Bulletin No. 202 - Grain vs. No Grain for Dairy Cows

University of Wyoming Agricultural Experiment Station

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Grain vs. No Grain for Dairy Cows

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*In cooperation with U. S. Department of Agriculture.
Grain vs. No Grain for Dairy Cows

By H. S. Willard

In view of recent publication by the U. S. Bureau of Dairy Industry (2)* of the results of experiments in which roughage was fed to dairy cows, and in view of the incorporation of a roughage feeding program in the proposed AAA dairy reduction plans, there is a great interest in experimental data presenting the results of research on the subject of roughage feeding.

REVIEW OF LITERATURE

Extent of Roughage Feeding. Feeding cows on roughage without grain has been a common practice in irrigated sections of the West for a number of years. There are no data to show how extensive this practice is. This method of feeding has been used in the West principally because there have been available large quantities of alfalfa and little grain. Reports from cow testing associations (10, 13) indicate that feeding high producing cows on alfalfa hay alone or alfalfa hay and irrigated pasture without grain is not the most economical practice. However, these reports show that the highest producing herds were the ones fed grain. One is tempted to ask whether it was not the fact that the cows had a large inherited capacity for milk production rather than the fact that some grain was fed which made these herds the most profitable ones.

Effect of Roughage Feeding on Health of Animals

Reproduction. That the feeding of poor quality roughage reduces the crop of healthy calves and leads to sterility in cows has been repeatedly demonstrated. (14, 15) The feeding of good quality hay seems to correct the difficulty. Venstrom and Headley (22) reported that the calf crop in Nevada, where alfalfa hay makes up almost the sole ration, is from 89 to 95%. Woll (25) stated that the calves were heavier when the cows received a grain mixture in addition to alfalfa hay and green alfalfa.

*Figures in parentheses refer to "References cited" at the end of this bulletin.
Headley's (9) data show that cows fed no grain required .73 extra breedings per cow year as compared with .53 extra breedings per cow year for cows fed grain. Headley considers his data insufficient to draw general conclusions. Reed et al. (21) found an exclusive diet of alfalfa hay had no injurious effect upon reproduction.

**Live Weight.** Headley's (9) data show that the cows fed no grain during pregnancy increased in weight 224 pounds, while the cows fed grain increased 164 pounds. After calving there was slight difference in weight between the two groups. Moseley et al. (18) reported the gain in weight during pregnancy of 53 cows fed mixed rations. The gain was 285 pounds of which 130 pounds was due to the cow and 155 pounds was due to the calf and placental membranes. An average of 59 cows showed loss in weight until the end of the fifth week following freshening. An average of 79 cows showed a loss in weight of 40 pounds the following 7 days after freshening. Morgan and Davis (16) reported that as cows advanced in age there was a decrease in the percentage gain in weight during pregnancy. Reed et al. (21) reported that after heifers had been on alfalfa hay alone from 6 months of age through two lactation periods there was a gain of 203 pounds after one year on a more adequate ration.

**Lack of Specific Nutrients in Alfalfa Hay.** Some evidence is accumulating which indicates that alfalfa hay may lack specific nutrients which makes its use as a sole feed inadvisable. Haag et al. (6, 8) in two series of metabolism trials feeding as a sole feed alfalfa hay with a composition of 2.06% nitrogen, 1.16% calcium, .153% phosphorus, reported that the nitrogen balances were sometimes positive and sometimes negative, the phosphorus balances always negative, and the calcium balance usually positive. Haag (7) in another article reported evidence to show that alfalfa lacked the amino acid cystine.

**Milk and Fat Production.** The literature reveals great difference in the comparative yields both of groups and individual cows fed grain and roughage as compared to a straight roughage ration. Woll (25) reported that cows fed a mixed ration produced 22% more milk and 32% more fat than on a ration con-
sisting of alfalfa hay and green alfalfa. Reed et al. (21) reported that heifers on grain, corn silage, and alfalfa produced 70% more fat their first lactation and 101% more fat their second lactation than heifers fed alfalfa hay alone. Individual cows at the Government Experiment Station at Huntley, Montana, (17) increased their production all the way from .04% to 77.24% when fed a grain ration at the rate of one pound of grain to three pounds of milk in the place of an all roughage ration. Over a period of 4 years the cows fed grain at the Newlands Experiment Station in Nevada, (9) produced 18% more fat than when fed alfalfa hay as a sole feed. The reports by Graves (2) state that cows on an average may be expected to produce 70% as much milk and fat (calculated to a mature basis) on an all roughage ration as compared with a full grain ration. Jones (12) reported that 8 cows in Oregon fed alfalfa hay alone from one to three years produced on an average 200 pounds of fat annually. No individual cow ever produced more than 278 pounds of butterfat in a lactation, and there were cows in the group that previously had official test records up to 621 pounds of fat in a year.

A review of literature adds to our knowledge of the influence of pasture in increasing milk yields. Wing (24) reported an increase in milk yield of cows for the first two weeks on pasture and a slight decrease during the next three weeks below the daily average for the last three weeks in the barn. He found that some spring freshening cows showed no more increase in milk yield on going to pasture than some fall freshening cows. Wing cited a report from the Vermont Experiment Station which showed increases in milk yield after cows were turned on to pasture. The data by Graves et al. (5) indicate wide differences in growth and composition of pasture grasses as the season advances. They found that the more rapid growth early in the season resulted in a more mature plant than the slower growth for the same length of time later in the season. Consumption by cows of these grasses decreased with their maturity and there was a decrease in milk production with the increase in maturity of the grasses. Call and Fitch (3) reported an experiment in pasturing dairy cattle on Sudan grass. More cows were turned on to the pasture than it
would carry continuously, making it necessary to run cows on good buffalo grass sod part of the time. The cows increased in milk yield on an average of 3.2 pounds per day each time they were turned on the Sudan grass pasture. In an experiment with Ladino clover reported by Jones and Brandt (11) significant increases in milk yield occurred when the cows were turned from dry feed to fresh pasture.

The feeding value of young grass is very high. Newlander (19) found the pasture grass of Vermont contained 17.36% digestible protein and 64.37% total digestible nutrients. Camburn (4) reported that artificially dried young grass having 14.23% digestible crude protein and 63.55% total digestible nutrients compared very favorably for milk production with a grain mixture containing 16.65% digestible crude protein and 72.87% total digestible nutrients.

There have been three ways by which investigators have determined the value of pasture: (a) by determining the carrying capacity per acre or the number of cow days per acre; (b) by determining the replacement value in terms of the dry feed necessary to replace it; (c) by determining the cost of maintenance or upkeep. All three items have been used together, by some, in the calculation of the net return per acre.

Economy of Production. The question is often asked, “Does it pay to feed grain to cows?” With such wide variations in the production of cows fed grain and no grain as have been cited in the literature, one is impressed with the probability that some cows may respond sufficiently in milk yield to pay for the extra grain while other cows will not.

Considerable data (2) are available which show that the cost of raising the feed nutrients in roughage is so much less than the feed nutrients in grain that even with a drop of 30% in milk yield the milk will be produced more cheaply than where grain is fed. A six-year average of production cost, under irrigation, of oats, barley, and wheat in Weld County, Colorado, (1) shows a yield of 48 bushels of grain and 2.47 tons of alfalfa to the acre. The cost per acre excluding interest on land was $23.87 for grain and $19.14 for alfalfa. However, the alfalfa produced 2549 pounds
of digestible food per acre as compared with 1618 pounds for the grains. The operating cost for the production of 100 pounds of digestible food in alfalfa was $0.75 as compared with $1.47 for the grains. The digestible food materials in alfalfa were produced at half the cost of the digestible food material in the grains. The relative yield of crops and operating costs in Weld County, Colorado, may compare favorably with the better farms in Wyoming. On an average, however, the production per acre of cereal grains in Wyoming is lower. The average yield of barley, oats, and wheat in 1929 was 28 bushels to the acre. A survey of 184 irrigated farms in Big Horn County (20) shows that these grains were produced at an operating cost of $19.40 per acre while alfalfa with a yield of 2.07 tons was produced at a cost of $15.54 per acre. According to these figures the digestible food in alfalfa may be produced at almost one-third the cost of the digestible food in the grains. Many alfalfa fields in Wyoming are so poorly cared for that the yields have been reduced to about one ton to the acre, and on the same farms barley may yield 40 bushels. Where such a situation exists, there would be little difference in the cost of the 100 pounds of digestible food in the two crops.

**EXPERIMENTAL PROCEDURE**

**Animals Used**

Thirteen head of purebred Holstein cows raised at the University Stock Farm were fed in this experiment for a total of 30 lactation periods. Ten of the 13 head whose growth periods up to 27 months of age have been previously reported (23) were continued for one or more lactation periods while 3 more were added during the course of the experiment.

**Rations Fed**

The cows were fed in two groups. Group I received no grain during the winter and summer months except for a brief period of two weeks one summer when the pasture became extremely short and no alfalfa hay was at hand to use as a supplement. Group II received ground barley during the winter months, fed at the rate of one pound to five pounds of milk produced. Both
groups received the same treatment on pasture, no grain being fed except for the brief period mentioned.

During the winter months all cows had access to alfalfa hay in a hay bunk. The cows were allowed hay in slight excess of that which they would clean up. Second cutting alfalfa was fed, and, for the most part, would grade U. S. No. 2.* Block salt and water were available at all times. During the summer the cows were allowed to graze on irrigated tame grass and sweet clover pasture. The cows were on this pasture day and night for about one hundred days each year. The pasture season is of short duration at this altitude, as is emphasized by the fact that frost necessitates the cutting of the second crop of alfalfa early in September.

**Feed Records**

The alfalfa hay was weighed out into a hay bunk as needed. From time to time all refused hay was cleaned out of the bunks and the weigh-back recorded. The daily grain allowance was recorded on the milk record sheet.

A record was kept of the cow days on pasture and the amount of supplemental feed.

**Body Weights and Measurements**

During the winter the cows were weighed for three consecutive days every thirty days. On the middle day of each weighing period the following measurements were taken: Height at withers, width at hooks, depth of chest, circumference of heart girth, and circumference of middle. During the summer, weights were taken once every thirty days. At this time the regular measurements were also made. All measurements were made in feet to the second decimal place.

**Reproduction Records**

An attempt was made to have the cows calve every twelve to fourteen months. All breeding and calving records were kept, including the name of the sire, weight and sex of calf.

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*The average chemical analysis of alfalfa in this region runs close to 16 per cent protein, 1.78 per cent of elemental calcium and .22 per cent of elemental phosphorus. The alfalfa normally possesses a high color but would average below 40 per cent leaf.*
Production Records

The cows were milked twice a day; the milk was weighed and the amount recorded on a seven-day milk sheet. For two consecutive days each month samples were taken of each milking and tested for butterfat by the Babcock method. The weighted average butterfat test for the two days was used as the average butterfat test for a thirty-day period. If the lactation period exceeded three hundred sixty-five days, only the first three hundred sixty-five days' production was reported.

Experimental Notes

A careful diary was kept of the health of the animals, changes made in the groups, and any unusual circumstances in connection with management. The Station Veterinarian had charge of the health of the animals. All of the cows were tested for abortion twice a year and any reactors were removed from the herd.

History of the Experiment

In December, 1925, plans were made to secure experimental data on the effects of alfalfa hay and pasture as an exclusive feed for dairy cattle. The results secured on growth of dairy heifers have been published (23). The conclusions drawn on growth of dairy heifers as reported in that article were that Holstein heifers, large for their age, starting on alfalfa hay and irrigated pasture at the age of twelve months, would make satisfactory gains in weight up to the period of first freshening. When these heifers came into milk they were retained in their respective lots. Those heifers fed ground barley previous to freshening were fed ground barley after freshening, and those fed no grain previous to freshening were fed no grain after freshening. Since the heifers were of various ages at the start, there were, for a period of time, cows in milk and heifers not yet having their first calf in the same lots. The cows were in different stages of lactation when the pasture was ready for grazing and when they were again placed on dry feed. The barley allowance to the grain group was fed in proportion to milk yield when the cows were on dry feed, and no grain was fed, except for a brief period, when
the cows were on pasture. Consequently, the amount of grain fed for each lactation varied with the season of freshening as well as with the milk yield. The method of feeding the animals by groups, with free access to hay in a bunk, eliminated the possibility of securing data on individual hay consumption. It was thought, however, that the reaction of the cows in milk yield and body weight would be more comparable to average irrigated farm conditions.

Three of the cows were in both groups for at least one lactation period. Table I gives some of the details of lactations secured by cows in both groups.

<table>
<thead>
<tr>
<th>Group No.</th>
<th>Cow No.</th>
<th>No. of lactations</th>
<th>No. continuous lactations</th>
<th>No. lactations on alternate rations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No grain ..................................</td>
<td>15 1 5 10 12 18</td>
<td>1 4 3 4 2 2</td>
<td>1 3 1 4 1 2</td>
<td>0 1 1 4 1 3</td>
</tr>
<tr>
<td>2. Grain supplement ..........................</td>
<td>2 12 18 8 10 16 16c 8c</td>
<td>1 2 1 1 1 1 2 2</td>
<td>1 2 1 2 1 1 2 2</td>
<td>0 4 0 2 0 0 0 0</td>
</tr>
<tr>
<td>Total group 1 ................................</td>
<td>6 15 14</td>
<td>14</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Total group 2 ................................</td>
<td>10 15 15</td>
<td>15</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Total ...........................................</td>
<td>16 30 29</td>
<td>29</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

The table shows that there was a total of 30 lactations in both groups, 29 of which were for one or more continuous lactations. For cows Nos. 5 and 10 there were 3 continuous lactations and for cow No. 12 there were 4 continuous lactations in group 1. The last column shows that there were a total of 13 lactations of the same cows fed in both groups.
EXPERIMENTAL RESULTS

Reproduction

Since rations which are low in phosphorus are known to affect adversely the ability of animals to reproduce themselves, a study was made of the breeding ability of all animals fed the experimental rations. A comparison was made between the number of breedings per cow in the experimental group as compared with the animals in the main herd. The data on the main herd show that from 1924-1933, 152 cows were bred 260 times, or an average of 1.71 breedings per cow. From 1927-1933 43 cows given the experimental rations were bred 61 times, or an average of 1.42 breedings per cow.

There is no evidence that the experimental rations were detrimental to the breeding ability of the cows.

Live Weight

Live weight may be used as a measure of the ability of dairy cattle to stay in good health from year to year. If the cows fail to regain the weight lost during the milking period before freshening again, then their general health is impaired, and they cannot be expected to continue on such rations. The heavy drain of milk in succeeding lactations would impair the health so seriously as to make the animal worthless either for milk or beef production. Cows may be expected to gain in weight quite rapidly toward the end of their lactation period, when dry, and when heavy in calf.

The changes in weight throughout twenty-three lactations in both groups are presented in Table II, which shows that there was a similarity in the two groups in the average length of lactation and dry periods, but gives group 1 the advantage in length of time between calves. Group 1 was also heavier than group 2 and showed less gain in weight between calves than group 2. Group 1 was heavier throughout the lactation period, lost more weight, and gained more weight from the low point than group 2. Included in the average figures for group 1 is cow No. 1 whose individual record is shown in the last column of Table II. Cow No. 1 at the time of second calving weighed 202 pounds less than she did before the first calf. After her second calf she weighed only 868 pounds.
Wyoming Agricultural Experiment Station

**TABLE II**
Influence of Ration on Live Weight of Dairy Cows Throughout Lactation Period.

<table>
<thead>
<tr>
<th>Cow No. 1*</th>
<th>Group 1</th>
<th>Group 2†</th>
<th>Cow No. 1 Group 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. lactations</td>
<td>13</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Length of lactation</td>
<td>328 days</td>
<td>308 days</td>
<td>300 days</td>
</tr>
<tr>
<td>Length of time dry</td>
<td>59 days</td>
<td>44 days</td>
<td>39 days</td>
</tr>
<tr>
<td>Length of time between calves</td>
<td>387 days</td>
<td>352 days</td>
<td>339 days</td>
</tr>
<tr>
<td>Average weight before calving</td>
<td>1438 lbs.</td>
<td>1259 lbs.</td>
<td>1322 lbs.</td>
</tr>
<tr>
<td>Average weight at next calving</td>
<td>1475 lbs.</td>
<td>1350 lbs.</td>
<td>1120 lbs.</td>
</tr>
<tr>
<td>Average increase in weight</td>
<td>-37 lbs.</td>
<td>+4 lbs.</td>
<td>-202 lbs.</td>
</tr>
<tr>
<td>Average low weight during lactation</td>
<td>1207 lbs.</td>
<td>1107 lbs.</td>
<td>950 lbs.</td>
</tr>
<tr>
<td>Increase in weight from low point to weight at next calving</td>
<td>268 lbs.</td>
<td>243 lbs.</td>
<td>170 lbs.</td>
</tr>
<tr>
<td>Weight after 11 months lactation</td>
<td>1369 lbs.</td>
<td>1257 lbs.</td>
<td>1120 lbs.</td>
</tr>
<tr>
<td>Increase in weight from low point to 11 months of lactation</td>
<td>162 lbs.</td>
<td>150 lbs.</td>
<td>170 lbs.</td>
</tr>
</tbody>
</table>

*Group 1 fed roughage throughout.
†Group 2 fed ground barley supplement while on dry feed.

Cow No. 1 failed to regain her weight lost during the lactation period, and after her second calf was in such poor and weak physical condition that it was necessary to take her off the experimental ration in order to save her life. One other cow not included in the average for group 1 was removed from the experiment because she was failing to gain in weight toward the end of the lactation period.

In order to show the size of the cows used, a comparison has been made with Eckles’ normal for Holsteins. The mean weight of 13 cows after their first calf was 1104 pounds or 144 pounds above Eckles’ normal. One heifer weighing only 850 pounds after her first calf, or 90 pounds below Eckles’ normal, failed to gain in weight toward the end of her lactation period and was taken off the experiment.

At the beginning of each lactation the weight of the cows which have had four or more lactation periods showed great variation. The cows may be divided into two groups, one consisting of two cows which were considerably above Eckles’ normal and the other which ran close to Eckles’ normal. Fig. 1 shows the average weight of the two groups as compared to Eckles’ normal weight for Holsteins following the first to the fifth calf. In the group of two cows there was a great increase in weight between the second and third calf. During this period one cow was receiving grain while the other received no grain. There were 382
and 450 days between calves, and the gains were 266 and 315 pounds respectively. Between the first and second calves the two cows were in opposite groups but in the same group (no grain) after the third calf. In the group of three cows, two received grain up to the third calf.

The evidence presented indicates that there were factors other than feed which were operating. Possibly inheritance played a part. That the number of days between calves was a factor is indicated by the fact that all cows in the experiment tended to increase in weight with the increase in number of days between calves.
At 28 months of age the cows measured 4.32 feet at withers or 1.14 inches higher than the cows reported by the Missouri Experiment Station. There was a tendency toward the normal height at withers with the advancing age of the cows. From the records available there was but slight difference in the two groups, irrespective of grain feeding, in this tendency to approach the normal.

As shown in Table II, there was a wide difference in weight of the cows during the course of the lactation period. It is natural to expect that skeletal measurements would have a tendency to vary with the changes in live weight. The difference in measurements during the lactation of 8 cows for 19 lactations was found to be as follows: Depth of chest .84 inches, heart girth 3.60 inches, paunch girth 8.88 inches.

**Milk and Fat Production**

It is well known that there are many factors other than feed which influence yearly production records. Some of these factors are: Inheritance, which includes milk yield at peak of production, persistency of production, and fat percentage; age; length of time between calves. The average production of the two groups for the lactations included is shown in Table III*.

*The production records of two cows in the grain group have been omitted in computing the average of the group, since their production of 169 and 178 pounds of fat was far below the production of the other cows in the group. The low production of these two cows tells the old, old story that some cows do not have the inherent capacity to give much milk and butterfat, even when they are given a plentiful supply of feed.

**TABLE III**

<table>
<thead>
<tr>
<th>Group</th>
<th>No. Cows</th>
<th>No. Lactations</th>
<th>Ave. Age</th>
<th>Time between calves</th>
<th>Milk yield</th>
<th>Fat yield</th>
<th>Milk yield</th>
<th>Fat yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>yr. mo. days</td>
<td>lbs.</td>
<td>lbs.</td>
<td>lbs.</td>
<td>lbs.</td>
</tr>
<tr>
<td>1 No Grain ..........</td>
<td>5</td>
<td>13</td>
<td>5</td>
<td>386</td>
<td>9,386</td>
<td>310.4</td>
<td>9,958</td>
<td>330.4</td>
</tr>
<tr>
<td>2 Grain supplement</td>
<td>6</td>
<td>9</td>
<td>3</td>
<td>1</td>
<td>404</td>
<td>323.1</td>
<td>11,745</td>
<td>373.2</td>
</tr>
<tr>
<td>Difference . . . . .</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>18</td>
<td>-794</td>
<td>-1,787</td>
<td>-42.8</td>
</tr>
</tbody>
</table>

*Age-conversion factors taken from B. D. I. M. 623.
May, 1934  

Grain vs. No Grain

On the mature equivalent basis the grain group (group 2) produced 18 per cent more milk and 13 per cent more fat than the group fed no grain (group 1).

To compare small groups of cows on the basis of mature equivalent production may not be fair for individual cows, since the factors are averages of production records from a large number of animals. A test of the usefulness of the mature equivalent to any set of data is the uniformity of the mature equivalent records from the same cow over several lactations. In Table IV are shown the production records of all cows with more than one lactation in group 1 or 2 or both. These production records have been calculated to maturity by the same age-conversion factors used in Table III.

**TABLE IV**

<table>
<thead>
<tr>
<th>No. of Cows</th>
<th>Age at beginning yrs. mo. days</th>
<th>Group No.</th>
<th>Time between calving days</th>
<th>Mature Equivalent Milk lbs.</th>
<th>Mature Equivalent Fat lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>2-6-9</td>
<td>2</td>
<td>375</td>
<td>11,131.3</td>
<td>350.7</td>
</tr>
<tr>
<td></td>
<td>3-6-19</td>
<td>2</td>
<td>376</td>
<td>11,169.7</td>
<td>363.1</td>
</tr>
<tr>
<td></td>
<td>4-7-2</td>
<td>1</td>
<td>398</td>
<td>10,926.7</td>
<td>356.5</td>
</tr>
<tr>
<td></td>
<td>5-8-5</td>
<td>1</td>
<td>*</td>
<td>11,594.6</td>
<td>377.7</td>
</tr>
<tr>
<td>12</td>
<td>2-4-24</td>
<td>2</td>
<td>377</td>
<td>9,041.0</td>
<td>264.9</td>
</tr>
<tr>
<td></td>
<td>3-5-7</td>
<td>1</td>
<td>382</td>
<td>10,402.2</td>
<td>251.6</td>
</tr>
<tr>
<td></td>
<td>4-5-13</td>
<td>1</td>
<td>351</td>
<td>10,125.1</td>
<td>285.5</td>
</tr>
<tr>
<td></td>
<td>5-5-12</td>
<td>1</td>
<td>420</td>
<td>10,773.1</td>
<td>325.7</td>
</tr>
<tr>
<td></td>
<td>6-7-7</td>
<td>1</td>
<td>365</td>
<td>10,556.1</td>
<td>299.6</td>
</tr>
<tr>
<td>5</td>
<td>2-6-20</td>
<td>1</td>
<td>413</td>
<td>10,614.9</td>
<td>374.7</td>
</tr>
<tr>
<td></td>
<td>2-9-13</td>
<td>2</td>
<td>450</td>
<td>12,085.2</td>
<td>381.0</td>
</tr>
<tr>
<td></td>
<td>4-11-7</td>
<td>1</td>
<td>350</td>
<td>8,612.7</td>
<td>295.3</td>
</tr>
<tr>
<td></td>
<td>5-10-27</td>
<td>1</td>
<td>523</td>
<td>12,092.4</td>
<td>359.1</td>
</tr>
<tr>
<td>lb</td>
<td>2-8-36</td>
<td>1</td>
<td>352</td>
<td>8,452.5</td>
<td>338.3</td>
</tr>
<tr>
<td></td>
<td>3-8-27</td>
<td>1</td>
<td>412</td>
<td>8,848.2</td>
<td>352.5</td>
</tr>
<tr>
<td></td>
<td>4-10-14</td>
<td>1</td>
<td>333</td>
<td>8,823.3</td>
<td>355.3</td>
</tr>
<tr>
<td>10</td>
<td>2-5-10</td>
<td>2</td>
<td>392</td>
<td>13,635.6</td>
<td>413.5</td>
</tr>
<tr>
<td></td>
<td>2-6-1</td>
<td>2</td>
<td>436</td>
<td>11,681.8</td>
<td>366.5</td>
</tr>
<tr>
<td></td>
<td>4-8-12</td>
<td>2</td>
<td>503</td>
<td>11,151.2</td>
<td>339.0</td>
</tr>
</tbody>
</table>

*Bred late in lactation period.

Most of the mature equivalent records of individual cows are very uniform. Those records of individuals in which there is a marked discrepancy with records of other years can, for the most part, be explained by the difference in the number of days be-
between calves. The record of cow No. 5 made as a 4-year-old is much lower than her other records, but her period of gestation began much earlier in her lactation that year than in others. The record of cow No. 10 as a 2-year-old was larger than in other years and cannot be explained on the basis of the number of days between calves.

The production records of the 3 cows, Nos. 18, 12, and 5, show considerable uniformity despite the group in which the record was made. Indeed, the average production of these 3 cows fed for 9 lactations in group 1 was 10,633 pounds of milk and 331.4 pounds of fat, as compared with their 4 lactations in group 2 of 10,855 pounds of milk and 339.9 pounds of fat. The difference in the production these cows in the two groups favors group 2 by only 2.1 per cent in milk and 2.5 per cent in fat.

Decline in Milk Yield with Advance in Lactation.

Milk yield in normal lactations might decline at a fairly constant rate from the peak of production, provided there are not factors such as inheritance, feed, and gestation to interfere. The average length of time between calves of groups 1 and 2 was about the same. The factor of inheritance is partially controlled, since about one-half of the cows were fed in both groups. It was thought that the influence of feed might be the factor measured if the two groups were compared on the basis of the average production during the high week, 20th, and 30th week of lactation.

In Table V is shown the average daily milk yield during these weeks for 13 lactations in group 1 and 9 lactations of group 2, together with the average production of the groups and the comparative yields as the lactation advanced. It is quite apparent that the cows in group 2 showed less decline in milk yield as the lactation advanced than the cows in group 1. The difference is not so marked at the end of the 20th week as at the end of the 39th week. The cows in group 1 produced more milk at the peak of production. The increase in yearly milk yield of group 2 over group 1 might be said to be due to the ground barley in the ration.
May, 1934  

Grain vs. No Grain

TABLE V

Influence of Ration on Persistency of Milk Production.

<table>
<thead>
<tr>
<th>Cow No.</th>
<th>Group 1 No Grain</th>
<th>Ave. daily milk yield</th>
<th>Group 2 Grain Supplement</th>
<th>Ave. daily milk yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Early peak</td>
<td>20th week</td>
<td>30th week</td>
<td>Early peak</td>
</tr>
<tr>
<td></td>
<td>lbs.</td>
<td>lbs.</td>
<td>lbs.</td>
<td>lbs.</td>
</tr>
<tr>
<td>18</td>
<td>45.0</td>
<td>27.9</td>
<td>18</td>
<td>38.9</td>
</tr>
<tr>
<td></td>
<td>44.4</td>
<td>17.8</td>
<td>18</td>
<td>47.1</td>
</tr>
<tr>
<td>12</td>
<td>39.8</td>
<td>40.4</td>
<td>12</td>
<td>35.4</td>
</tr>
<tr>
<td></td>
<td>55.8</td>
<td>30.3</td>
<td>17.8</td>
<td>47.1</td>
</tr>
<tr>
<td>5</td>
<td>28.9</td>
<td>30.0</td>
<td>46.1</td>
<td>34.3</td>
</tr>
<tr>
<td></td>
<td>42.0</td>
<td>19.1</td>
<td>35.0</td>
<td>27.7</td>
</tr>
<tr>
<td></td>
<td>50.0</td>
<td>18.7</td>
<td>44.2</td>
<td>27.2</td>
</tr>
<tr>
<td>1b</td>
<td>43.9</td>
<td>12.5</td>
<td>41.2</td>
<td>25.9</td>
</tr>
<tr>
<td>1</td>
<td>36.2</td>
<td>9.9</td>
<td>45.0</td>
<td>20.5</td>
</tr>
<tr>
<td></td>
<td>32.8</td>
<td>8.9</td>
<td>43.8</td>
<td>33.6</td>
</tr>
<tr>
<td>Ave.</td>
<td>45.5</td>
<td>18.1</td>
<td></td>
<td>43.0</td>
</tr>
<tr>
<td>Comparative yield</td>
<td>100</td>
<td>78.1</td>
<td></td>
<td>71.9</td>
</tr>
<tr>
<td>yield</td>
<td>100</td>
<td>51.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Effect of Pasture on Milk Yield.**

In the discussion of Table V the influence of pasture on milk yield is not taken into account. The cows were on pasture at different intervals of their lactation, and this accounts for some of the variations apparent in the persistency of yield at the end of the 20th and 30th week. It may be noted from Table V that in the second lactation of cow 18, in the first lactation of cow 12, and in the first lactation of cow 5 of group 1, the cows were giving slightly more milk at the end of the 20th week of their lactation than they were during the early peak of lactation. These cows were on pasture during the 20th week of their lactation. In almost every instance the cows showed an increase in milk yield in response to the change from dry feed to pasture. Considerable variation was observed in the response of individual cows. As shown in Table VI, the quantity of milk produced previous to pasture exerted a big influence on the increase in yield on pasture.
TABLE VI
Influence of Milk Yield Previous to Pasture on the Increase in Milk Yield on Pasture.

<table>
<thead>
<tr>
<th>Ave. daily milk yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of cows</td>
</tr>
<tr>
<td>lbs.</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>10</td>
</tr>
</tbody>
</table>

As the yield previous to pasture increased, there was less difference in the effect of the pasture on milk yield. Since the yield of milk previous to pasture is influenced by the time of freshening, it might be expected that the effect of pasture in increasing milk yields would be greater in fall- and winter-freshening cows than in spring-freshening cows. The average daily increase in milk yield for 22 lactations on pasture was 6.3 pounds over the yield for the week previous to pasture. The greatest daily increase was 16 pounds of milk made by cow No. 12 whose record for persistency was noted in the discussion of Table V.

The cows during the 22 lactations were on pasture for about 100 days. The average daily milk yield for 7 weeks previous to pasture and 14 weeks on pasture is plotted in figure 2. The broken line represents the theoretical milk yield had the cows been on dry feed and had they declined at the same rate as they did for 7 weeks previous to pasture. Figure 2 shows that the lines for actual and theoretical yield meet after 8 weeks on pasture, and from the eighth to the fourteenth week the theoretical yield is greater than the actual yield. The difference in the actual and theoretical yield was 43.25 pounds per cow, or an average of .44 pounds of milk per cow per day.

One method of evaluating pasture is to calculate the nutrients necessary for maintenance, gain in weight, and milk production of cows grazing. The nutrients thus calculated may be interpreted in terms of hay or a combination of feeds used in any locality. The calculations of pasture value by the above method in terms of alfalfa hay necessary to replace it are shown in Table VII. With alfalfa at $5 and $10 per ton the pasture had a value of 9.58...
and 19.17 cents per cow per day respectively. Irrigated pastures in Wyoming rent for about 63½ cents per cow per day or $2 per month. At this rate one could afford to pay only $3.47 per ton for alfalfa to substitute for pasture.

The value of pasture per acre depends largely upon its carrying capacity. It was found quite impractical to secure the carrying capacity of the pasture on which these cows grazed, since the soil and supply of irrigation water were not typical of conditions throughout the state.
### TABLE VII
Estimated Pasture Value in Terms of Alfalfa Necessary to Replace It.
Data from 22 Lactations of Cows Each Fed 98 Days on Pasture.

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Ave. per cow per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain in weight*</td>
<td>909.0</td>
<td>.42</td>
</tr>
<tr>
<td>Milk yield</td>
<td>64,575.21</td>
<td>29.95</td>
</tr>
<tr>
<td>Fat yield</td>
<td>2,073.82</td>
<td>.96</td>
</tr>
<tr>
<td>Equivalent yield of 4% milk?</td>
<td>56,938.88</td>
<td>26.41</td>
</tr>
<tr>
<td>T. D. N. requirement</td>
<td>42,988.00</td>
<td>19.93</td>
</tr>
<tr>
<td>T. D. N. supplement to pasture</td>
<td>1,642.30</td>
<td>.76</td>
</tr>
<tr>
<td>T. D. N. supplement to pasture per cent</td>
<td>3.82</td>
<td>3.82</td>
</tr>
<tr>
<td>Net T. D. N. supplied by pasture</td>
<td>41,345.70</td>
<td>19.17</td>
</tr>
<tr>
<td>Alfalfa equivalent to pasture</td>
<td>82,691.40</td>
<td>38.30</td>
</tr>
<tr>
<td>Value of alfalfa equivalent to pasture</td>
<td>82,691.40</td>
<td>38.30</td>
</tr>
<tr>
<td>Alfalfa at $5 per ton</td>
<td>206.70</td>
<td>.0958</td>
</tr>
<tr>
<td>at $10 per ton</td>
<td>413.40</td>
<td>.1917</td>
</tr>
<tr>
<td></td>
<td>Total 25,669</td>
<td>1166.77</td>
</tr>
<tr>
<td>End weight</td>
<td>26,668</td>
<td>1212.18</td>
</tr>
</tbody>
</table>

*Beginning weight               lbs.

†Gaines formula AM + (15 X Fat)

Four pounds total digestible nutrients were used as an estimated requirement per pound of gain. Haecker's feeding standard was used in computing the requirements for maintenance and milk production.

### SUMMARY AND CONCLUSIONS
In an effort to determine the effect on dairy cows of a ration made up solely of alfalfa hay and irrigated pasture, 13 cows have been fed for a total of 30 lactation periods. Six cows have been fed for 15 lactation periods without grain and were designated group 1. Ten cows have been fed for 15 lactations with ground barley in addition to alfalfa hay during the winter and were designated group 2. Three of the 10 cows in group 2 were fed for 2 or more lactations in group 1. There were available for study 13 lactations of three cows fed in the two groups. Four cows have been fed continuously each for 3, 3, 4, and 2 lactations respectively in group 1.

All cows had free access to alfalfa hay in a hay bunk. The cows in group 2 were fed ground barley during the winter at the rate of 1 pound of barley to 5 pounds of milk produced. While on pasture the cows in both groups received no grain except one season when, for a brief period of two weeks, some grain was used as a supplement.
May, 1934  
Grain vs. No Grain

There was no evidence that the experimental rations were injurious to the breeding ability of the cows. Two cows were removed from group 1 because they failed to regain their weight lost during the lactation period. The mean weight of all cows after their first calf was 1104 pounds or 144 pounds above Eckles' normal. The cows seemed to gain in weight with succeeding lactations irrespective of the group in which they were fed. On an average group 1 lost more weight and regained more weight during the lactation period than group 2.

The average yearly production for 13 lactations of the cows in group 1 which received no grain was 9384 pounds of milk and 310.4 pounds of fat as compared with 10,180 pounds of milk and 323.1 pounds of fat for 9 lactations for the cows in group 2 which received the grain supplement. On a mature equivalent basis the cows in group 2 produced 18 per cent more milk and 13 per cent more fat than the cows in group 1. When the production records of 3 cows fed for 13 lactations in both groups were compared on a mature equivalent basis, there was a difference of only 2.1 per cent in milk and 2.5 per cent in fat in favor of grain feeding. The cows fed grain showed a greater persistency in milk yield. The milk yield secured in group 1 at the peak of production showed an average of 45.5 pounds of milk daily, with a high point of 65 pounds for one cow during her fourth continuous lactation without grain.

Milk yields in both groups increased after the cows were turned from dry feed onto pasture. The less the milk yield previous to pasture, the greater was the increase in milk yield in response to the change in ration. The cows reached their peak of production on pasture in 2 weeks and returned to their yield while on dry feed after 5½ weeks on pasture. From that time on the yields dropped rather sharply. If the quality and quantity of pasture grass had held up to that of the first of the season, the cows would have undoubtedly shown greater persistency of milk yield.

The actual milk yield for 22 cows fed 98 days on pasture showed an increase of 43 pounds of milk per cow over the theoretical milk yield on dry feed. Measuring the pasture value in terms of the
alfalfa necessary to replace it showed that the pasture had a value of 9.58 cents and 19.17 cents per cow per day when alfalfa was valued at $5 and $10 per ton respectively. Irrigated pastures in Wyoming rent for about 6½ cents per cow per day. At this rate one could afford to pay only $3.47 per ton for alfalfa to replace it.

The actual cost of the feed consumed by these cows was not obtained, because no record of individual hay consumption was kept. It is believed that, with the great difference between the cost of raising grain and alfalfa, as reported here in the review of literature, it would not be profitable to feed grain to cows with no more inherited capacity for milk production than these cows possessed. With cows of such production capacity grain feeding would show (2) the most benefit when the animal fails to gain in weight toward the end of the lactation period.

The important demonstration reported here is that cows of good inherited capacity for milk production will remain in good health from year to year on a roughage ration without grain, and at the same time produce a good supply of milk and butterfat.

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