk, 13 daughters exceeded dams in butterfat, and 7 daughters exceeded dams in per cent of butterfat.

TABLE 36.—*Production records of the daughters and dams of daughters of sire H–257; all records calculated to a mature basis*

No.	Daughters				Dams			
	Yearly records	Milk	Butterfat		Yearly records	Milk	Butterfat	
			Per cent	Pounds			Per cent	Pounds
	Number	*Pounds*			*Number*	*Pounds*		
1	1	11,077.3	3.55	414.91	1	5,427.7	4.27	231.50
2	1	8,028.7	3.62	291.31	4	9,003.7	3.47	312.39
3	1	10,343.0	3.50	362.41	3	7,712.9	3.88	299.59
4	2	9,876.7	3.63	358.94	3	7,712.9	3.88	299.59
5	1	9,428.1	3.96	374.01	2	6,034.9	4.18	252.17
6	2	7,235.9	4.06	293.70	3	12,183.7	3.40	414.62
7	3	10,062.4	3.24	326.12	3	10,117.0	3.22	325.54
8	3	8,746.2	3.42	298.82	3	8,581.7	3.17	271.89
9	1	11,481.5	3.58	411.88	2	8,082.8	3.52	305.69
10	1	9,161.7	3.49	319.75	2	8,082.8	3.52	305.69
11	2	14,520.1	3.41	495.60	2	14,174.3	3.23	458.04
12	2	10,691.1	3.31	354.73	4	10,430.1	3.57	372.66
13	1	8,420.0	3.30	277.89	1	3,762.0	3.28	123.22
14	1	7,194.8	3.64	261.76	3	8,719.6	3.24	282.74
Average		9,776.2	3.54	345.84		8,659.0	3.51	303.95
Increase or decrease of daughters over dams[1]		1,117.2	.03	41.89				
Per cent increase or decrease		12.90	.85	13.78				

[1] 10 daughters exceeded dams in milk, 10 daughters exceeded dams in butterfat, and 8 daughters exceeded dams in per cent of butterfat.

TABLE 37.—*Production records of the daughters and dams of daughters of sire A–108; all records calculated to a mature basis*

No.	Daughters				Dams			
	Yearly records	Milk	Butterfat		Yearly records	Milk	Butterfat	
			Per cent	Pounds			Per cent	Pounds
	Number	*Pounds*			*Number*	*Pounds*		
1	2	8,290.9	3.44	285.90	4	8,730.0	3.31	289.15
2	2	8,713.4	3.23	281.42	3	9,899.1	3.07	303.92
3	2	9,491.0	3.23	306.71	2	8,871.4	3.31	293.70
4	1	6,259.4	3.64	228.05	3	9,894.8	3.22	318.33
5	2	9,995.2	3.26	325.87	1	12,660.5	3.04	385.00
6	1	9,239.3	3.48	322.04	1	6,840.8	3.69	252.53
Average		8,666.3	3.30	291.66		9,484.4	3.24	307.26
Increase or decrease of daughters over dams [1]		−818.1	.12	−15.60				
Per cent increase or decrease		−8.63	3.70	−5.07				

[1] 2 daughters exceeded dams in milk, 2 daughters exceeded dams in butterfat, and 4 daughters exceeded dams in per cent of butterfat.

TABLE 38.—*Production records of the daughters and dams of daughters of sire A–109; all records calculated to a mature basis*

No.	Daughters				Dams			
	Yearly records	Milk	Butterfat		Yearly records	Milk	Butterfat	
			Per cent	Pounds			Per cent	Pounds
	Number	*Pounds*			*Number*	*Pounds*		
1	2	9,833.0	3.89	383.33	2	8,684.1	3.22	280.18
2	2	9,457.3	3.47	328.27	1	10,825.4	3.22	348.97
3	2	9,300.2	3.65	339.98	1	9,133.8	3.92	358.14
4	2	9,060.8	3.42	310.01	3	9,530.6	3.12	297.58
5	1	10,028.2	3.47	348.47	1	9,110.4	2.92	357.56
6	1	9,537.9	3.71	357.94	3	8,147.4	3.31	269.68
Average		9,552.9	3.61	344.66		9,241.3	3.45	318.68
Increase or decrease of daughters over dams [1]		311.6	.16	25.98				
Per cent increase or decrease		3.37	4.64	8.15				

[1] 4 daughters exceeded dams in milk, 3 daughters exceeded dams in butterfat, and 4 daughters exceeded dams in per cent of butterfat.

Sire H–109 is now in use in a cooperative breeding experiment at the Oregon Agricultural College, sire H–111 is at the Montana Agricultural College, and sire H–257 is at the Utah Agricultural Experiment Station. Sire H–112 is at the Woodward (Okla.) station, and sire H–120 is at the Mandan (N. Dak.) station of the Bureau of Dairy Industry. Sire H–105 is being used in a cooperative breeding experiment in the herd of the United States Veterans' Bureau Hospital at Fort Bayard, N. Mex.

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