

Feeding Alfalfa Hay Alone and With Concentrates to Dairy Cows

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PRICE ABOVE WHICH BUTTERFAT MUST SELL TO MAKE CONCENTRATE FEEDING MORE PROFITABLE THAN HAY ALONE

Concentrate per ton	Hay per ton									
	\$6.00	\$7.00	\$8.00	\$9.00	\$10.00	\$11.00	\$12.00	\$13.00	\$14.00	\$15.00
	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>
\$20.00	20.1	19.4	18.7	18.0	17.3	16.6	.....	.....	.....	.....
22.50	23.1	22.4	21.7	21.0	20.3	19.6	.....	.....	.....	.....
25.00	26.1	25.5	24.8	24.1	23.4	22.7	22.0	21.3	.....	.....
27.50	29.2	28.5	27.8	27.1	26.4	25.7	25.0	24.3	.....	.....
30.00	32.2	31.5	30.8	30.1	29.4	28.8	28.0	27.4	26.7	26.0
32.50 .....	.....	.....	33.9	33.2	32.5	31.8	31.1	30.4	29.7	29.0
35.00 .....	.....	.....	36.9	36.2	35.5	34.8	34.1	33.4	32.7	32.1
37.50 .....	.....	.....	.....	.....	38.5	37.8	37.1	36.4	35.8	35.1
40.00 .....	.....	.....	.....	.....	41.5	40.8	40.1	39.4	38.8	38.2

The calculated price that must be realized from the sale of butterfat before it becomes more profitable to feed a concentrate supplement than hay alone is shown in this table. From these figures a dairyman may decide whether or not the feeding of a concentrate supplement would be economical. For example, with concentrates worth \$25 a ton and hay at \$8 it would be economical to feed concentrates if butterfat were worth more than 24.8 cents per pound.

Concentrates to be most economical must be fed during the period of peak production. These results are chiefly applicable to cows of approximately the same productive capacity as those used in this experiment.

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SUMMARY

The experiment that forms the basis for this bulletin consisted in feeding one group of cows alfalfa hay and another, alfalfa hay and concentrates, for four lactation periods. During the last two summers limited pasture was also made available. The cows were grades of average production.

The hay-fed group consumed 31.7 pounds of hay per cow per day during the first two years and 26.1 pounds during the two seasons that pasture was available. The hay- and concentrate-fed cows consumed 29.8 pounds of hay and 5.0 pounds of concentrates per day during the first two years and 24.2 pounds of hay and 4.0 pounds of concentrates per day the last two years with pasture available.

The hay-fed cows averaged 4,192 pounds of milk with 238.3 pounds of butterfat. The hay- and concentrate-fed cows averaged 5,358 pounds of milk containing 294.0 pounds of butterfat. The mature equivalent 4-per-cent-fat-corrected milk was 5,875 and 7,181 pounds, respectively. The mature equivalent butterfat averaged 266.4 pounds for the hay group and 322.2 pounds for the hay-concentrate group.

The total digestible nutrients required per pound of butterfat was 18.2 pounds for the hay-fed group and 17.2 pounds for the hay-concentrate-fed group, of which 13.9 pounds were derived from hay and 3.3 from concentrates. The hay-fed group required 5.8 per cent more digestible nutrients to produce a pound of butterfat than did the other group.

The solids-not-fat averaged slightly higher in the milk from the hay-fed group than from the hay-concentrate-fed group.

The hay-concentrate-fed cows averaged slightly heavier than the hay-fed cows. The concentrate group lost weight during lactation until the fourth month and made no gain until the seventh month, while the hay group lost until the fifth month but gained consistently after that time. At the end of the twelfth month from freshening, the cows in both groups were heavier than at freshening. Feeding methods had no apparent detrimental effect on the health of the herd.

The reproductive record of the herd was excellent, with no appreciable difference between the groups.

Even though sterilized bone meal or di-sodium phosphate was available to all cows, the inorganic phosphorus content of the blood was below normal, which was in harmony with other findings for cows fed largely on alfalfa hay. No consistent difference occurred between the two groups.

A table is included that shows the margin over feed costs for both methods of feeding at various prices for feeds, with butterfat at different values. The prices above which butterfat must sell to make hay-and-concentrate feeding more profitable than hay alone are also given.

Feeding Alfalfa Hay Alone and With Concentrates to Dairy Cows*

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INTRODUCTION

ALFALFA hay is commonly used in irrigated sections of the West as the sole, or principal ration of dairy cows. This is as true in the irrigated sections of Oregon as it is in other states, and dairying has come to be an important industry in practically every Oregon county that has a large acreage of alfalfa.

The agricultural census of 1934 shows a close relationship between alfalfa raising and dairying. Seventy-six per cent of the alfalfa in Oregon is grown in nine irrigated counties of eastern Oregon and in Jackson County of southern Oregon. Lane County of the Willamette Valley is the principal alfalfa section outside of the irrigated regions. These 10 counties that produce 76 per cent of the alfalfa in the state have 27 per cent of the state's dairy cows. The five eastern Oregon counties, Baker, Klamath, Malheur, Umatilla, and Union, with the largest acreages of alfalfa, have 61 per cent of the dairy cows maintained in the two principal alfalfa regions. These 5 counties average 6.4 cows per farm as compared to 6.0 cows per farm in the 10 principal counties and 5.2 cows per farm in the state as a whole. They produce an average of more than 63,000 tons of alfalfa per county, or approximately 48 tons per farm, and maintain an average of 8,381 cows per county.

The average milk production per cow in the alfalfa counties is slightly lower than for the state as a whole. The 5 counties leading in alfalfa production produce 16 per cent of the milk produced in the state and 64 per cent of the milk produced in the 10 irrigated counties leading in alfalfa production.

REVIEW OF LITERATURE

The feeding of alfalfa hay as a sole ration for dairy cattle is a fairly common western feeding practice, and several western stations have done experimental work recognizing this practice. Experiments have been conducted comparing alfalfa with other roughages and with supplementary rations of light and heavy grain feeding.

Headley (1) reported an increased butterfat production of 16.9 per cent and an increased milk production of 17.4 per cent when grain was fed in addition to alfalfa hay as compared with alfalfa hay alone. He reported that low-producing cows were able to obtain most of their nutrient requirements from hay, and responded but little to grain; while high-producing cows produced

*The experiments reported in this publication were conducted at the United States Umatilla Field Station at Hermiston, Oregon, on which the Oregon Agricultural Experiment Station is responsible for the livestock projects.

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considerably better if they received grain. With prices that ordinarily prevail he found that it was definitely profitable to feed grain to high-production animals. He fed a variety of mixtures of barley, mill run, and corn at the approximate rate of 1 pound of grain for every $2\frac{1}{2}$ pounds of milk produced per day in excess of 30 pounds.

Graves and Shepherd (2) with a group of 15 Holsteins on three times a day milking, report the exceptional production of 402.1 pounds of butterfat in 365 days from feeding hay alone. The same cows on full grain ration of 1 pound of grain to 3 pounds of milk produced 620.7 pounds of butterfat. Another group of 10 cows had average production records of 478.0 pounds, 584.1 pounds, and 619.9 pounds on rations consisting respectively of roughage, including pasture in season, roughage and limited grain, and roughage and full grain. The limited-grain-fed cows received 1 pound of grain to 6 pounds of milk and the full-fed cows 1 to 3. These investigators concluded that it was more economical to feed hay alone or hay with limited grain than to feed a full grain ration.

Jones, Brandt, and Haag (3) found that cows receiving grain supplement of two parts barley and one part oats with alfalfa hay converted feed total digestible nutrients into milk total digestible nutrients with 7 per cent greater efficiency than cows receiving alfalfa hay alone. They secured a production calculated to maturity of 179 pounds fat from long hay alone, 231 pounds from chopped hay, and 337 pounds from hay and grain. They concluded that it was economical to chop hay for \$2.25 a ton if butterfat were worth 30 cents or more per pound.

Dickson and Kopland (4) report that feeding a limited grain ration (1 to 6) resulted in an increased production of 22 per cent over that obtained from feeding roughage alone. The roughage that they fed consisted of alfalfa hay, corn silage, sugar beets, a small amount of dried beet pulp, and pasture. Cows fed on the limited grain ration produced 94 per cent as much as those fed a full ration of 1 to 3, and these investigators conclude that a full grain ration is wasteful and uneconomical. They used Holsteins of above-average productive ability in obtaining these results. The grain mixture used consisted of two parts ground corn, two parts ground oats, two parts mill feed, and one part linseed oil meal.

Investigators seem to agree that alfalfa hay as a sole ration does not interfere with breeding efficiency.

PLAN OF EXPERIMENT

In October 1933 an experiment was inaugurated at the Umatilla Field Station, Hermiston, Oregon, to determine the value of an alfalfa-hay ration for dairy cows as compared to a ration consisting of alfalfa hay plus grain. During the first two lactation years, 1933-34 and 1934-35, one group of cows was fed a ration consisting exclusively of alfalfa hay and a second group was fed a limited grain ration in addition to the alfalfa hay. During the third and fourth lactation years, 1935-36 and 1936-37, animals in both groups had access to limited pasture. Since the entire herd freshened in the fall and early winter the majority of the cows were in the fifth lactation month at the time of going on pasture. In addition, all cows had free access to stock salt, di-sodium phosphate, and steamed bone meal, records being kept of the amount of each consumed by each group. All cows were kept continuously in the same group during the entire four years, if they remained in the herd that long.

The various lactation years will hereafter be referred to as first, second, third, and fourth, rather than by the calendar dates.

Animals used. The original foundation stock for the herd was a number of yearling heifers purchased from farmers on the Umatilla project. These animals were largely grade Jerseys and were thought to have about the same productive capacity as the average animal on the project. The animals added to the herd since have been the daughters of the original stock sired by unproved, registered Jersey bulls.

During the first year of this experiment the herd consisted of 11 grade Jerseys and 3 grade Guernseys, which were divided into two groups, 7 fed hay and grain, and 7 hay alone. All but 3 of these animals were immature, although 10 of them had previous records.

An attempt was made to place animals of approximately the same actual or potential productive ability in each group. The grouping and previous production are shown in Table 1, which shows previous production of 334.7 pounds for the cows in the hay group, and 306.3 pounds for the cows in the other group. Number 45, a mature cow, was considered capable of producing 400 pounds or more, which would bring the two groups nearly together as far as previous production is concerned.

For the second year 2 animals were removed from the herd because of garget and low production, and 8 heifers, progeny of the original cows, were added, so that each group consisted of 10 animals. In the third year 5 low producers from the second year's experiment were eliminated and 9 heifers added, so that 11 cows were in the grain group and 13 in the hay group. At the conclusion of the third year 1 cow died and 9 were sold, 8 for low production and one as a nonbreeder. Nine heifers were added, however, and for the fourth year the herd consisted of 12 cows receiving hay only, and 11 receiving grain. Heifers that were added to each group for each year were balanced according to production of their dams as nearly as possible. Full sisters were placed in opposite groups.

Table 1. PRODUCTION OF ANIMALS FOR YEAR PREVIOUS TO EXPERIMENT
October 1, 1932 to October 1, 1933

Cow number	In milk	Carried calf	Milk	Butter-fat	Butter-fat	Age	Weight
	Days	Days	Pounds	Per cent	Pounds	Years	Pounds
<i>Hay group*</i>							
2	323	248	5,897	6.24	368.0	5	1,005
3	282	238	6,389	5.09	325.4	5	973
11	327	248	5,617	5.46	308.2	5	963
13	324	249	5,176	6.37	329.7	5	902
75	326	267	6,663	5.13	342.0	Mature	990
Average	316	250	5,949	5.63	334.7	....	967
<i>Concentrate group*</i>							
1	301	240	7,260	4.41	320.2	5	933
4	365	183	6,094	5.64	343.5	5	1,051
12	365	228	4,942	5.46	270.0	5	1,039
15	297	247	6,369	4.64	295.7	5	990
45	No record	No record	No record	No record	No record	Mature	987
67	325	241	6,163	4.90	302.1	Mature	1,055
Average	331	228	6,165	4.97	306.3	....	1,009

* The grouping in this table is that used in the experiment the following year.

Methods of feeding and handling. During the entire period of the experiment the cows were handled in much the same manner as the majority of the dairy animals in eastern Oregon. Each group had a separate corral and shelter shed and the cows were brought in the barn twice daily for milking, which was done by hand during the first year and in later years by machine. The hay, which for the most part was of good quality, was fed in mangers in outside corrals immediately after milking. The cows were given all the hay they would consume without waste, and records were kept of the amount consumed by groups. The same quality of unchopped hay was fed to each group, and when any hay was refused, it was weighed back.

The concentrate mixture consisted of four parts mill run, two parts ground barley, and one part ground oats. This was fed at the time of milking according to the amount of butterfat produced. During the first 2 years, 1 pound of grain was allowed per day for each pound of fat produced in 5 days. For the third and fourth years of the experiment the grain-feeding level was changed so that 1 pound of grain was fed for each 1/10 pound of butterfat above a minimum level of 0.7 pound of butterfat daily. Under this plan high-producing cows received more grain during peak production than during the first 2 years of the experiment and low-producing cows received less. Concentrates fed at these rates would be considered a limited grain ration, averaging during the 4 years approximately 1 pound of grain to 4 pounds of milk.

Dry cows were allowed pasture during the summer, and the rest of the season were fed hay with some succulent feed such as squash or roots when available. No grain was fed to dry animals.

Data recorded. Records of hay and grain consumption were kept on a lactation-month basis to correspond with the milk- and butterfat-production records. Milk was weighed at each milking, and butterfat tests were made by the Babcock method on separate samples of morning and evening milk the middle of each month. During the first 3 years determinations of the solids-not-fat in the milk were made at the same time as the butterfat tests. As an indication of health and condition, the cows were weighed the first 3 days of each month. Individual breeding records were kept, including periods of oestrus, service, calving, and condition, sex, and weight of calf.

RESULTS OBTAINED

Feed consumption. Table 2 gives information on the length of lactation period, the average number of days the cows were pregnant, the feed consumption per day, and the feed required to produce a pound of butterfat by each group.

Both groups had lactation periods of approximately 300 days for all 4 years. The hay-fed group was pregnant during lactation for an average of 207 days, and the concentrate group for 199 days, although in the third year the latter decreased to 180 days, due to the fact that No. 27 proved to be a non-breeder.

The hay-fed group had a daily consumption of 29.0 pounds of hay per cow, or only 2.1 pounds more daily than the 26.9 pounds consumed by the concentrate-fed group.

The addition of pasture to the ration in the last 2 years resulted in the hay consumption of each group being lowered by approximately 4 pounds daily in the third year, and 7 pounds daily in the fourth year, on the basis of daily

average for the entire lactation year. Cows of both groups were allowed all the hay they would clean up when on pasture, and consumption ranged from 2 pounds to nearly 20 pounds per cow day, depending on the quality of the pasture. The average cow in the concentrate group during the 4-year period also consumed 4.5 pounds daily of the concentrate mixture during the entire lactation period. The daily concentrate consumption during the first 2 years was 4.9 and 5.2 pounds respectively, but with the change in rate of concentrate feeding consumption was reduced to 3.8 pounds daily for the third year, and 4.2 pounds for the fourth year.

For each pound of fat produced in the 4 years the average consumption of cows fed on hay alone was 36.7 pounds of hay, while the concentrate-fed group consumed 27.9 pounds of hay in addition to the concentrate. For both groups the rate was highest in the first year and lowest in the fourth year. The amount of concentrate for each pound of butterfat produced was 5.2 pounds, 5.0 pounds, 4.0 pounds, and 4.2 pounds respectively for the 4 years, which was an average of 4.6 pounds.

Table 2. FEED CONSUMPTION AND INCIDENTAL LACTATION DATA BY GROUPS

Year	Cows	Lactation period	Carried calf	Hay per day	Concentrate per day	Hay per pound fat	Concentrate per pound fat	Pasture
	Number	Days	Days	Pounds	Pounds	Pounds	Pounds	Days
<i>Hay group</i>								
First	7	301	214	31.7	.....	41.3	.....	.....
Second	10	297	206	31.9	.....	39.7	.....	.....
Third	13	304	199	27.5	.....	35.2	.....	88
Fourth	12	302	208	24.7	.....	30.6	.....	124
Four-year average	11	301	207	29.0	.....	36.7	.....	.....
<i>Concentrate group</i>								
First	7	301	205	30.0	4.9	32.6	5.2	.....
Second	10	300	213	29.3	5.2	28.7	5.0	.....
Third	11	303	180	25.8	3.8	27.3	4.0	91
Fourth	11	305	196	22.6	4.2	22.9	4.2	124
Four-year average	10	302	199	26.9	4.5	27.9	4.6	.....

Milk and butterfat production. Table 3 gives the production of each group of cows for each of 4 years and the average for the 4 years. Milk production is given as number of pounds actually produced and pounds calculated to a 4-per-cent-butterfat basis on both an actual and mature equivalent basis. Butterfat is also shown on the basis of mature equivalent as well as actual production. The factors used in making the conversions to maturity were those given in Dairy Herd Improvement Association Letter, Volume 9, No. 9, November 1933.

Table 3. MILK AND BUTTERFAT PRODUCTION
By groups

Year	Total milk	4-per-cent fat-corrected milk	Mature equivalent 4-per-cent fat-corrected milk	Butterfat	Butterfat	Mature equivalent butterfat
	Pounds	Pounds	Pounds	Per cent	Pounds	Pounds
<i>Hay group</i>						
First	4,433	5,297	5,654	5.27	233.8	251.0
Second	3,998	5,198	5,848	5.96	238.4	268.0
Third	4,098	5,205	5,950	5.79	237.3	270.2
Fourth	4,237	5,381	6,048	5.75	243.5	276.5
Four-year average	4,192	5,270	5,875	5.68	238.3	266.4
<i>Concentrate group</i>						
First	5,654	6,502	6,782	4.97	280.1	295.0
Second	5,496	6,815	7,534	5.61	308.1	340.2
Third	5,055	6,343	7,098	5.66	286.2	321.3
Fourth	5,227	6,638	7,311	5.76	301.0	332.3
Four-year average	5,358	6,560	7,181	5.48	294.0	322.2

The hay-fed cows produced an average of 4,192 pounds of milk per year as compared with 5,358 pounds for the concentrate-fed animals. The group production of the hay-fed cows showed a decline in milk from the first to second year, and the concentrate-fed cows from the first to the third year, largely due to the addition of a number of young cows that produced less milk but with higher butterfat content.

The hay-fed group was very consistent in the amount of butterfat produced: 233 pounds the first year; 238 the second; 237 the third, and 243 the fourth; an average of 238 for the four years. The concentrate-fed group produced a low of 280 pounds of butterfat the first year and a high of 308 pounds the second year. In the third and fourth years they averaged 286 and 301 pounds respectively for a 4-year average of 294 pounds, or 56 pounds more than was produced by the hay-fed group. The difference as calculated to maturity was also 56 pounds.

Mature equivalent production for the hay-fed group averaged 266 pounds for the 4 years and 322 pounds for the cows receiving a concentrate supplement. This average would have been 331 except for low production the first year.

The production of 265 to 275 pounds of mature equivalent butterfat per cow annually seems to be about what a dairyman may expect when high-testing cows weighing 850 to 900 pounds consume about $4\frac{1}{2}$ tons of hay annually.

Similar cows consuming approximately $4\frac{1}{2}$ tons of hay and 1,500 pounds of concentrate annually produced 320 to 340 pounds of butterfat.

The milk records have been converted to 4-per-cent-fat-corrected milk so that the two groups might be compared on an equal butterfat-percentage basis. Factors used in making these conversions were taken from a modification of the Gaines formula developed by Perkins of the Ohio Station in which factors are used for converting weights of milk of other fat content to their energy equivalent weight of 4-per-cent milk. On this converted basis the concentrate-fed cows had a 4-year average production of 7,181 pounds of 4-per-cent-fat-corrected milk. The production of the hay-fed cows, on the same basis, was 5,875 pounds, or 1,306 pounds less than that produced by the concentrate-fed cows.

Figure 1 shows the average mature equivalent milk production by lactation months for each group and normal production for cows under good farm conditions as given by Eckles (5).

MILK BY LACTATION MONTHS WITH HAY ALONE AND WITH HAY AND CONCENTRATE COMPARED WITH ECKLE'S NORMAL

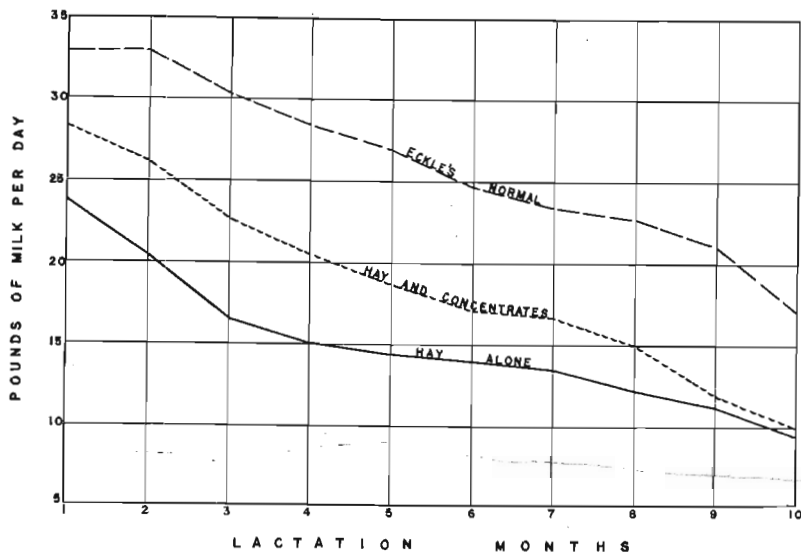


Figure 1.

Hay consumed by lactation months. The amount of hay consumed per cow per day by groups for each lactation month is shown in Table 4. The consumption of hay shows very little variation within each group until the third and fourth years, when limited pasturage became available. During the first year, the most hay per day was consumed during the last 2 months of the lactation, apparently being due to the feeding of new hay. In the second year the most hay was consumed in the first month, and the least in the eighth month. The hay fed that spring or the latter part of the lactation year, was not especially good and contained some volunteer rye with the alfalfa. In the third year the cows were on pasture for about 90 days, and in the fourth year had access to pasture for 125 days, and for this reason the hay consumption declined in the latter months of the lactation. The concentrate-fed cows ate less hay than the others during the season on pasture, just as they had done when on dry feed exclusively.

The yearly average consumption of hay for the first 2 years was 31.7 pounds per day for the hay-fed group, and 29.8 pounds for the grain-fed group, a difference of only 1.9 pounds. In the 2 years that pasture was available, the yearly average declined to 26.1 pounds, and 24.2 pounds per day respectively for the two groups.

During the 4 years the greatest difference between the groups was approximately 3.5 pounds per day in the first month of each of the first 3 years. The least difference occurred in the latter stages of the lactation and was some-

Table 4. TOTAL AND AVERAGE HAY CONSUMED DAILY BY BOTH GROUPS, BY LACTATION MONTHS

Year	Lactation months										Yearly total	Average
	1	2	3	4	5	6	7	8	9	10		
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
<i>Hay group</i>												
First	31.5	28.8	28.4	29.6	30.4	32.1	32.4	34.1	34.2	35.2	9,542	31.7*
Second	35.6	31.5	34.8	32.5	30.5	30.4	30.2	30.0	30.6	32.3	9,415	31.7
Third	32.6	33.8	33.5	32.9	29.9	27.7	23.5	20.8	19.2	20.2	8,359	27.4
Fourth	34.0	34.6	33.3	33.6	28.5	21.6	15.8	13.4	13.4	17.6	7,449	24.7
<i>Concentrate group</i>												
First	27.5	26.1	27.9	28.4	30.0	30.1	31.3	31.9	33.0	32.9	9,147	30.0
Second	32.1	31.1	30.9	30.0	29.0	28.1	28.3	28.0	28.2	28.3	8,839	29.5
Third	29.4	31.0	30.4	30.3	30.8	25.9	24.0	20.9	15.5	18.3	7,809	25.7
Fourth	32.3	31.7	31.6	28.8	26.9	21.6	15.4	12.0	11.1	14.0	6,882	22.6

* Average is based on days actually in milk. See text.

times so low as to be negligible. The total consumption of hay per cow year was greatest in the first year and declined each year, particularly in the last 2 years, when some pasture was available. As mentioned previously, the daily hay consumption of the hay-fed cows was the same for the first 2 years but as the average lactation period was slightly longer the first year the total consumption per year was greater.

Concentrates consumed by lactation months. Concentrate consumption is shown in Table 11 (Appendix) by individual cows and on a group-average basis by lactation months for each year of the experiment.

In the first year the most concentrate per day was consumed in the first month, when the average was 7.5 pounds. In the second year the maximum consumption was less than for the first year; however, the average was greater due to greater persistency of production. The third-year maximum of 6.6 pounds was reached in each of the first two months. The fourth-year maximum of 8.0 pounds was reached in the second month and from that point consumption declined to 1.3 pounds in the tenth month. The third- and fourth-year minimums of 1.0 and 1.3 were below the minimum of the first 2 years, due to the change in feeding schedule.

The highest individual concentrate consumption was the third year when cow No. 1 consumed an average of 12.9 pounds per day during the second month. One or two cows occasionally received up to 15 pounds for part of a month, but none would have consumed much more than that even if they had been entitled to it. Some of the lower-producing cows received no concentrate at all during the last month or so, especially in the third and fourth years when concentrate feeding was stopped and when the daily fat production declined to .7 pound.

Digestible nutrients consumed. The amount of feed consumed per pound of butterfat produced has been converted to pounds of total digestible nutrients (T.D.N.) consumed per pound of butterfat produced, with the resulting data given in Table 5. The total digestible-nutrient content per 100 pounds of total weight is considered as being 49.7 pounds for the alfalfa hay and 72.5 pounds for the concentrate mixture. The analysis of the concentrate mixture is based on published data (6) and the hay analysis is based on analyses of composite samples continuously taken. The analyses are given in Table 8.

The intake of total digestible nutrients per pound of butterfat produced was 18.2 pounds for the hay-fed group and 17.2 pounds for the concentrate-fed group, of which amount 13.9 pounds were derived from hay, and the remainder from grain. This indicates a difference between the groups of 1.0 pound, or 5.8 per cent; in other words, the hay-fed cows consumed 5.8 per cent more digestible nutrients per pound of butterfat produced than did the concentrate-fed animals.

Although this is a comparatively small difference, it would seem to be a clear indication that the better-fed animals are able to utilize their feed more efficiently than the poorer-fed animals. It will be noted that in the second year when the difference in butterfat production was greatest—almost 70 pounds—the difference in efficiency was 10.1 per cent, while in the first year, when the concentrate animals consumed more concentrate and the difference in production was only 46 pounds of fat, the difference in efficiency of the two groups was only 2.5 per cent. In the third and fourth years the differences of 6.0 per cent and 5.6 per cent, respectively, are very close to the 4-year average.

The lower ratio of total digestible nutrients per pound of butterfat, in the last two years is due to pasture having been available. Since a relatively

small amount of nutrients was obtained from pasture, it was not considered in the calculations. Both groups having had an equal access to pasture, however, they are still on a comparable basis. The average difference in efficiency for the first 2 years when pasture was not available was the same as the average for the years when pasture was available; namely, 5.8 per cent.

Table 5. CONSUMPTION OF TOTAL DIGESTIBLE NUTRIENTS PER POUND OF BUTTERFAT*

Year	Hay group	Concentrate group			Difference	
	Hay T.D.N.	Hay T.D.N.	Concentrate T.D.N.	Total T.D.N.		
	Pounds	Pounds	Pounds	Pounds	Pounds	Per cent
First	20.5	16.2	3.8	20.0	0.5	2.5
Second	19.7	14.3	3.6	17.9	1.8	10.1
Average, first 2 years	20.1	15.3	3.7	19.0	1.1	5.8
Third	17.5	13.6	2.9	16.5	1.0	6.0
Fourth	15.2	11.4	3.0	14.4	.8	5.6
Average, last 2 years	16.4	12.5	3.0	15.5	.9	5.8
Four-year average	18.2	13.9	3.3	17.2	1.0	5.8

* Based on Oregon analysis: Alfalfa 49.7 per cent T.D.N.; concentrate mixture 72.5 per cent T.D.N.

Average and maximum daily milk production. The average and the maximum daily milk production are given in Table 12 (Appendix) to show the production of which the animals in each group were capable. This shows more clearly than the other tables the increased production obtained by feeding concentrates, especially from the cows of above-average productive ability. In most cases the average production of the concentrate-fed group was above that of the highest cow in the hay-fed group.

In both groups the maximum production was higher for the first year than for any of the succeeding years. This was due to the fact that in later years the herd contained more immature animals, which on the average produced milk containing a higher percentage of butterfat.

The highest maximum attained by an individual cow of the hay-fed group was 36.4 pounds of milk, produced by No. 11 on the eleventh day of the third lactation. Several cows of the concentrate-fed group produced in excess of 40 pounds of milk and No. 45 attained a production of 44.7 pounds on the twenty-sixth day of the fourth lactation year.

In the first year the concentrate-fed cows reached the maximum 3 days earlier than the hay-fed cows, but in later years they reached the peak a few days later. The difference is so slight, however, that it probably is not particularly significant. There does not seem to be any consistent difference in the time required to reach the maximum production for the first or succeeding lactations of individual cows. The age of each cow at calving time is shown in Table 13 (Appendix), which gives the milk and butterfat production of each cow.

Detailed milk and butterfat production. The detailed production of each cow for each year that she was in the experiment is given in Table 13 (Appendix) in order that additional calculations may be made if desired. Data are given on the age of the cows at calving time, the number of days in milk,

and the number of days between calves. When a cow's dam was also in the herd during this experiment, her number is also given. Milk and butterfat records are given both for the entire lactation period and for 305 days, which was the period on which averages were based. The percentage of butterfat is also given, as are the pounds of milk on a 4-per-cent-fat-corrected basis, and the pounds of milk as calculated to maturity on a 4-per-cent basis for 305 days.

A few cows were in milk for less than 305 days. In some instances this was necessary in order to give the animals 6 weeks rest before the start of the next lactation; in other instances production declined to the point that it was not worth while to milk them.

Several cows were sold on account of low production at the completion of their lactation, and before they had calved again, so data are not available on days between calves. These animals were all apparently pregnant at the time of sale. Two cows were sold as nonbreeders, No. 27 at the end of the third year and No. 45 at the end of the fourth year. Both of these cows were in the concentrate-fed group, and No. 27 had completed one lactation period while No. 45 was twelve years of age and had been in the herd since it was first founded.

Table 13 is presented particularly for the purpose of giving the total butterfat production of each individual cow, and clearly shows how butterfat production is increased by the feeding of a concentrate mixture.

The highest butterfat production attained by any cow of the hay group was 323.5 pounds by No. 3 in the second year, and only two other cows, No. 11 in the fourth year and No. 13 in the second and third years surpassed 300 pounds, while the 4-year average of the concentrate group was 294 pounds, or only 29.5 pounds less than the best record in the hay group. Of the cows in the concentrate group, No. 45 in the second and fourth years, and No. 47 in the fourth year surpassed 400 pounds of butterfat, and No. 1 and No. 18 were within a few pounds of the 400-pound figure. Exclusive of first-calf heifers, the majority of the cows in the concentrate group surpassed 300 pounds, and No. 47 made 312 pounds as a 2-year old. The poorest records of cows in the concentrate group, however, are only slightly better than the poorest records of hay-fed animals, which would seem to indicate that cows with low potentials do not respond to concentrate feeding as well as the better animals, which is in line with what one would expect.

The five highest yearly records in the concentrate group averaged 419.1 pounds, while the five highest records in the hay group averaged 307.3 pounds, a difference of 111.8 pounds, or 36.4 per cent. By comparison there is a difference of only 12.6 per cent or 21.3 pounds, between the five low records of the two groups, the low records of the hay group averaging 169.3 pounds, as compared with 190.6 pounds for the low records of the other group. Looking at it in another way, the high records of the concentrate group are equal to 220 per cent of the low records of the same group, while the high records of the hay group are equal to 181 per cent of the low yields.

Milk production of individual cows in the two groups is discussed under the heading, "Average and maximum daily milk production," and as the significant averages are given in Table 3 and Table 12, no averages are given in Table 13.

Solids-not-fat content of milk. During the first 3 years of the experiment the milk was tested for its solids-not-fat content by means of a Quevenne lactometer, the tests being made in conjunction with the butterfat tests the

Table 6. AVERAGE PERCENTAGE OF SOLIDS-NOT-FAT BY LACTATION MONTHS

Month and milking	First year		Second year		Third year		Three-year-average	
	Hay	Hay and concentrate	Hay	Hay and concentrate	Hay	Hay and concentrate	Hay	Hay and concentrate
	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
1 { a.m.	9.18	9.46	9.43	9.02	9.02	8.34	8.98	8.94
1 { p.m.	9.05	9.15	8.79	8.91	8.64	7.94	8.83	8.67
2 { a.m.	9.11	9.37	9.45	9.39	8.94	8.94	9.16	9.23
2 { p.m.	9.32	9.18	8.76	8.85	8.90	8.83	8.99	8.95
3 { a.m.	9.19	9.45	9.34	9.09	9.02	8.97	9.18	9.17
3 { p.m.	9.05	9.32	9.05	8.67	8.70	8.78	8.93	8.92
4 { a.m.	9.07	9.42	9.28	9.21	9.29	8.98	9.21	9.20
4 { p.m.	8.78	9.12	9.40	9.02	8.63	8.55	8.94	8.90
5 { a.m.	8.99	9.24	8.82	9.15	8.82	8.82	8.88	9.07
5 { p.m.	8.72	9.04	8.82	9.14	8.59	8.52	8.71	8.90
6 { a.m.	9.46	9.15	9.17	9.13	8.89	8.76	8.17	9.01
6 { p.m.	9.08	8.95	8.94	8.99	8.32	8.12	8.78	8.69
7 { a.m.	9.30	9.20	8.86	9.00	8.99	8.62	9.55	8.94
7 { p.m.	9.03	9.09	8.94	8.60	8.30	8.18	8.96	8.62
8 { a.m.	9.34	9.20	9.09	9.12	8.90	8.67	9.11	8.99
8 { p.m.	9.24	9.09	8.98	8.89	8.41	8.05	8.88	8.68
9 { a.m.	9.37	9.14	9.28	9.11	8.98	8.86	9.21	9.04
9 { p.m.	9.25	8.98	9.19	9.01	8.78	7.89	9.07	8.63
10 { a.m.	9.42	9.22	9.35	8.95	8.95	8.81	9.24	8.99
10 { p.m.	9.07	8.99	9.13	9.11	8.80	8.52	9.00	8.87
Average a.m.	9.24	9.28	9.21	9.12	9.00	8.77	9.15	9.06
Average p.m.	9.06	9.09	9.00	8.92	8.61	8.33	8.89	8.71

middle of each month. These tests were made with two objects in view; first, to determine if the feeding had any effect on the solids-not-fat content of the milk, and second, to compare the average percentage of solids-not-fat with the amount required by Oregon law; namely 8.5 per cent. The results are given in Table 6.

The morning tests were consistently higher than the evening tests. The average for all morning tests in 3 years for the hay group was 9.15 per cent as compared to 8.89 per cent for the evening tests. The concentrate group had morning and evening tests of 9.06 and 8.71 per cent, respectively. The higher morning tests were apparently due to the cooler temperature, as the animals gave more milk of a lower fat content in the morning than in the evening.

The stage of the lactation and season of the year seemed to have but little effect on the solids-not-fat content of the milk, although there was considerable variation from month to month.

No significant difference was observed between groups in regard to solids-not-fat. During the first year the solids-not-fat content of the milk from concentrate-fed cows was slightly higher than the others, but for the last 2 years the reverse was true. The average of the three years also shows the hay-fed cows to be slightly higher than the others. Both groups had the highest test in the first year and lowest in the third year. What decrease did occur was due apparently to the addition of young animals with a lower test.

In a number of instances in the third year, the average test of the herd was below the Oregon requirement of 8.5 per cent of solids-not-fat. If the milk of the herd was standardized down to the butterfat requirements of the law, the solids-not-fat content would probably be further decreased.

Cow-weight data. All cows were weighed the first 3 days of each month as an indication of health and condition. Individual cow-weight data are given in Table 14 (Appendix) for the last month before freshening and for the 12 months following freshening. The 4-year average of cow and heifer weights by lactation months is shown in Figure 2. Some cows were removed from the herd before the 12-month period was completed, but only those cows are included in the record that were in the herd for the entire period. Heifers are considered separately from cows, as weights on them are not available for the month before freshening and as their rate of gain or loss is not the same as for cows.

The concentrate-fed cows were heavier at all times than were the hay-fed cows, partly due to the fact that larger cows happened to have been selected originally for the hay-and-concentrate group than for the hay group. The heifers of the hay-fed group were heavier than the others during the first two months of the lactation, but after the third month the concentrate-fed heifers were heavier until the time of going dry. The hay-fed heifers gained somewhat more rapidly than the others between the eleventh and twelfth months.

The hay-and-concentrate-fed cows practically maintained their weights from the first month after freshening until the seventh month, following which they gained. The hay-fed cows continued to lose weight from the first month after freshening until the fifth month, gained slightly during the sixth and seventh months, and gained rather rapidly thereafter. The curves in Figure 2 illustrate the average rates of loss and gain for the 4 years.

The concentrate-fed cows were lightest, 900 pounds, at the fourth month, and made no great gain until the seventh month, but from that time gained consistently to weigh 994 pounds at the tenth month of the lactation. At the

twelfth month they weighed 1,047 pounds, or 31 pounds more than at the month before freshening.

The hay-fed cows reached a minimum of 831 pounds at the fifth month but after that gained consistently and weighed 927 pounds at the tenth month. At the end of 12 months they weighed 1,001 pounds, a gain of 34 pounds from the month prior to freshening. The weight curve of the heifers is quite similar to that of the cows, but the rate of gain during the lactation, due to natural growth, was greater. The concentrate-fed heifers gained 166 pounds from the first to the tenth months and the others 132 pounds during the same period.

WEIGHTS OF COWS AND HEIFERS BY LACTATION MONTHS
4-YEAR AVERAGE

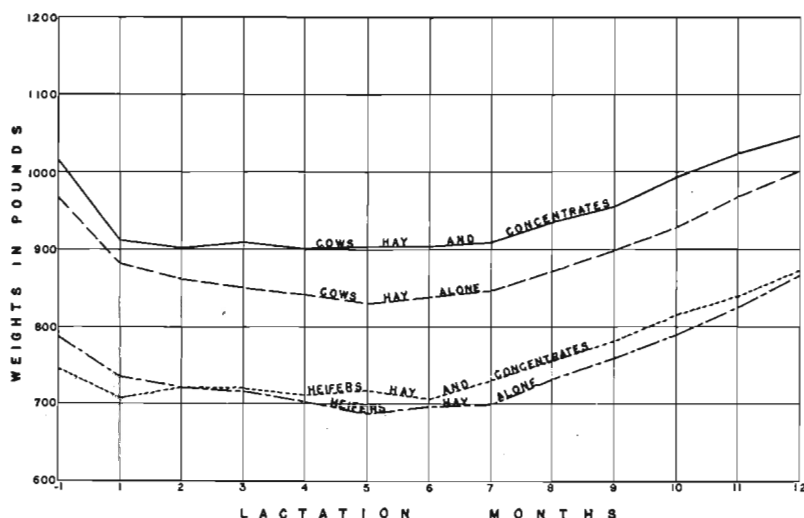


Figure 2.

Health of cows. The health of all cows was excellent, on the whole, but in the winter of the second year there were several mild cases of dysentery caused by feeding wet hay during a rainy period. The hay-fed cows were more severely affected than the concentrate-fed cows and young cows were affected more than the older ones. Cows receiving a large concentrate ration occasionally showed signs of constipation for a day or two but this was usually corrected by removing the concentrate ration until the animal returned to normal.

Cows in the concentrate group were in noticeably better condition than the others at all times, especially in the winter. Their coats were distinctly smoother and they showed better flesh, as well as presenting a more vigorous appearance.

Two cows of the concentrate group, No. 67 the first year and No. 1 the third year, had milk fever; but they had received no concentrate at the time of going down, so apparently the feed was not responsible.

Reproductive record of herd. The record of both groups of cows was excellent, on the whole, throughout the period of the experiment. During the

first year, one cow in the hay group required six services but finally conceived. Several cows in both groups required two services. The second was the best year and only one cow in each group required a second service. In each of the last 2 years one cow of the concentrate group proved to be a nonbreeder, and was not included in the herd breeding average. The detailed record is given in Table 7.

For the 4 years the average number of services per pregnancy was 1.41 for the hay-fed cows and 1.38 for the concentrate-fed cows. The number of days between heat periods was, in most cases, regular; and the average for the 4 years was 24.8 for the hay-fed group and 26.9 for the concentrate-fed group. In a few cases the periods between heat were from 40 to 60 days, which brought the average above the normal period of 21 days.

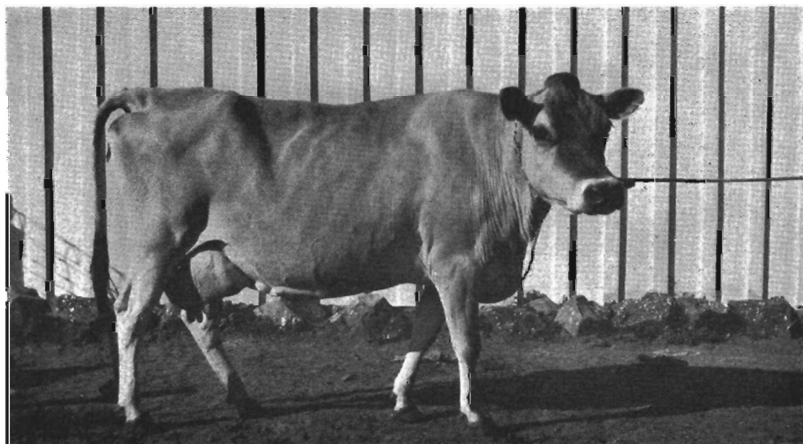
In the majority of cases the gestation period was slightly in excess of the so-called normal period of 282 days. In the third year No. 23 of the concentrate group carried her calf only 259 days, and No. 28 of the hay group was pregnant only 262 days, thus lowering the average of both groups. Both calves were bulls and were small and weak, but otherwise normal.

An attempt was made to have cows freshen at intervals of 1 year and in most cases this was done. For the 4 years the average number of days between calves was 373 for the hay-fed group, and 372 for the concentrate-fed group.

The calves from the hay-fed cows were practically as heavy as those from cows in the concentrate group. The average weight of calves for the 4 years was 56.8 pounds for the hay group and 57.1 pounds for the concentrate group.

In the first year one concentrate-fed cow produced a set of twins, otherwise the calves of that group would probably have weighed as much as the others. Only in the fourth year were the calves born to the concentrate-fed group heavier than the others.

Each year at least one cow was sold before she had calved again so data are not available on calves from the full herd.



Cow No. 26—Hay Group. Average production first two 305-day lactations: 265.3 pounds butterfat with 29.8 pounds alfalfa hay consumed per pound butterfat.

Table 7. REPRODUCTIVE RECORD OF HERD

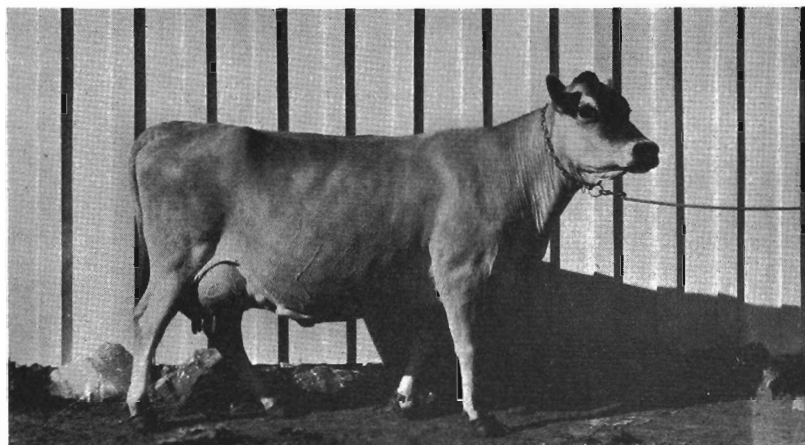
Group	Number of cows	Services per pregnancy	Time between heats	Gestation period	Calved again	Weight of calves	Sex of calves		Cows retained
							Heifers	Bulls	
			Days	Days	Days	Pounds	Number	Number	Number
<i>First year</i>									
Hay	7	1.86*	23	287	378	55.6	6	1	6
Concentrate	7	1.57	29	284	382	54.9	5†	3	6
<i>Second year</i>									
Hay	10	1.1	29	284	371	60.9	3	5	8
Concentrate	10	1.1	28	285	370	60.9	3	6	9
<i>Third year</i>									
Hay	13	1.33	24	283	379	59.5	5	3	8
Concentrate	11	1.36‡	24	279	361	54.7	2	4	6
<i>Fourth year</i>									
Hay	12	1.33	23	285	363	51.3	5	4	9
Concentrate	11	1.50‡	26	287	373	57.8	3	5	7
<i>Four-year average</i>									
Hay	10.5	1.41	24.8	284.8	372.8	56.8	4.8	3.3	8
Concentrate	10.0	1.38	26.8	283.8	371.5	57.1	3.3	4.5	7

* One cow required six services.

† One pair twins—one each sex.

‡ One cow proved to be a nonbreeder; not included in average.

For the hay-fed group the percentage of heifer calves was 59.4 per cent of the entire calf crop of that group and for the concentrate-fed group the percentage of heifers was 41.9 per cent. Only in the first year were more heifers than bull calves born to cows in the concentrate group. In the entire 4 years 19 heifers and 13 bulls were born to cows of the hay-fed group and 13 heifers and 18 bulls were born to the other group.



Cow No. 47—Hay and Concentrate Group. Average production first two 305-day lactations: 360.0 pounds butterfat with 20.4 pounds alfalfa hay and 5.0 pounds concentrates consumed per pound of butterfat.

Consumption of salt, bone meal, and di-sodium phosphate. All cows had access to half-ground common stock salt throughout the experiment; di-sodium phosphate was available except for a few months in the first and second years and steamed bone meal was available after the first year but none was consumed except during months of peak production. Data showing the salt, di-sodium phosphate, and bone meal consumption of each group by calendar months and years are shown in Table 15 (Appendix). It is impossible to present this material by lactation months since not all animals freshened in the same month; however, since they all freshened in the fall or early winter the months of peak production were December, January, and February. The maximum consumption of minerals ordinarily took place in those peak months and declined as production declined.

During the first year the hay group and concentrate group consumed approximately the same amount of di-sodium phosphate, 25.05 and 25.36 ounces per cow respectively in a month. In the following years the heavier-producing concentrate group consumed somewhat more than the others, taking monthly 16.16, 19.64, and 28.9 ounces respectively for the next 3 years, as compared with 15.54, 16.13, and 20.7 ounces for the hay group. Each of the groups consumed approximately the same amount of salt during the entire period of the experiment. The highest average monthly consumption was 17.98 ounces per cow taken by the hay group during the first year, and the lowest amount 10.3 ounces taken by the same group in the fourth year. On the average the

Table 8. ANALYSIS OF FEEDS USED IN EXPERIMENT

Year and crop	Sample number	Description	Period fed	Moisture	Ash	Crude fat	Crude fiber	Crude protein	Calcium	Phosphorus
				<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
First	H1229	Concentrate	8/1/33-2/6/34	8.12	5.07	3.58	7.68	14.40	0.13	0.77
First	H1273	Mixture								
First	H1273	Concentrate	2/6/34-12/20/34	7.07	4.69	3.82	7.54	15.20	.16	.75
Second	H1587	Mixture								
Second	H1587	Concentrate	12/20/34-9/20/35	8.86	4.97	3.85	8.53	13.99	.15	.76
Third	H2113	Mixture								
Third	H2113	Concentrate	9/20/35-11/23/36	9.73	4.64	3.86	6.80	15.04	.17	.71
First	H1228	Mixture								
First	H1228	Alfalfa	8/1/33-2/6/34	7.83	10.53	1.78	30.33	13.16	1.36	.21
First	H1274	Alfalfa	3/15-5/8/34	7.26	9.33	1.26	33.29	13.89	1.31	.20
First	H1275	Alfalfa	3/15-5/8/34	7.26	9.33	1.26	33.29	12.78	1.28	.20
<i>First year</i>										
1st crop	H1276	Alfalfa	5/8-6/25/34	6.53	10.07	1.72	23.88	16.09	1.50	.25
1st crop	H1277	Alfalfa	5/8-6/25/34	6.53	10.07	1.72	23.88	15.87	1.28	.25
2nd crop	H1278	Alfalfa	6/25-8/6/34	6.56	9.57	1.44	29.65	13.46	1.20	.24
2nd crop	H1279	Alfalfa	6/25-8/6/34	6.56	9.57	1.44	29.65	15.06	1.31	.25
3rd crop	H1280	Alfalfa	8/6-12/26/34	7.02	8.66	1.45	30.89	13.45	1.29	.21
3rd crop	H1281	Alfalfa	8/6-12/26/34	7.02	8.66	1.45	30.89	13.28	1.27	.20
<i>Second year</i>										
1st crop	H1586	Rye, Alfalfa	5/1/35-6/14/35	6.98	9.36	1.58	28.16	8.56	.69	.24
1st crop	H1872	Rye, Alfalfa	11/5-11/16/35	7.02	9.95	1.24	30.87	10.83	1.08	.25
1st and 2nd crops	H1582	Alfalfa	12/26/34-2/20/35	7.96	8.32	1.31	34.23	12.43	1.21	.17
2nd crop	H1583	Alfalfa	2/20-3/20/35	8.09	8.55	1.41	32.50	13.19	1.05	.18
4th crop	H1584	Alfalfa	3/20-5/1/35	7.19	8.68	1.39	31.44	12.42	1.29	.18
2nd crop	H1585	Alfalfa	7/25-9/23/35	7.05	8.24	1.31	31.76	10.46	1.05	.19
2nd crop	H1873	Alfalfa	3/5/36-3/28/36	6.21	15.52	1.00	35.80	8.87	1.06	.22
3rd crop	H1874	Alfalfa	3/5/36-3/28/36	6.47	8.85	1.49	35.06	11.63	1.14	.19
2nd crop	H1880	Alfalfa	3/28-5/5/36	6.71	11.80	1.32	30.05	12.48	1.26	.22
<i>Third year</i>										
1st crop	H1881	Alfalfa	5/5-12/29/36	6.93	9.02	1.90	34.45	10.43	1.17	.18
1st crop	H2080	Alfalfa	5/5-12/29/36	7.73	8.22	2.25	32.90	10.49	1.15	.19
<i>Fourth year</i>										
2nd crop	H2081	Alfalfa	12/29-3/14/37	8.08	7.20	1.88	35.34	11.23	.93	.18
3rd crop	H2082	Alfalfa	3/14-4/14/37	7.96	7.91	1.50	31.65	11.59	1.12	.20

Table 9. BLOOD-PHOSPHORUS DETERMINATIONS OF COWS USED IN EXPERIMENT

Hay group		Hay and concentrate group	
Cow number	Inorganic P per 100 cc whole blood	Cow number	Inorganic P per 100 cc whole blood
	Milligrams		Milligrams
<i>First year, February 1934</i>			
13	3.38	45	4.66
75	3.23	1	3.10
3	2.74	12	3.76
2	3.48	18	3.06
16	4.32	67	3.48
11	3.26	15	3.58
19	4.02	4	3.62
Average	3.49	....	3.61
<i>Third year, May 1936</i>			
3	3.43	1	3.83
11	4.95	4	3.54
16	4.00	17	4.04
20	3.94	23	4.04
26	4.15	47	3.70
28	4.32	34	4.94
32	4.71	15	4.24
13	3.42	18	3.66
22	5.33	27	4.42
24	4.55	31	3.98
25	5.03	45	4.31
30	4.52	46	3.25
37	4.17	....	....
Average	4.35	....	4.00
<i>Fourth year, April 1937</i>			
28	4.21	48	4.06
26	4.17	23	4.79
40	4.26	47	3.69
36	3.70	18	3.40
43	3.47	38	3.78
49	4.48	46	3.26
42	3.52	1	3.46
30	3.48	45	3.77
3	3.89	17	4.39
11	3.31	39	5.40
16	3.04	41	4.63
24	3.81	....	....
Average	3.78	....	4.06
<i>Fourth year, August 1937</i>			
11	4.26	18	3.71
26	3.09	38	3.99
30	3.98	39	4.17
36	3.69	45	2.88
42	4.38	46	2.95
43	3.65	48	4.08
3	3.85	1	3.39
16	3.82	17	3.60
24	3.51	23	4.17
28	3.83	47	5.48
49	4.96	....	....
40	4.98	....	....
Average	4.00	....	3.84

animals consumed about two-thirds as much salt as di-sodium phosphate, and as a rule the maximum consumption of both occurred in the same months.

The averages given in the table are calculated on the basis of months in which the material was actually available, as there were a few months in which di-sodium phosphate and bone meal were not available. In the last 2 years, when the animals were on pasture, salt and di-sodium phosphate were available both in the pasture and in the feed lot. It was assumed that each group took an equal amount per cow from the boxes of material in the pasture.

Chemical composition of feed stuffs.* The chemical analyses of the feed stuffs used are given in Table 8. Perhaps the most striking feature of these analyses is the general tendency toward somewhat low crude-protein contents, particularly in the 1935 and 1936 hays. It will also be noted that the phosphorus contents for the 1936 samples are slightly lower than for other years. The crude-fat contents are quite variable and in many cases quite low.

Blood phosphorus determinations.* During various periods free access was allowed to bone meal and to di-sodium phosphate. It is significant that while very little bone meal was consumed, di-sodium phosphate was consumed even more readily than common salt. In this connection it is of interest to note that these animals quite consistently showed low inorganic blood phosphorus. Eighty-five samples of blood variously taken during February 1934, May 1936, April 1937, and August 1937 averaged 3.94 milligrams of inorganic phosphorus per 100 cubic centimeters of whole blood. This observation is in harmony with our general experience with rations in which alfalfa hay constitutes the sole ration or roughage. There was no significant difference between the average blood phosphorus of the hay and hay-plus-grain groups. The data are recorded in Table 9.

In these experiments di-sodium phosphate was used for experimental reasons only. Whether it has any practical value as a mineral feed remains to be determined.

ECONOMY OF PRODUCTION

The profitableness of the dairy herd is determined by the cost of production and the value of the products. The dairy animal of good type and capable of converting feed into milk efficiently is the basis of economical production. Assuming that the herd is capable, the relations between the cost of feeds and the selling price of the product determine the profit.

From the determined production secured from definite amounts of feed, alfalfa hay alone in one instance and alfalfa hay and concentrates in the other, a means of calculating the relative profitableness of the two methods of feeding becomes available. The group fed hay only consumed an average of 11,224 pounds per head annually during the 4 years of the experiment. The hay-and-concentrate-group cows consumed annually 10,460 pounds of hay and 1,354 pounds of concentrate. The method of calculating the margin over feed cost was to determine the value of the production for 305 days at the various prices for butterfat and from this to subtract the feed cost for 365 days at the several values for hay and concentrate. The feed costs and butterfat returns only are calculated, since these are the factors under consideration in this study. True,

* Prepared by Dr. J. R. Haag.

other sources of income are obtained from the dairy herd, but consideration should also be given to the fact that the feed cost was only 52 per cent of the cost of maintaining a dairy herd in Oregon (7).

In Table 10 are given figures of the margin over feed cost produced by the sale of butterfat to be expected from cows fed alfalfa hay alone and alfalfa hay and concentrate with hay prices ranging from \$6 to \$15 per ton, concentrates from \$20 to \$40 per ton, and selling prices for butterfat from 24 cents to 39 cents per pound. These figures apply directly to cows capable of producing around 300 pounds of butterfat a lactation when well fed, but may be used with considerable latitude in view of the findings of other investigators in addition to those of our experiments that cows fed only hay produced from 60 per cent to 80 per cent as much as those fed hay and moderate amounts of concentrates.

The margin above feed cost for cows on hay alone shows that each \$1.00 increase in the cost of hay decreased the annual margin per cow \$5.61, while each cent increase realized from a pound of butterfat increased the annual margin \$2.38. For the hay group, in most instances and except for the higher prices for hay and the lower prices for butterfat, the value of the butterfat is in excess of the feed cost for the year.

The margins on hay and concentrate feeding decreased \$5.23 per cow per year for each \$1.00 increase in the price of hay, while each \$1.00 increase in the price of concentrates decreased the margin 67.8 cents. Each cent increase in the price of butterfat increased the annual margin \$2.94. With the lower prices of butterfat and the higher prices for hay instances also occur, when concentrates are fed, when the butterfat value does not equal the feed cost. These deficiencies are somewhat more pronounced with higher than with lower concentrate costs. In order that the relative margins produced by the two methods of feeding may readily be determined at the various prices for hay, hay and concentrates, and butterfat, the figures having a margin in favor of hay and concentrate are in light type in the table, while those giving a margin in favor of only feeding hay are black. Minus figures indicate that the feed cost per year was in excess of the butterfat return.

Using again the basic annual figures of feed consumption and production of cows with an inherited capacity of about 300 pounds of butterfat, a table has been calculated that gives the price above which butterfat must sell to make concentrate feeding more profitable than hay alone. This table will be found on the front cover page of this bulletin. For example, the average cow in the hay group consumed 11,224 pounds of hay, which at \$6 per ton cost \$33.67, while the consumption for the hay-and-concentrate group was 10,460 pounds of hay and 1,354 pounds of concentrate, which would be valued at \$31.38 for the hay at \$6 per ton and \$13.54 for concentrate at \$20, or a total feed cost of \$44.92 for the year. The difference in the feed cost between the two groups was \$11.25 while the difference in production was 56 pounds of butterfat. The additional cost divided by the additional production gave a cost of 20.1 cents per pound for the additional butterfat. Hay and concentrate feeding would be more profitable than hay alone when the price per pound of butterfat was above that stated in the table at any given price for hay and concentrate.

Table 10. YEARLY MARGIN PER COW OVER FEED COST FROM THE SALE OF BUTTERFAT WITH BUTTERFAT, HAY, AND CONCENTRATES AT VARYING PRICES

Based on 305 days production and 365 days feeding cost

Butterfat	Average margin—4 years of experiments									
	\$6.00	\$7.00	\$8.00	\$9.00	\$10.00	\$11.00	\$12.00	\$13.00	\$14.00	\$15.00
<i>Cents per pound</i>										
HAY ALONE										
24	\$23.45	\$17.84	\$12.23	\$ 6.62	\$ 1.01	\$-4.60	\$-10.21	\$-15.82	\$-21.43	\$-27.04
27	30.59	24.98	19.37	13.76	8.15	2.54	- 3.07	- 8.68	-14.29	-19.90
30	37.73	32.12	26.51	20.90	15.29	9.68	4.07	- 1.54	- 7.15	-12.76
33	44.87	39.26	33.65	28.04	22.43	16.82	11.21	5.60	- .01	- 5.62
36	52.01	46.40	40.79	35.18	29.57	23.96	18.35	12.74	7.13	1.52
39	59.15	53.54	47.93	42.32	36.71	31.10	25.49	19.88	14.27	8.66
HAY AND CONCENTRATES										
<i>Concentrates \$20 per ton</i>										
24	25.64	20.41	15.18	9.95	4.72	- 0.51	.....	.....	.....	.....
27	34.46	29.23	24.00	18.77	13.54	8.31	.....	.....	.....	.....
30	43.28	38.05	32.82	27.59	22.36	17.13	.....	.....	.....	.....
33	52.10	46.87	41.64	36.41	31.18	25.95	.....	.....	.....	.....
36	60.92	55.69	50.46	45.23	40.00	34.77	.....	.....	.....	.....
39	69.74	64.51	59.28	54.05	48.82	43.59	.....	.....	.....	.....
<i>Concentrates \$25 per ton</i>										
24	22.25	17.02	11.79	6.56	1.33	- 3.90	- 9.13	-14.36	.....	.....
27	31.07	25.84	20.61	15.38	10.15	4.92	- 3.31	- 5.54	.....	.....
30	39.89	34.66	29.43	24.20	18.97	13.74	8.51	3.28	.....	.....
33	48.71	43.48	38.25	33.02	27.79	22.56	17.33	12.10	.....	.....
36	57.73	52.30	47.07	41.84	36.61	31.38	26.15	20.92	.....	.....
39	66.35	61.12	55.89	50.66	45.43	40.20	34.97	29.74	.....	.....
<i>Concentrates \$30 per ton</i>										
24	18.86	13.63	8.40	3.17	- 2.06	- 7.29	-12.52	-17.75	-22.98	-28.21
27	27.68	22.45	17.22	11.99	- 6.76	- 1.53	- 3.70	- 8.93	-14.16	-19.39
30	36.50	31.27	26.04	20.81	15.58	10.35	5.12	- 1.11	- 5.34	-10.57
33	45.32	40.09	34.86	29.63	24.40	19.17	13.94	8.71	3.48	- 1.75
36	54.14	48.91	43.68	38.45	33.22	27.99	22.76	17.53	12.30	7.07
39	62.96	57.73	52.50	47.27	42.04	36.81	31.58	26.35	21.12	15.89
<i>Concentrates \$35 per ton</i>										
24 .....	.....	.....	5.01	- 0.22	- 5.45	-10.68	-15.91	-21.14	-26.37	-31.60
27 .....	.....	.....	13.83	8.60	- 3.37	- 1.86	- 7.09	-12.32	-17.55	-22.78
30 .....	.....	.....	22.65	17.42	6.96	1.73	- 3.50	- 8.73	-13.96	-19.19
33 .....	.....	.....	31.47	26.24	21.01	15.78	10.55	5.32	.09	- 5.14
36 .....	.....	.....	40.29	35.06	29.83	24.60	19.37	14.14	8.91	3.68
39 .....	.....	.....	49.11	43.88	38.65	33.42	28.19	22.96	17.73	12.50
<i>Concentrates \$40 per ton</i>										
24 .....	.....	.....	.....	.....	- 8.84	-14.07	-19.30	-24.53	-29.76	-34.99
27 .....	.....	.....	.....	.....	- 0.02	- 5.25	-10.28	-15.51	-20.74	-25.97
30 .....	.....	.....	.....	.....	8.80	3.57	- 1.66	- 6.89	-12.12	-17.35
33 .....	.....	.....	.....	.....	17.62	12.39	7.16	1.93	- 3.30	- 8.53
36 .....	.....	.....	.....	.....	26.44	21.12	15.98	10.75	5.52	.29
39 .....	.....	.....	.....	.....	35.26	30.03	24.80	19.57	14.34	9.11

Light figures—margin favors hay and concentrates.

Minus figures indicate feed costs greater than butterfat values.

Black figures—margin favors hay alone.

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Table 11. AMOUNT OF CONCENTRATES FED COWS BY LACTATION MONTHS

Year	Lactation months										Monthly average	Yearly total
	1	2	3	4	5	6	7	8	9	10		
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
<i>Cow number 1</i>												
First	7.2	6.6	5.4	5.8	5.0	4.5	4.8	4.4	3.6	3.3	5.1	1,517
Second	7.2	7.5	7.0	5.6	5.4	5.1	5.1	5.0	4.7	4.5	5.7	1,744
Third	10.1	12.9	10.0	7.0	6.5	4.5	2.9	2.9	2.0	1.9	6.1	1,852
Fourth	8.7	8.3	9.5	5.5	4.3	2.0	2.0	2.0	.4	none	4.6	1,416
<i>Cow number 4</i>												
First	9.5	8.5	6.8	5.8	6.0	5.0	4.5	3.8	2.6	1.3	5.4	1,601
Second	7.6	9.7	8.9	7.0	7.0	5.6	4.4	1.8	none	none	5.7	1,581
<i>Cow number 12</i>												
First	7.3	7.0	5.2	4.4	3.1	2.5	2.3	2.5	2.0	2.0	3.9	1,167
Second	7.4	6.3	5.1	4.7	4.7	3.8	3.8	3.5	2.2	1.6	4.5	1,285
<i>Cow number 15</i>												
First	6.9	5.4	6.1	5.0	4.3	3.9	3.1	2.8	2.7	2.5	4.2	1,328
Second	5.7	6.0	5.6	4.6	4.2	3.5	3.0	2.8	2.9	2.3	4.1	1,238
Third	5.4	3.8	4.0	1.7	2.0	.3	none	none	none	none	1.7	522
<i>Cow number 18</i>												
First	4.5	4.7	5.1	5.0	4.2	3.1	4.1	4.2	3.7	3.7	4.3	1,433
Second	6.9	7.5	6.8	6.2	6.0	5.7	6.1	5.8	5.3	4.6	6.1	1,862
Third	7.2	7.1	7.4	5.4	4.0	2.4	3.0	2.8	2.4	1.0	4.3	1,308
Fourth	8.0	10.4	8.0	6.0	6.6	5.5	5.5	3.8	3.0	2.1	5.9	1,801
<i>Cow number 45</i>												
First	7.8	9.3	8.3	8.1	7.0	5.6	3.8	2.9	2.8	2.3	5.8	1,567
Second	9.7	11.7	7.9	9.0	8.7	7.9	7.8	7.6	4.6	2.8	7.7	2,361
Third	7.1	7.5	7.9	5.0	4.1	2.7	2.7	2.2	2.0	2.0	4.5	1,866
Fourth	9.4	12.4	9.2	6.9	8.7	7.2	5.2	4.2	2.0	1.7	6.8	2,082
<i>Cow number 67</i>												
First	9.0	8.1	6.2	5.9	5.1	5.0	5.0	3.6	1.6	none	5.5	1,498
<i>Cow number 17</i>												
Second	5.8	5.6	5.9	5.0	5.4	5.0	5.0	5.6	4.6	4.5	5.2	1,584
Third	6.9	7.7	6.5	5.3	3.6	2.9	1.2	2.4	2.0	.9	4.0	1,204
Fourth	6.9	6.6	6.7	6.2	3.5	4.0	1.5	none	.4	none	3.5	1,081
<i>Cow number 21</i>												
Second	4.1	4.8	4.3	4.0	3.6	4.0	3.9	4.0	3.5	2.9	3.9	1,193

Appendix
DETAILED TABLES

Table 11. AMOUNT OF CONCENTRATES FED COWS BY LACTATION MONTHS—Continued

Year	Lactation months										Monthly average	Yearly total
	1	2	3	4	5	6	7	8	9	10		
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Cow number 23												
Second	4.8	4.6	4.3	3.9	4.0	4.2	4.2	4.2	3.2	3.5	4.1	1,247
Third	6.9	6.9	4.4	2.0	1.0	1.7	2.0	1.7	1.0	.3	2.8	849
Fourth	4.3	4.3	2.5	3.0	1.6	none	none	none	none	none	1.6	481
Cow number 46												
Second	4.7	5.8	5.7	5.6	5.1	5.0	4.1	4.1	4.2	4.1	4.9	1,480
Third	7.1	7.5	7.9	5.0	4.1	2.7	2.7	2.2	2.0	2.0	4.5	1,266
Fourth	11.2	12.6	6.5	4.7	4.1	2.0	2.0	2.0	2.0	.9	4.8	1,467
Cow number 27												
Third	8.0	6.0	3.4	3.0	2.5	2.5	2.1	2.8	3.0	2.1	3.6	1,084
Cow number 31												
Third	2.8	2.0	2.8	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.2	662
Cow number 34												
Third	2.6	2.1	2.0	2.0	2.0	1.0	2.0	1.8	none	none	1.6	477
Cow number 47												
Third	5.8	7.7	6.8	5.0	4.4	4.3	4.8	5.0	3.7	2.0	5.0	1,516
Fourth	9.3	12.4	11.7	9.0	6.8	4.8	4.5	4.7	3.3	2.0	6.9	2,098
Cow number 38												
Fourth	3.7	4.7	4.2	5.0	3.7	2.4	3.3	4.0	3.5	3.0	3.8	1,152
Cow number 39												
Fourth	1.2	2.0	2.0	2.4	2.0	2.0	2.0	1.3	none	none	1.5	455
Cow number 41												
Fourth	5.6	6.9	7.0	4.5	2.8	2.8	2.8	2.3	2.0	2.0	3.9	1,186
Cow number 48												
Fourth	3.0	4.0	2.6	2.0	2.0	2.7	2.0	2.0	2.0	2.0	2.5	749
Average												
First	7.5	7.1	6.2	5.7	5.0	4.2	3.8	3.5	2.7	2.2	4.9	1,444
Second	6.4	7.0	6.2	5.6	5.4	5.0	4.7	4.4	3.5	3.1	5.2	1,557
Third	6.6	6.6	6.0	4.3	3.5	2.8	2.6	2.2	1.8	1.0	3.8	1,146
Fourth	6.5	8.0	6.4	5.1	4.2	3.4	2.8	2.4	1.8	1.3	4.2	1,270

Table 12. AVERAGE AND MAXIMUM DAILY MILK PRODUCTION
305-day lactation period

Cow number	First year			Second year			Third year			Fourth year		
	Average daily milk	Highest daily milk		Average daily milk	Highest daily milk		Average daily milk	Highest daily milk		Average daily milk	Highest daily milk	
		Amount milk	Day of lactation		Amount milk	Day of lactation		Amount milk	Day of lactation		Amount milk	Day of lactation
<i>Hay Group</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Day</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Day</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Day</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Day</i>
2	12.2	32.1	12	12.0	26.5	20	17.3	32.4	24	16.3	33.9	15
3	17.5	35.5	22	19.3	34.5	33	17.3	32.4	24	16.3	33.9	15
11	17.4	31.8	12	16.6	30.0	14	15.3	36.4	11	18.5	32.2	13
13	13.4	30.5	17	15.5	29.8	15	15.5	23.9	29	16.2*	29.2	28
16	13.3	21.8	15	15.1	24.8	12	15.5	23.9	8	16.2*	29.2	28
19	8.4	13.8	14	10.1	16.4	15	15.5	23.9	8	16.2*	29.2	28
75	20.8	36.2	24	10.1	16.4	15	15.5	23.9	8	16.2*	29.2	28
20	.....	.....	.....	12.0	21.2	10	11.5	21.3	9	.....	.....	.....
22	.....	.....	.....	10.5	18.1	7	12.7	19.2	14	.....	.....	.....
24	.....	.....	.....	12.7	18.3	25	14.1	20.6	10	13.9	22.1	15
25	.....	.....	.....	10.1	15.9	11	10.4	15.0	26	.....	.....	.....
26	.....	.....	.....	.....	.....	.....	16.3	30.0	17	16.6	29.4	9
28	.....	.....	.....	.....	.....	.....	11.4	18.9	15	9.3	17.0	11
30	.....	.....	.....	.....	.....	.....	13.4	22.9	18	17.3	25.6	7
32	.....	.....	.....	.....	.....	.....	10.8	19.2	11	.....	.....	.....
37	.....	.....	.....	.....	.....	.....	10.6	16.0	33	.....	.....	.....
36	.....	.....	.....	.....	.....	.....	.....	.....	.....	11.8	22.5	15
40	.....	.....	.....	.....	.....	.....	.....	.....	.....	11.3	18.0	8
42	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.2	19.2	31
43	.....	.....	.....	.....	.....	.....	.....	.....	.....	10.7	15.6	23
49	.....	.....	.....	.....	.....	.....	.....	.....	.....	14.9	21.0	29
Average ..	14.7	28.8	17	13.4	23.6	16	13.5	23.4	17	13.9	23.8	17
<i>Concentrate Group</i>												
1	21.7	38.1	12	23.7	39.7	11	25.6	44.4	19	23.0	42.6	43
4	20.5	39.7	8	21.0	36.4	19	.....	.....	.....	.....	.....	.....
12	14.0	29.7	18	16.4	36.5	12	.....	.....	.....	.....	.....	.....
15	18.8	31.9	14	16.2	32.7	14	14.2	32.0	13	.....	.....	.....
18	14.1	22.3	13	16.9	25.9	15	15.7	25.8	10	18.5	27.8	11
45	21.9	39.1	13	27.6	43.4	18	24.3	40.3	36	26.4	44.7	26
67	20.9	40.2	19	.....	.....	.....	.....	.....	.....	.....	.....	.....
17	.....	.....	.....	17.2	28.7	13	17.1	30.7	14	16.1	28.9	14
21	.....	.....	.....	14.9	23.5	16	.....	.....	.....	.....	.....	.....
23	.....	.....	.....	15.1	23.9	16	15.8	26.9	20	12.5	20.6	15
46	.....	.....	.....	14.4	19.2	29	17.1	28.3	25	16.6	33.1	11
27	.....	.....	.....	.....	.....	.....	14.5	23.5	17	.....	.....	.....
31	.....	.....	.....	.....	.....	.....	11.1	16.3	11	.....	.....	.....
34	.....	.....	.....	.....	.....	.....	9.6	16.0	19	.....	.....	.....
47	.....	.....	.....	.....	.....	.....	17.8	23.3	48	22.4	35.9	17
38	.....	.....	.....	.....	.....	.....	.....	.....	.....	16.4	29.4	33
39	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.5	15.3	15
41	.....	.....	.....	.....	.....	.....	.....	.....	.....	15.8	24.3	16
48	.....	.....	.....	.....	.....	.....	.....	.....	.....	11.3	17.7	28
Average ..	18.8	34.4	14	18.3	31.0	17	16.7	28.0	21	17.1	29.1	21

* Average of 264-day lactation.

Table 13. MILK AND BUTTERFAT PRODUCTION AND PERTINENT DATA

Year	Age of calving	Calved again	Total days in milk	Total milk production	Total butterfat production	Milk 305-day lactation	Butterfat 305-day lactation	Butterfat	4% fat corrected milk 305 days	Mature equivalent fat-corrected milk 305 days	Concentrate consumption in 305 days
Year - Month	Days	Days	Pounds	Pounds	Pounds	Pounds	Pounds	Per cent	Pounds	Pounds	Pounds
HAY GROUP											
<i>Cow number 2</i>											
1934	4 — 4	469	401	4,321	274.9	3,718	228.0	6.13	4,884	4,987	.....
1935	5 — 7	sold	236	2,821	206.4	2,821	206.4	7.32	4,217	4,217	.....
<i>Cow number 3</i>											
1934	4 — 5	365	305	5,331	261.5	5,331	261.5	4.91	6,051	6,171	.....
1935	5 — 5	360	310	5,922	325.8	5,885	323.5	5.50	7,210	7,210	.....
1936	6 — 5	376	305	5,288	282.7	5,288	282.7	5.35	6,319	6,319	.....
1937	7 — 5	372	305	4,958	268.3	4,959	268.3	5.40	6,000	6,000	.....
<i>Cow number 11</i>											
1934	4 — 4	360	312	5,374	283.4	5,306	278.5	5.25	6,261	6,385	.....
1935	5 — 4	355	305	5,056	274.7	5,056	274.7	5.43	6,118	6,118	.....
1936	6 — 4	372	322	4,873	301.6	4,662	286.1	6.14	6,130	6,130	.....
1937	7 — 4	362	305	5,640	311.5	5,640	311.5	5.52	6,909	6,909	.....
<i>Cow number 13</i>											
1934	4 — 3	365	305	4,103	252.2	4,103	252.2	6.15	5,395	5,502	.....
1935	5 — 3	353	313	4,802	317.7	4,717	312.2	6.62	6,556	6,556	.....
1936	6 — 3	died	295	4,746	303.1	4,746	303.1	6.39	6,455	6,455	.....
<i>Cow number 16, dam number 14</i>											
1934	2 — 0	374	323	4,243	214.2	4,057	205.6	5.07	4,726	6,037	.....
1935	3 — 0	366	309	4,619	254.2	4,604	253.4	5.50	5,640	6,480	.....
1936	4 — 0	389	320	4,811	276.2	4,747	271.2	5.71	5,958	6,339	.....
1937	5 — 1	sold	264	4,308	232.5	4,308	232.5	5.40	5,213	5,306	.....
<i>Cow number 19, dam number 8</i>											
1934	2 — 0	355	294	2,469	131.6	2,469	131.6	5.33	2,990	3,579	.....
1935	3 — 0	sold	309	3,109	189.5	3,089	188.2	6.10	4,025	4,667	.....
<i>Cow number 75</i>											
1934	6 — 4	358	291	6,048	279.0	6,048	279.0	4.61	6,592	6,592	.....
<i>Cow number 20, dam number 13</i>											
1935	2 — 1	358	318	3,757	226.9	3,647	220.3	6.04	4,742	6,065	.....
1936	3 — 0	sold	321	3,724	236.4	3,517	223.3	6.35	4,783	5,496	.....
<i>Cow number 22, dam number 2</i>											
1935	2 — 2	430	348	3,458	218.0	3,199	196.1	6.13	4,208	5,318	.....
1936	3 — 4	sold	330	4,011	253.2	3,879	244.7	6.31	5,217	5,838	.....
<i>Cow number 24, dam number 1</i>											
1935	2 — 1	384	336	4,108	228.7	3,881	213.9	5.51	4,756	6,081	.....
1936	3 — 2	367	314	4,386	247.4	4,304	242.1	5.62	5,337	6,058	.....
1937	4 — 2	373	305	4,253	252.8	4,253	252.8	5.94	5,527	5,760	.....
<i>Cow number 25, dam number 5</i>											
1935	2 — 0	364	309	3,108	197.0	3,085	195.0	6.32	4,149	5,371	.....
1936	3 — 0	355	317	3,267	211.6	3,186	205.5	6.45	4,380	5,033	.....

Table 13. MILK AND BUTTERFAT PRODUCTION AND PERTINENT DATA—Continued

Year	Age of calving	Calved again	Total days in milk	Total milk production	Total butterfat production	Milk 305-day lactation	Butterfat 305-day lactation	Butterfat	4% fat corrected milk 305 days	Mature equivalent fat-corrected milk 305 days	Concentrate consumption in 305 days
Year - Month	Days	Days	Pounds	Pounds	Pounds	Pounds	Pounds	Per cent	Pounds	Pounds	Pounds
HAY GROUP—Continued											
<i>Cow number 26, dam number 70</i>											
1936	2 — 2	384	340	5,346	290.3	4,964	268.8	5.42	6,007	7,593	.....
1937	3 — 3	358	334	5,342	277.5	5,063	261.7	5.17	5,974	6,823	.....
<i>Cow number 28, dam number 11</i>											
1936	2 — 2	367	325	3,568	209.9	3,486	203.9	5.85	4,427	5,596	.....
1937	3 — 2	sold	305	2,847	174.1	2,847	174.1	6.11	3,734	4,249	.....
<i>Cow number 30, dam number 16</i>											
1936	2 — 1	418	335	4,211	217.8	3,980	200.3	5.03	4,506	5,850	.....
1937	3 — 3	351	305	5,284	277.1	5,284	277.1	5.24	6,235	7,028	.....
<i>Cow number 32, dam number 19</i>											
1936	2 — 0	sold	342	3,560	183.7	3,311	169.9	5.10	3,887	5,634	.....
<i>Cow number 37, dam number 75</i>											
1936	2 — 0	sold	305	3,225	182.9	3,225	182.9	5.67	4,047	5,238	.....
<i>Cow number 36, dam number 12</i>											
1937	2 — 10	343	319	3,701	223.8	3,606	217.6	6.04	4,688	5,470	.....
<i>Cow number 40, dam number 13</i>											
1937	2 — 3	387	305	3,461	242.8	3,461	242.8	7.01	5,018	6,272	.....
<i>Cow number 42, dam number 20</i>											
1937	2 — 3	375	305	3,727	215.3	3,727	215.3	5.78	4,733	5,854	.....
<i>Cow number 43, dam number 16</i>											
1937	2 — 2	sold	305	3,264	197.3	3,264	197.3	6.05	4,245	5,363	.....
<i>Cow number 49, dam number 3</i>											
1937	2 — 0	349	305	4,432	270.8	4,432	270.8	6.11	5,828	7,542	.....
HAY AND CONCENTRATE GROUP											
<i>Cow number 1</i>											
1934	4 — 2	376	322	6,834	314.1	6,625	300.6	4.54	7,122	7,264	1,544
1935	5 — 3	377	328	7,487	369.7	7,225	356.8	4.94	8,308	8,308	1,744
1936	6 — 4	380	330	8,056	408.5	7,822	396.4	5.07	9,113	9,113	1,852
1937	7 — 5	424	336	7,190	336.3	7,020	327.2	4.66	7,757	7,757	1,416
<i>Cow number 4</i>											
1934	4 — 6	400	309	6,319	314.8	6,265	310.8	4.96	7,205	7,379	1,651
1935	5 — 7	335	275	5,770	309.2	5,770	309.2	5.36	6,982	6,982	1,581
<i>Cow number 12</i>											
1934	4 — 5	377	315	4,360	227.8	4,277	220.4	5.15	5,047	5,577	1,175
1935	5 — 5	sold	284	4,654	255.3	4,654	255.3	5.49	5,702	5,702	1,285
<i>Cow number 15</i>											
1934	4 — 2	362	320	5,868	256.2	5,723	249.5	4.36	6,067	6,187	1,294
1935	5 — 2	366	318	5,025	241.0	4,947	237.0	4.79	5,542	5,542	1,238
1936	6 — 2	sold	305	4,339	207.8	4,339	207.8	4.79	4,859	4,859	522
<i>Cow number 18, dam number 13</i>											
1934	2 — 0	389	339	4,705	290.6	4,296	263.3	6.13	5,650	7,310	1,297
1935	3 — 0	349	305	5,150	361.5	5,150	361.5	7.02	7,468	8,581	1,862
1936	4 — 0	351	322	4,978	349.7	4,793	337.5	7.04	6,950	7,395	1,308
1937	5 — 0	362	305	5,655	397.0	5,655	397.0	7.02	8,200	8,349	1,801

Table 13. MILK AND BUTTERFAT PRODUCTION AND PERTINENT DATA—Continued

Year	Age of calving	Calved again	Total days in milk	Total milk production	Total butterfat production	Milk 305-day lactation	Butterfat 305-day lactation	Butterfat	4% fat corrected milk 305 days	Mature equivalent fat-corrected milk 305 days	Concentrate consumption in 305 days
	Year - Month	Days	Days	Pounds	Pounds	Pounds	Pounds	Per cent	Pounds	Pounds	Pounds
HAV AND CONCENTRATE GROUP—Continued											
Cow number 45											
1934	8 — 0	409	320	6,804	349.8	6,675	342.0	5.12	7,776	7,776	1,767
1935	9 — 2	378	305	8,423	475.4	8,423	475.4	5.64	11,708	11,708	2,361
1936	10 — 2	399	305	7,410	378.5	7,410	378.5	5.11	8,633	8,633	1,866
1937	11 — 3	sterile	365	8,504	447.2	8,067	419.0	5.20	9,519	9,519	2,082
Cow number 67											
1934	6 — 8	364	274	5,718	278.9	5,718	278.9	4.88	6,490	6,490	1,508
Cow number 17, dam number 1											
1935	3 — 0	368	318	5,415	323.9	5,261	313.9	5.95	6,839	8,385	1,584
1936	3 — 11	345	305	5,228	323.3	5,228	323.3	6.18	6,953	7,979	1,204
1937	4 — 10	348	316	4,977	311.5	4,899	306.0	6.25	6,591	6,674	1,081
Cow number 21, dam number 14											
1935	2 — 1	365	305	4,544	236.0	4,544	236.0	5.20	5,361	6,857	1,193
Cow number 23, dam number 12											
1935	2 — 1	379	321	4,740	256.9	4,995	245.8	5.35	6,044	7,563	1,247
1936	3 — 2	338	317	4,880	281.5	4,810	276.7	5.75	6,109	6,934	849
1937	4 — 1	sold	324	3,902	238.2	3,821	233.1	6.10	5,025	5,320	481
Cow number 46, dam number 45											
1935	2 — 0	410	350	4,799	323.1	4,395	290.3	6.61	6,109	7,904	1,480
1936	3 — 4	327	283	5,038	304.1	5,038	304.1	6.04	6,549	7,328	1,266
1937	4 — 3	359	305	5,051	312.7	5,051	312.7	6.19	6,718	7,071	1,467
Cow number 27, dam number 83											
1936	2 — 1	sterile	403	5,659	330.6	4,411	257.7	5.84	5,602	7,165	1,084
Cow number 31, dam number 8											
1936	2 — 0	sold	331	3,591	206.5	3,384	192.4	5.69	4,247	5,496	662
Cow number 34, dam number 4											
1936	2 — 0	sold	305	2,942	162.0	2,942	162.0	5.50	3,604	4,664	477
Cow number 47, dam number 45											
1936	2 — 0	389	305	5,423	312.1	5,423	312.1	5.76	6,887	8,911	1,516
1937	3 — 0	369	305	6,825	407.9	6,825	407.9	5.98	8,873	10,195	2,098
Cow number 38, dam number 15											
1937	2 — 2	389	328	5,196	274.3	5,008	262.2	5.22	5,909	7,469	1,152
Cow number 39, dam number 11											
1937	2 — 1	370	322	2,962	179.5	2,903	175.9	6.06	3,817	4,878	455
Cow number 41, dam number 17											
1937	2 — 2	365	312	4,851	258.2	4,811	255.2	5.31	5,749	7,268	1,186
Cow number 48, dam number 18											
1937	2 — 0	sold	305	3,442	214.7	3,442	214.7	6.24	4,578	5,924	749

Table 14. WEIGHTS OF COWS BY MONTHS

Month	First year				Second year				Third year				Fourth year				Averages			
	Concentrate		Hay		Concentrate		Hay		Concentrate		Hay		Concentrate		Hay		Concentrate average		Hay average	
	1	6	2	5	4	4	4	4	2	7	4	8	4	7	4	5	2.75	6.0	3.5	5.5
	heifer	cows	heifers	cows	heifers	cows	heifers	cows	heifers	cows	heifers	cows	heifers	cows	heifers	cows	heifers	cows	heifers	cows
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
1	746	1,009	787	967	756	1,052	720	978	679	1,007	746	935	722	995	748	987	746	1,016	787	967
2	672	893	727	878	752	950	711	909	693	910	746	855	722	889	748	886	707	911	735	882
3	704	889	737	877	752	919	711	890	693	913	732	853	733	883	702	830	721	901	721	863
4	701	896	726	858	759	932	707	866	702	909	729	850	717	897	704	831	720	909	717	851
5	695	890	707	846	758	934	691	850	690	907	706	827	701	868	703	839	711	900	702	841
6	713	886	696	841	769	925	689	852	689	910	695	828	701	893	676	801	718	904	689	831
7	682	901	722	847	775	935	686	854	658	908	678	825	709	877	697	824	706	905	696	838
8	697	918	713	837	798	942	689	869	678	902	686	837	743	882	709	836	729	911	699	845
9	734	940	761	874	824	962	722	899	700	927	700	845	764	916	746	871	756	936	732	872
10	771	959	805	900	836	990	744	935	720	948	724	875	802	929	766	881	782	957	760	898
11	806	1,009	826	927	864	1,035	776	948	759	983	750	909	830	950	803	925	815	994	789	927
12	818	1,045	874	960	894	1,048	812	974	773	1,014	793	960	871	990	822	976	839	1,024	825	968
Gain	863	1,094	895	1,004	912	1,039	845	971	819	1,036	852	1,003	897	1,017	877	1,025	873	1,047	867	1,001
Loss	117	85	108	37	.....	13	.....	7	.....	29	.....	68	.....	22	.....	38	127	31	80	34

* Month before freshening.

Table 15. CONSUMPTION OF SALT, BONE MEAL, AND DI-SODIUM PHOSPHATE BY GROUPS
AND COW MONTHS
Ounces per cow month

Month	Hay group			Concentrate group		
	Salt	Di-sodium phosphate	Bone meal	Salt	Di-sodium phosphate	Bone meal
	<i>Ounces</i>	<i>Ounces</i>	<i>Ounces</i>	<i>Ounces</i>	<i>Ounces</i>	<i>Ounces</i>
1933						
October	62.62	†	†	72.85	†	†
November	25.80	†	†	25.80	†	†
December	34.43	†	†	21.04	†	†
1934						
January	27.90	†	†	23.87	†	†
February	*	†	†	*	†	†
March	*	31.92	†	13.95	32.00	†
April	*	11.40	†	*	10.23	†
May	*	3.41	†	21.08	3.41	†
June	22.86	11.40	†	*	11.40	†
July	27.28	31.93	†	30.07	35.03	†
August	*	6.82	†	*	6.20	†
September	*	†	†	*	†	†
October	16.0	†	†	16.9	†	†
November	23.9	78.0	†	13.3	74.6	†
December	28.9	25.5	†	10.6	30.0	†
Average per cow month ..	17.93	25.05	.....	16.63	25.36	.....
1935						
January	21.8	24.7	9.7	14.0	44.0	17.1
February	10.2	14.5	11.6	19.2	24.0	16.0
March	7.3	14.5	*	7.3	2.2	11.6
April	5.8	8.7	*	5.8	8.7	*
May	15.6	27.6	8.7	16.4	27.6	4.6
June	5.8	*	*	*	*	*
July	10.6	15.1	*	10.6	15.1	*
August	11.9	11.9	*	11.0	11.0	*
September	*	†	*	*	†	†
October	52.0	†	4.1	44.5	†	3.6
November	25.4	†	*	17.7	†	*
December	16.8	22.9	7.6	17.5	21.8	7.3
Average per cow month	15.27	15.54	3.48	13.67	17.16	5.02
1936						
January	23.2	58.9	10.3	29.9	82.2	3.0
February	17.2	24.6	7.4	18.7	26.7	*
March	9.8	13.5	3.7	8.6	12.3	2.5
April	14.8	25.8	2.5	16.0	34.8	2.0
May	10.2	8.0	5.1	10.2	8.7	*
June	19.2	8.3	1.2	19.2	8.5	*
July	20.6	8.8	*	20.6	8.8	*
August	3.4	*	*	3.4	*	*
September	5.9	7.4	*	16.2	12.6	*
October	8.0	10.7	*	9.2	12.3	*
November	10.0	12.5	*	8.8	13.2	*
December	13.1	15.0	*	12.2	15.6	*
Average per cow month	12.78	16.13	2.52	14.42	19.64	.63
1937						
January	21.3	28.0	2.7	20.0	46.1	3.1
February	18.7	24.0	5.4	22.1	49.3	6.9
March	14.7	46.7	2.7	30.5	75.6	4.4
April	6.7	47.7	5.4	11.6	69.8	5.8
May	12.0	18.7	4.0	14.5	23.3	1.5
June	9.3	20.0	*	8.7	14.5	*
July	4.1	6.9	*	9.2	7.7	*
August	3.8	7.5	*	7.6	6.1	*
September	5.6	7.5	*	5.9	7.8	*
October	6.2	14.3	*	16.2	10.2	*
November	9.6	9.6	*	18.3	18.3	*
December	11.2	6.8†	9.0	12.5	4.2†	5.6
Average per cow month	10.3	20.7	2.4	14.7	28.9	2.3

* None consumed.

† None available.

‡ Di-sodium phosphate available only half of month.