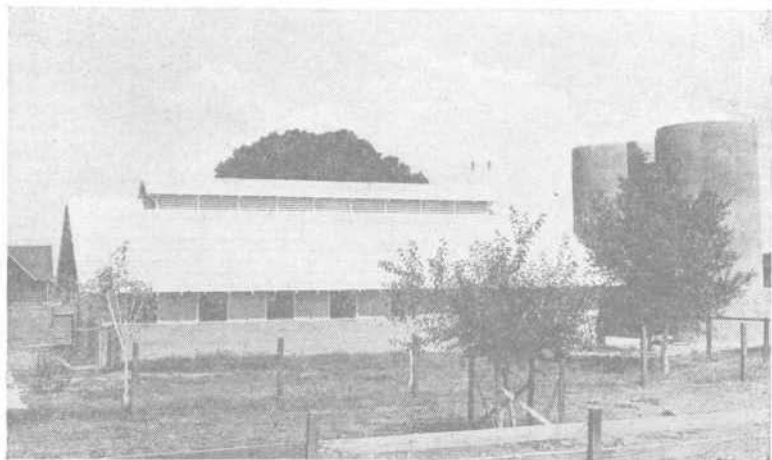




University of Arizona
College of Agriculture
Agricultural Experiment Station

**FEEDING DAIRY CATTLE IN
ARIZONA**

BY W. S. CUNNINGHAM



Dairy Barn, University Farm, Tucson, Arizona.

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FEEDING DAIRY CATTLE IN ARIZONA

By W. S. CUNNINGHAM*

INTRODUCTION

Dairying has become a well-established industry in the irrigated valleys of Arizona. The economic status of the dairyman has been good, as compared with other lines of agriculture. It has become a recognized fact, however, that to be successful, the dairyman must cull his herd and feed his cows properly. The purpose of the series of experiments reported in this bulletin was to study the feeding value of various feeding stuffs and to determine their effect on milk production.

PART I.—DRIED BEET-PULP *VERSUS* A MIXTURE OF DRIED BEET-PULP AND ROLLED BARLEY FOR DAIRY COWS

During the spring of 1916, an experiment was conducted to determine whether it would be more profitable to feed dairy cows a mixture of equal parts of rolled barley and dried beet-pulp rather than dried beet-pulp as the only concentrate of the ration.

COWS USED

Ten cows were divided into two groups of five cows each, balancing the groups as nearly as possible according to breed, period of lactation, and amount of milk given.

METHOD OF EXPERIMENT

One group of cows was fed molasses-dried-beet-pulp as the only concentrate while the other group was fed a mixture of equal parts of rolled barley and molasses-dried-beet-pulp, both groups being fed at the rate of 1 pound of concentrate to 4 pounds of milk produced. Alfalfa hay was fed alike to both groups, and they were given an amount they would clean up well. The experiment was divided into two periods and at the end of the first period the concentrate part of the ration was alternated so that the lot receiving rolled barley the first period was fed

*Credit is due to Dr. R. H. Williams who planned and supervised some of the earlier feeding tests reported in this bulletin. Professor R. N. Davis has been of material assistance in planning and supervising some of the later feeding tests. Appreciation is expressed for the assistance of G. J. Darling and J. R. Reed, foremen of the University Farm, in conducting the feeding tests.

the mixture of equal parts of rolled barley and dried beet-pulp the second period and *vice versa*. The actual period of the test was 68 days. In computing the results, the amounts of milk produced by both groups of cows while being fed a particular ration were added together, so that the data are given on the basis of the rations fed.

DISCUSSION OF FEEDS USED

Beet-pulp and rolled barley are similar in percentage of digestible nutrients, the barley being a little higher in digestible crude protein and fat, but lower in carbohydrates. Since alfalfa hay is low in carbohydrates, but relatively high in protein, it furnishes the greater part of the protein required in the ration. At the time this experiment was conducted, the retail prices of the feeds used were as follows: Dried beet-pulp, \$1.35 per hundred pounds; rolled barley, \$1.70 per hundred pounds; and alfalfa hay, \$14.00 per ton. At these prices alfalfa hay furnishes the total nutrients most cheaply, the beet-pulp next, and the barley last.

TABLE I—ALFALFA, BEET-PULP, AND ROLLED BARLEY *VERSUS* ALFALFA AND BEET-PULP FOR MILK PRODUCTION

	Milk produced	Cost of ration	Feed cost per 100 pounds-milk	Feed cost per gallon milk	Value of milk at 25¢ per gallon	Profit over cost of feed
	Pounds	Dollars	Dollars	Cents	Dollars	Dollars
Ration 1: Alfalfa Beet-pulp Rolled barley	7,316.2	91.75	1.25	10.7	212.68	120.93
Ration 2. Alfalfa Beet-pulp	6,993.4	87.00	1.24	10.7	203.20	116.20
Difference caused by rolled barley	322.8	4.75	0.01	0.0	9.30	4.64

DISCUSSION OF RESULTS

The amount of milk produced by the groups fed the ration containing a mixture of equal parts of rolled barley and molasses-dried-beet-pulp was 7,316.2 pounds, while the amount of milk from the groups fed the ration containing beet-pulp as the only concentrate was 6,993.4 pounds, or a difference of 322.8 pounds in favor of the rolled barley-beet-pulp mixture. Barley, being higher in price than beet-pulp, increased the total cost of the ration in which it was fed to \$91.75 as

compared with a total cost of \$87.00 where only alfalfa hay and dried beet-pulp were fed. Enough more milk was produced by the substitution of rolled barley to make the feed-cost of 100 pounds of milk about the same as when beet-pulp was the only concentrate fed.

The milk produced by the groups that were fed the rolled barley-beet-pulp mixture, valued at 25 cents per gallon was worth \$212.68 as compared with a value of \$203.29 for the milk produced by the groups that were fed dried beet-pulp without rolled barley. Feeding rolled barley resulted in an increase of \$4.75 in the cost of the ration, but the milk produced by the groups that were fed the rolled barley ration was worth \$9.39 more than was the milk produced by the groups fed beet-pulp only.

EFFECT OF FEEDS ON COWS

The cows relished the feed more when equal parts of rolled barley and beet pulp were fed. Some of the cows refused to eat the beet-pulp alone after having been fed beet-pulp with which rolled barley had been mixed. They also kept up in weight better when rolled barley was fed than when only beet-pulp was fed.

SUMMARY

The two groups of cows when fed a mixture of equal parts of rolled barley and molasses-dried-beet-pulp produced a total of 7,316.2 pounds of milk, or 322.8 pounds more than when fed beet-pulp alone as the only concentrate.

The feed-cost per gallon of milk was the same for both rations.

The substitution of barley for part of the beet-pulp increased the cost of the feed \$4.75, but caused an increase of \$9.39 in the value of the milk produced. This gave a profit of \$4.64 more over cost of feed, than when beet-pulp was fed as the only concentrate.

PART II—CORN SILAGE AS A SUPPLEMENT TO ALFALFA HAY IN FEEDING DAIRY COWS

A feeding test was conducted during the spring of 1917 to determine the value of corn silage as a supplement for alfalfa hay when fed to dairy cows.

COWS USED

Only seven cows were available for this experiment. These were divided into two groups, four in one group and three in the other.

Since the groups could not be evenly balanced in number, quantity of milk produced, period of lactation, and breed, the feeds were alternated so that each lot was fed each ration the same length of time. The data given are on the basis of rations fed. The production of milk and butterfat given herein represents the sum of the yields by both groups of cows when fed a particular ration.

METHOD OF EXPERIMENT

The groups of cows were kept in separate lots. The hay was fed in mangers in the corrals, and accurate weights were kept of the amounts fed and of the amounts not eaten. The corn silage was fed individually at the time of milking.

The experiment was divided into two periods of 21 days each. The cows were fed for a preliminary period of 10 days to accustom them to the rations. At the end of the first period of 21 days the rations were reversed and an interval of 10 days was allowed to elapse before the second period of feeding began.

RATIONS USED

Ration 1 consisted of 20 pounds of alfalfa hay and 35 pounds of corn silage, while Ration 2 consisted of 30 pounds of alfalfa hay. The feeds were weighed carefully, but since the hay was not fed individually, some cows in a group may have eaten more of it than did others.

The silage was rather dry, due to being quite mature when put into the silo, and was not very well relished.

The price of alfalfa hay at the time was \$20 per ton and silage was worth \$6 per ton.

TABLE II.—ALFALFA HAY VERSUS ALFALFA HAY AND CORN SILAGE FOR DAIRY COWS.

Rations	Average daily yield		Cost of ration per head daily
	Milk	Butterfat	
	Pounds	Pounds	Cents
Ration 1: Alfalfa hay, 20 lbs..... Corn silage, 35 lbs.....	24.278	.881	30
Ration 2: Alfalfa hay, 30 lbs.....	24.72	.846	30

DISCUSSION OF RESULTS

The average daily milk and butterfat yields as shown in Table II were practically the same for both rations. Where alfalfa hay is priced at \$20 per ton and corn silage at \$6 per ton, the cost of the rations was the same for each lot. This indicates that the two rations are practically on a par in feeding value and economy. Ration 1 contains 20 pounds of hay and 35 pounds of silage, while Ration 2 contains 30 pounds of hay. The experiment indicates that 1 pound of alfalfa hay is equal to $3\frac{1}{2}$ pounds of corn silage when fed to dairy cows. A better quality of silage probably would have given somewhat different results.

EFFECT OF FEED ON COWS

All the cows lost weight while on the test, but they maintained their weights better when fed 30 pounds of alfalfa hay than when fed 20 pounds of the hay and 35 pounds of corn silage.

RESULTS AT OTHER STATIONS

The New Mexico Agricultural Experiment Station* found that it required 3 tons of good corn silage to replace 1 ton of choice alfalfa hay. The Utah Experiment Station† found that 250 pounds of corn silage was equal to 100 pounds of alfalfa hay.

SUMMARY

Results of this feeding test indicate that $3\frac{1}{2}$ pounds of corn silage are required to equal 1 pound of alfalfa hay for dairy cows.

Other stations report a value of about $2\frac{1}{2}$ to 3 pounds of corn silage as equalling 1 pound of alfalfa hay for milk production.

PART III.—COTTONSEED CAKE AND COTTONSEED MEAL
AS FEEDS FOR DAIRY COWS

Cottonseed meal has been fed very extensively since cotton has become a major crop in Arizona. In 1918 and 1919 an experiment was conducted to test the value of cottonseed products as supplements to alfalfa hay and corn silage. The experiment was divided into two feeding tests, the first using cottonseed cake and the second cottonseed meal.

*New Mexico Agri. Exp. Sta. Bul. 122.

†Reported in Henry and Morrison's "Feeds and Feeding."

COWS USED IN FIRST TEST

Eleven cows were available for this test. These were divided into three groups of four cows in each of two groups and three in the third group.

METHOD OF FIRST TEST

The cows were balanced in the three groups as evenly as possible with regard to period of lactation, breed, and individuality. Since it was impossible to balance the groups evenly, the test was divided into three periods of 28 days each, and the rations were alternated so that each ration was fed to each group of cows for the same length of time. In this way it was possible to overcome to a considerable extent any differences of breed, period of lactation, individuality, and number of the cows. There was a 1-week interval between the periods to allow the cows to become accustomed to the change in rations. In computing the results, the amounts of milk and butterfat produced by the three groups were added to determine the effect of any of the three rations.

RATIONS USED IN FIRST TEST

Ration 1:	15 pounds alfalfa hay
	40 pounds corn silage
Ration 2:	22 pounds alfalfa hay
	4 pounds cottonseed cake
Ration 3:	11 pounds alfalfa hay
	40 pounds corn silage
	3 pounds cottonseed cake

During the third period, 3 additional pounds of alfalfa hay were added to each of the rations. The rations contained about the same energy value. The prices of the feeds were as follows: Alfalfa hay, \$15 per ton; corn silage, \$5 per ton; cottonseed cake, \$30 per ton.

DISCUSSION OF EXPERIMENTAL RESULTS IN FIRST TEST

Table III shows the summary of the feeds used and the production of milk and butterfat. The cows gave 459.7 pounds of milk and 26.79 pounds of butterfat more when fed Ration 2 consisting of alfalfa hay and cottonseed cake than when fed Ration 1 consisting of alfalfa hay and corn silage, and 590.8 pounds of milk and 20.2 pounds of butterfat more than when fed Ration 2 than when fed Ration 3 consisting of alfalfa hay, corn silage, and cottonseed cake. It was noted that the production varied directly with the narrowness of the ration. Ration 3 which is the most nearly balanced with a feeding standard gave the lowest production of milk.

TABLE III.—SUMMARY OF FEEDS USED AND YIELDS OF MILK AND BUTTERFAT.

Rations	Total feed consumed	Total milk yield	Total butterfat yield	Number of days in test
	Pounds	Pounds	Pounds	
Ration 1: Alfalfa hay Silage	4,956 12,320	7,810.5	262.3	84
Ration 2: Alfalfa hay Cottonseed cake	7,028 1,232	8,270.2	289.1	84
Ration 3: Alfalfa hay Silage Cottonseed cake	3,724 12,320 924	7,679.4	268.9	84

TABLE IV.—COST OF PRODUCTION AND PROFIT OVER COST OF FEED.

Rations	Cost of feed per gallon of milk	Cost of feed per pound of butterfat	Value of milk at 30 cents per gallon	Profit over cost of feed
	Cents	Cents	Dollars	Dollars
Ration 1	7.5	25.9	272.43	204.46
Ration 2	7.4	24.6	288.48	217.29
Ration 3	8.1	26.9	267.87	195.28

The cost of feed per gallon of milk as indicated in Table IV was least in Ration 2, which was 7.4 cents per gallon as compared with 7.5 cents for Ration 1 and 8.1 cents for Ration 3. The cost of feed per pound of butterfat was 25.9 cents in Ration 1, 24.6 in Ration 2, and 26.9 cents in Ration 3.

The value of the milk at 30 cents per gallon, over cost of feed, was greatest in the case of Ration 2, the profit being \$217.29 for the 84 days as compared with \$204.46 for Ration 1, and \$195.28 for Ration 3. The profit over cost of feed per day for each cow, was as follows: Ration 1, 66.5 cents; Ration 2, 70.7 cents; and Ration 3, 63.5 cents.

COWS USED IN SECOND TEST

Nine cows were used in this test. These were divided into three groups of three cows each. All were giving a fairly good flow of milk at the beginning of the test.

METHOD OF SECOND TEST

The feeding was divided into three periods of 4 weeks each, 1 week being allowed between periods for changing the rations. The rations were alternated so that each group received each of the three rations during one of the periods. The test proper covered a period of 84 days.

DISCUSSION OF FEEDS USED

In this test cottonseed meal was substituted for cottonseed cake.

The rations used were as follows:

- Ration 1: Alfalfa hay, 22 pounds
Corn silage, 45 pounds
- Ration 2: Alfalfa hay, 30 pounds
Cottonseed meal, 4 pounds
- Ration 3: Alfalfa hay, 15 pounds
Cottonseed meal, 4 pounds
Corn silage, 45 pounds

PLAN OF FEEDING

The plan of feeding was as follows:

- First period: Group A was fed Ration 1
Group B was fed Ration 2
Group C was fed Ration 3
- Second period: Group A was fed Ration 2
Group B was fed Ration 3
Group C was fed Ration 1
- Third period: Group A was fed Ration 3
Group B was fed Ration 1
Group C was fed Ration 2

TABLE V.—SUMMARY OF MILK AND BUTTERFAT PRODUCED.

Rations	Total milk yield	Total butterfat yield	Number of days in test
	Pounds	Pounds	
Ration 1.....	6,084.8	238.05	84
Ration 2.....	6,776.2	237.95	84
Ration 3.....	6,675.1	250.07	84

DISCUSSION OF EXPERIMENTAL RESULTS

The total yields of milk and butterfat are shown in Table V. Ration 2 which consisted of alfalfa hay and cottonseed meal produced the most

milk, the yield in 84 days being 6,776.2 pounds as compared with 6,084.8 pounds from Ration 1, consisting of alfalfa hay and corn silage, and 6,675.1 pounds from Ration 3 consisting of alfalfa hay, corn silage, and cottonseed meal. The yield of butterfat was higher, however, when Ration 3 was fed.

TABLE VI.—COST OF PRODUCTION AND PROFIT OVER FEED-COST.

Rations	Cost of feed	Feed-cost per gallon of milk	Feed-cost per pound butterfat	Value of milk at 30c per gallon	Profit over feed-cost
	Dollars	Cents	Cents	Dollars	Dollars
Ration 1	69.93	9.88	29.4	212.22	142.29
Ration 2	76.86	9.75	32.3	236.34	159.48
Ration 3	76.86	9.90	30.7	232.83	155.97

The feed-cost per gallon of milk was less when Ration 2 was fed, the cost being 9.75 cents as compared with 9.88 cents for Ration 1, and 9.90 cents for Ration 3. The feed-cost per pound of butterfat was greater in Ration 2 than in either of the other rations. These results are shown in Table VI.

Valuing the milk at 30 cents per gallon, the profit over feed-cost was \$142.29 for Ration 1, \$159.48 for Ration 2, and \$155.97 for Ration 3.

The narrow ration consisting of only alfalfa hay and cottonseed meal produced the most milk and at the least cost per gallon. This indicates that for short periods of time a very narrow ration stimulates production and can be used with satisfactory results.

CAUTION

While a narrow ration of alfalfa hay and cottonseed meal stimulates production, it is a common opinion among stockmen that rations containing a great excess of protein have a deleterious effect on the breeding qualities and general health of animals, if fed to them for a long period of time. Such rations should be fed with caution. Cottonseed meal is poisonous to cows if fed in large amounts for long periods of time.

SUMMARY

The narrow rations of alfalfa hay and cottonseed cake or cottonseed meal produced more milk in each trial than did alfalfa hay and silage, or alfalfa hay, silage, and cottonseed cake, where the amounts of feed given provided about the same amount of total digestible nutrients.

The cost of feed per gallon of milk was least and the profit over cost of feed was most for Ration 2. In the first trial, this ration consisted of 22 pounds of alfalfa hay and 4 pounds of cold-pressed cottonseed cake while in the second trial it consisted of 30 pounds of alfalfa hay and 4 pounds of cottonseed meal.

The ration highest in protein and containing the most alfalfa hay gave the largest yield.

In both trials, Ration 2, consisting of alfalfa hay and cottonseed meal or cake, gave the lowest cost per gallon of milk and the greatest profit over cost of feed.

A narrow ration such as alfalfa hay and cottonseed meal should be fed with caution. Cottonseed meal is poisonous when fed in large amounts for long periods of time.

PART IV.—GREEN ALFALFA VERSUS ALFALFA HAY FOR DAIRY COWS

Recent investigations have shown the value of fresh green feeds for animals. The value of pasture for dairy cows has long been recognized. In Arizona both pasturing and soiling have been practiced to a considerable extent. While soiling is considered too expensive as a general practice, the soiling of alfalfa may have some merit under conditions as found in Arizona.

A feeding test was conducted during the summer of 1921 to compare the feeding value of green alfalfa and alfalfa hay.

METHOD OF EXPERIMENT

As there were only four cows in suitable condition for a feeding test, they were placed in one group. The experiment was divided into four periods of 14 days each. In order to overcome the effects of advancing lactation period on the results, the cows were fed green alfalfa during the first and fourth periods and alfalfa hay during the second and third periods. This plan will give accurate results only in case the natural tendency to decline in production remains uniform throughout the period of the test.

DISCUSSION OF FEEDS USED

During the periods when the cows were fed green alfalfa, the feed was cut once each day and they were given all they would clean up well. When alfalfa hay was fed, the hay was taken from the same field as was the green alfalfa and the cows were given all they would clean up.

In order to get a comparison of the amounts of dry matter eaten in the green alfalfa and alfalfa hay and to estimate the loss in weight in curing hay, several loads of green alfalfa were weighed and the alfalfa was then spread out to dry. When it was as dry as it ordinarily would be for baling it was re-weighed to determine the amount of weight lost during the drying process. It was found that 39 percent of the original weight remained in the hay. Working on this basis, when the cows were fed all they would eat, they consumed 28.5 pounds of alfalfa hay per head daily, and the weights of the green alfalfa eaten were the equivalent of 28.7 pounds of dry alfalfa hay per head. This does not take into account the probable shrinkage that takes place in hay after it is baled. Thus, they ate approximately the same amount of dry matter, whether fed green alfalfa or dry hay.

TABLE VII—GREEN ALFALFA VERSUS ALFALFA HAY FOR DAIRY COWS

Rations	Green alfalfa per head daily	Alfalfa hay per head daily	Grams per head daily	Milk per head daily	Butter fat per head daily
	Pounds	Pounds	Pounds	Pounds	Pounds
Alfalfa hay ration		28.5	4.44	21.4	.85
Green alfalfa ration	73.6		4.26	21.0	.86

DISCUSSION OF EXPERIMENTAL RESULTS

As shown in Table VII, the cows ate on an average 73.6 pounds of green alfalfa per head daily during the periods in which green feed was given and 28.5 pounds of alfalfa hay when confined to dry feed. The average daily milk production was 21.4 pounds when fed hay and 21.0 pounds when given green alfalfa. The amount of butterfat produced daily was about the same for the two rations or an average of .85 pound a head when the cows were fed alfalfa hay and .86 pound when they were fed green alfalfa.

SUMMARY

When the cows were given all they would eat, they consumed approximately the same amount of dry matter whether given green alfalfa or alfalfa hay.

The cows gave an average of 21.4 pounds of milk per head daily when fed alfalfa hay and 21 pounds when fed green alfalfa.

PART V —ALFALFA-MOLASSES MEAL *VERSUS* ALFALFA HAY FOR DAIRY COWS

In Arizona, it is a common practice among dairymen to feed dairy cattle only the first and last cuttings of alfalfa hay. This is because alfalfa in mid-summer becomes stemmy and frequently is mixed with grass and weeds. When third- or fourth-cutting alfalfa is fed, there is usually a large amount wasted as the coarse stems and grass are unpalatable to dairy cows. If this grade of alfalfa can be made more palatable, it is possible that its feeding value can be increased.

A manufacturer of alfalfa-molasses meal in the vicinity of Mesa, Arizona, furnished the Experiment Station with a quantity of the meal and a supply of standard alfalfa hay of the same grade as that from which the meal was made in order to compare their feeding values. A feeding test was conducted during the spring of 1925 to determine the comparative feeding values of standard alfalfa hay and alfalfa-molasses meal.

COWS USED

Six cows were used in this test. They were divided into two groups, two Holstein-Friesians and one Jersey in each group. The groups were balanced as evenly as possible, with regard to age, size of cows, and their periods of lactation.

METHOD OF EXPERIMENT

The experiment was divided into two periods of 28 days each, with 1 week intervening for the changing of rations. In Period 1, Group A was fed standard alfalfa hay and Group B alfalfa-molasses meal. In Period 2 these feeds were reversed.

TABLE VIII.—METHOD OF ALTERNATING RATIONS

Groups	Period 1	Period 2
Group A.....	Standard alfalfa hay	Alfalfa-molasses meal
Group B.....	Alfalfa-molasses meal	Standard alfalfa hay

All cows were weighed at the beginning of and at the end of each period to find the effect of the ration on body weight. Tests for the percentage of butterfat in the milk were made about the middle of each period.

DISCUSSION OF FEEDS USED

Both the standard alfalfa hay and the alfalfa-molasses meal were provided by the Tremaine alfalfa ranch of Mesa, Arizona. The meal

was prepared at that ranch and 15 percent black-strap molasses added during the process of preparation. The standard alfalfa hay was of the same grade as that from which the meal was prepared, and contained about 15 percent grass. In addition to the hay and meal, both groups of cows were fed corn silage and a grain-mixture prepared by mixing 210 pounds of mill-run wheat bran, 210 pounds of rolled barley, and 100 pounds of cottonseed meal.

The two groups of cows were kept in separate lots and the hay and alfalfa meal were fed in mangers, the cows of the respective groups eating together. The three cows fed standard alfalfa hay were given 76 pounds or 25 $\frac{1}{3}$ pounds per head daily, while the three given alfalfa-molasses meal were fed 60 pounds or 20 pounds per head daily. These weights were decided upon at the beginning of the experiment, since it was evident that as much production would have to be obtained from about 60 pounds of alfalfa-molasses meal as from 76 pounds of alfalfa hay in order to justify the expense of manufacturing the meal.

The silage and grain were fed each cow separately in the barn. The Holstein-Friesian cows were given 30 pounds of silage per head daily while the Jerseys were fed 20 pounds per head daily. The grain was fed at the rate of approximately 1 pound of grain to 5 pounds of milk produced by Holstein-Friesians and 1 pound of grain to 4 pounds of milk produced by Jerseys, based on the amount of milk given by the cows at the beginning of the experiment. The amounts of grain fed were not changed during the feeding test and none was refused by the cows. All feeds were weighed at the time of feeding and the silage and hay that were not eaten were weighed and removed from the mangers.

The alfalfa-molasses meal was eaten up clean each day, but a considerable amount of silage and hay was not consumed. The hay was not eaten up clean, largely because of its stemmy character and the amount of unpalatable grass it contained.

TABLE IX.—AVERAGE DAILY RATION.

Rations	Grain mixture	Silage	Alfalfa-molasses meal	Standard alfalfa hay
	Pounds	Pounds	Pounds	Pounds
Ration 1.....	5.8	26.2	20
Ration 2.....	5.8	26.4	25.3

TABLE X—CHEMICAL COMPOSITION OF FEEDS USED (EXPRESSED IN PERCENTAGE OF THE FRESH SUBSTANCE.)

Feed	Water	Ash	Crude protein	Fiber	Nitrogen-free extract	Fat
	Percent	Percent	Percent	Percent	Percent	Percent
Alfalfa-molasses meal	6.27	8.81	13.43	21.07	40.07	1.35
Standard alfalfa hay	5.25	6.51	11.05	37.65	38.11	1.42
Corn silage	72.10	1.80	1.45	7.75	16.37	.53
Gram mixture	6.51	4.96	19.56	6.88	57.40	4.59

TABLE XI—ALFALFA-MOLASSES MEAL VERSUS STANDARD ALFALFA HAY

Rations		Grain	Silage	Alfalfa-molasses meal	Standard alfalfa hay
		Pounds	Pounds	Pounds	
Ration 1	Amount fed	980	4,396	3,350	
	Amount refused		565		
Ration 2	Amount fed	980	4,430		4,254
	Amount refused		423		868

DISCUSSION OF EXPERIMENTAL RESULTS

Table XI shows the total amounts of feed allowed and the amounts refused. The amount of grain consumed by each of the groups was 980 pounds. In Ration 1, 4,396 pounds of silage were allowed and 565 pounds weighed back. In Ration 2, 4,430 pounds of silage were allowed and 423 pounds were refused. The amount of alfalfa-molasses meal eaten was 3,350 pounds.

In Ration 2, 4,254 pounds of hay were given and 868 pounds were weighed back as waste hay.

The yield of milk while the cows were on Ration 1 was 4,124 pounds or an average of 24.5 pounds per head daily, as compared with 3,823.8 pounds or an average of 22.8 pounds while the cows were on Ration 2, a total difference of 300.2 pounds in favor of Ration 1. The yield of butterfat was about the same for the two rations. The summary of the production of milk and butterfat is shown in Table XII.

TABLE XII—PRODUCTION OF MILK AND BUTTERFAT.

Rations	Milk yield	Butterfat yield	Number of days on test
	Pounds	Pounds	
Ration 1			
Total for experiment	4,124 0	153 28	
Average per head daily	24 5	.91	56
Ration 2			
Total for experiment	3,823 8	152 62	
Average per head daily	22 8	.91	56

If we value the standard alfalfa hay at \$12 per ton, the additional yield of milk from Ration 1 would make the alfalfa-molasses meal worth \$16.45 per ton, provided we do not deduct from the total the amount of hay which was refused. The actual amount of standard alfalfa hay eaten in the experiment was 3,386 pounds or 1.69 tons. Valuing this amount of hay at \$12 per ton, the alfalfa-molasses meal would be worth \$13.08 per ton.

EFFECT OF THE FEEDS ON COWS

The cows maintained their body weights better when fed alfalfa-molasses-meal ration than when the alfalfa hay ration. They gained an average of 14 pounds per head on that ration while they lost an average of 2 pounds on the standard alfalfa hay ration. They relished the alfalfa-molasses meal much more than they did the standard alfalfa hay.

SUMMARY

Alfalfa-molasses meal was relished by cows much more than the standard alfalfa hay from which it was made.

The alfalfa-molasses meal was eaten up clean while the cows left a quantity of stems and grasses in the standard alfalfa hay.

The average daily yield of milk when on the alfalfa-molasses meal ration was 24.5 pounds per cow while the average daily yield of milk on the alfalfa-hay ration was 22.8 pounds per cow. The yield of butterfat was the same from both rations.

If we value the standard alfalfa hay at \$12 per ton and do not deduct the hay left in the mangers, the alfalfa-molasses meal is worth \$16.45 a ton. On the other hand, if we charge the cows with only the amount of hay actually consumed, the alfalfa-molasses meal would be worth \$13.08 per ton.

The cows maintained their body weights better when the alfalfa-molasses meal than when fed standard hay.

PART VI.—GROUND HEGARI GRAIN *VERSUS* ROLLED BARLEY AS FEEDS FOR DAIRY COWS

Sorghum grain, in general, is looked upon with disfavor by dairy-men, on account of its lack of palatability and because it is generally considered to be a poor milk producer. Hegari, however, has been creating much attention in the Southwest as a hog and beef-cattle feed. The yield of hegari grain is higher than that of many other sorghums and the quality of its fodder and silage is good. It has become the chief grain sorghum raised in southern Arizona. This feeding test was conducted to study the feeding value of hegari grain compared with that of rolled barley.

COWS USED

Ten cows were used in this test. They were divided into two groups of three Holstein-Friesians and two Jerseys in each group. The groups were well balanced with respect to period of lactation, breed, age, and milk production of cows.

METHOD OF EXPERIMENT

The feeding test was divided into four periods of 14 days each with an interval of 7 days between the periods for changing rations. The groups of cows were kept in adjacent pens and were fed as nearly as possible the same amounts of hay and silage throughout the experiment. During the first period, Group A was given Ration 1, the concentrate portion of which consisted of a grain-mixture made up of 2 parts ground hegari and 1 part wheat bran while Group B was fed Ration 2 containing a grain-mixture of 2 parts rolled barley and 1 part wheat bran. In each case, the grain-mixture was fed at the rate of 1 pound of grain to 5 pounds of milk produced by Holsteins and 1 pound of grain to 4 pounds of milk produced by Jerseys. The amount of grain fed was adjusted at the beginning of each period and was not changed during the periods. At the end of each of the first three periods, the rations were alternated so that Group A received the hegari ration during the first and third periods and the barley ration during the second and fourth periods, while Group B received the hegari ration during the second and fourth periods and the barley ration during the first and third periods. The milk was weighed daily and a butterfat test was made of a 2-day composite sample of milk from each cow at about the middle of each period.

DISCUSSION OF FEEDS USED

Hegari is one of the grain sorghums. The rolled barley was purchased from a milling company and was of average grade. The alfalfa hay fed was of the Hairy Peruvian variety and was of No. 1 grade.

TABLE XIII.—SUMMARY OF FEEDS USED.

Rations	Grain mixture	Alfalfa hay	Silage
Ration 1—Hegari ration	Pounds	Pounds	Pounds
Total amount fed.....	1,757.00	5,012.0	6,400.0
Average per cow daily.....	6.27	17.9	22.9
Ration 2—Barley ration			
Total amount fed.....	1,788.50	4,998.00	6,349.0
Average per cow daily.....	6.39	17.85	22.7

TABLE XIV.—MILK PRODUCTION BY PERIODS AND PERCENTAGE OF DECREASE.

Name of cow	Milk		Percent- age of decrease	Milk period 3	Percent- age of decrease	Milk period 4	Percent- age of decrease
	Period 1	Period 2					
	Pounds	Pounds		Pounds		Pounds	
Nora	193.1	189.7	1.7	174.8	+ 7.1	196.1	-12.2
Noble	226.4	189.6	16.2	201.3	- 6.1	225.1	-11.8
Jessie	254.3	204.5	19.5	212.0	- 3.7	204.7	+ 3.4
Theresa							
Belle	777.1	699.9	9.9	688.8	+ 1.6	697.9	= 1.3
Korndyke..	407.5	336.9	17.3	334.5	+ .7	363.7	- 8.7
*Group A total	1,858.4	1,620.6	12.8	1,611.4	+ .6	1,687.5	- 4.7
Lass	265.3	241.2	9.1	229.1	5.0	241.6	- 5.4
Gipsy	373.5	337.4	9.7	326.9	3.1	352.4	- 7.8
Pell	743.2	715.2	3.8	646.4	9.6	641.6	+ .7
DeVries	634.3	581.9	8.3	499.2	14.2	540.6	- 8.3
Dixie	428.0	412.0	3.7	411.1	.2	397.3	+ 3.3
*Group B total	2,444.3	2,287.7	6.4	2,112.7	7.6	2,173.5	- 2.8

The average daily ration per head for groups when fed Ration 1 (Table XIII) containing grain-mixture consisting of 2 parts hegari grain and 1 part wheat bran was as follows: grain-mixture, 6.27 pounds; alfalfa hay, 17.9 pounds; and, corn silage, 22.9 pounds. The average daily ra-

*Group A was fed Ration 1 during periods 1 and 3, and Ration 2 during periods 2 and 4, while Group B was fed Ration 1 during periods 2 and 4, and Ration 2 during periods 1 and 3.

tion per head when the cows were fed Ration 2 containing the grain-mixture consisting of 2 parts rolled barley and 1 part wheat bran was as follows: grain-mixture, 6.39 pounds; alfalfa hay, 17.85 pounds; and, corn silage, 22.7 pounds. These rations, as well as the total amount of feed used, are shown in Table XIII. The cows seemed to like the barley ration better than they did the hegari-grain ration, but when fed in the above quantities both grain-mixtures were cleaned up well.

DISCUSSION OF RESULTS

Table XIV shows the production of the two groups of cows by periods and percentage of decrease from one period to the next. The data in this table indicate that the hegari ration is as effective as the barley ration in maintaining the milk flow. The increased production by both groups in the fourth period over that of the third is unexplained except, possibly, by better weather conditions.

TABLE XV.—SUMMARY OF MILK AND BUTTERFAT PRODUCED.

Ration	Group	Periods	Milk yield	Butterfat yield	Number of days in actual test period
			Pounds	Pounds	
Ration 1	A	1	1,858.4	74.59	14
	B	2	2,287.7	90.91	14
	A	3	1,611.4	69.92	14
	B	4	2,173.5	82.64	14
Total for Ration 1			7,931.0	318.06	56
Ration 2	B	1	2,444.3	97.94	14
	A	2	1,620.6	67.47	14
	B	3	2,112.7	81.94	14
	A	4	1,687.5	70.60	14
Total for Ration 2			7,865.1	319.95	56
Difference in favor of Ration 1			+65.9	-1.9	

Table XV shows the yield of milk and butterfat with the two rations. When fed ground hegari the cows produced 7,931.0 pounds of milk and 318.06 pounds of butterfat, and when fed the barley ration, the yields of milk and butterfat were 7,865.1 pounds and 319.95 pounds respectively, a difference of 65.9 pounds of milk in favor of the hegari ration and 1.9 pounds of butterfat in favor of the barley ration. The results

were so close that the difference may result from error or uncontrolled factors. Since the amounts of feed given in the two rations are so similar and the cost of the feeds are nearly identical it is useless to show a comparison of the feed-costs per gallon of milk or per pound of butterfat, or the profit over cost of feed. The yields of milk and of butterfat and the value of the feeds used are so nearly the same in the case of the two rations that the feed-costs per unit of production are almost identical.

PART VII.—GROUND YELLOW CORN *VERSUS* ROLLED BARLEY FOR DAIRY COWS

In March and April, 1927, a feeding test was conducted to compare ground yellow corn with rolled barley when fed with wheat bran, corn silage, and alfalfa hay as a feed for dairy cows.

COWS USED

Twelve cows were used in the experiment, six Holsteins and six Jerseys. These were divided into two groups, each of which included three Holsteins and three Jerseys. The groups were balanced as nearly as possible in regard to period of lactation of the cows, amount of milk flow, and age of cows.

METHOD OF EXPERIMENT

The experiment was divided into two periods of 28 days each with a 7-day interval between periods for changing rations. There was also a 7-day preliminary feeding period at the beginning of the feeding test. During the first period, the cows of Group A were given a grain-mixture consisting of 2 parts ground yellow corn and 1 part wheat bran, while those in Group B were given a concentrate mixture of 2 parts rolled barley and 1 part wheat bran. During the second period, Group B received the yellow-corn mixture and Group A the concentrate mixture containing rolled barley. In addition to the concentrate allowance, both groups of cows were fed alfalfa hay at the rate of 20 pounds per head daily. Corn silage was fed to both groups at the rate of 30 pounds per head daily for Holstein-Friesians and 20 pounds per head daily for Jerseys. The concentrate mixture was apportioned to each cow individually at the rate of 1 pound of grain for each 4 pounds of milk produced daily by Holsteins and 1 pound of grain for each 3 pounds of milk produced by Jerseys. The amount of grain was apportioned on the basis of the amount of milk being given at the beginning of each

period and was not changed during the period. This procedure was followed because it was believed that if the production decreased due to some temporary condition, it would not be possible for the cows to regain their former production if the rations were reduced at the time of the decrease in production.

The cows were milked twice daily and the milk weighed at each milking. At about the middle of each period, a 2-day composite sample of each cow's milk was tested for percentage of butterfat.

TABLE XVI.—METHOD OF ALTERNATING RATIONS.

	Period 1	Period 2
Group A.....	Ration 1: Alfalfa hay Corn silage Corn and bran mixture	Ration 2: Alfalfa hay Corn silage Barley and bran mixture
Group B.....	Ration 2: Alfalfa hay Corn silage Barley and bran mixture	Ration 1: Alfalfa hay Corn silage Corn and bran mixture

TABLE XVII.—AVERAGE DAILY RATIONS PER COW.

Rations	Grain mixture corn and bran	Grain mixture barley and bran	Corn silage	Alfalfa hay
	Pounds	Pounds	Pounds	Pounds
Ration 1:				
Group A, Period 1.....	8.8	---	25.0	20.0
Group B, Period 2.....	8.0	---	11.7	22.5
Ration 2:				
Group B, Period 1.....	---	9.6	25.0	20.0
Group A, Period 2.....	---	7.7	11.7	22.5

TABLE XVIII.—TOTAL AMOUNTS OF FEED FED.

Rations	Grain mixture corn and bran	Grain mixture barley and bran	Corn silage	Alfalfa hay
	Pounds	Pounds	Pounds	Pounds
Ration 1:				
Group A, Period 1.....	1,484	-----	4,200	3,360
Group B, Period 2.....	1,344	-----	1,962	3,780
Total for Ration 1.....	2,828	-----	6,162	7,140
Ration 2:				
Group B, Period 1.....	-----	1,607	4,200	3,360
Group A, Period 2.....	-----	1,302	1,962	3,780
Total for Ration 2.....	-----	2,909	6,162	7,140

DISCUSSION OF FEEDS USED

The feeding values of ground corn and rolled barley for dairy cows are quite well known. There is a tendency, however, in the Southwest to exclude all corn from the ration in favor of lighter concentrates in the belief that corn makes too heavy a ration. It is possible that this is overdone and is not necessary, particularly where wheat bran, alfalfa hay, and silage are fed along with the concentrates or where the ground corn is scattered over the silage at feeding time.

At the middle of the second period, the corn silage was used up and hence could not be fed during the last 14 days. When the silage was eliminated from the ration, the alfalfa hay allowance was increased to 25 pounds per head daily for each group. This increase in amount of hay was not sufficient to replace the silage, but was enough to satisfy the requirements of the cows. Table XVII shows the average daily rations.

TABLE XIX.—MILK AND BUTTERFAT PRODUCTION SHOWING DECREASE.

Name of cow	Milk		Percent- age of decrease	Butterfat		Percent- age of decrease
	Period 1	Period 2		Period 1	Period 2	
	Pounds	Pounds		Pounds	Pounds	
Theresa Belle	1,081.2	787.4	27.2	25.98	26.77	- 0.3
Roxanna	987.5	855.5	13.4	25.67	28.23	-10.0
Ormsby	745.5	668.1	10.4	22.36	22.77	- 1.8
Myrtle	1,090.1	902.1	17.3	47.96	39.69	+17.2
No. 19.....	482.9	440.6	8.8	20.76	19.38	+ 6.6
Noble Eminent.....	511.1	396.4	22.4	23.00	17.90	+22.2
Total, Group A.....	4,898.3	4,050.1	17.3	165.73	154.68	+ 6.7
Josephine	1,372.4	1,144.8	16.6	35.68	25.18	29.4
Moensje	1,023.0	837.4	18.6	33.25	28.89	13.1
DeVries	816.3	682.6	16.4	17.96	16.38	8.8
Lass	327.0	291.8	10.8	16.35	13.71	16.1
No. 20.....	449.1	386.8	13.9	23.31	18.95	18.7
Topsy	928.2	842.6	9.2	48.70	38.51	20.9
Total, Group B.....	4,916.0	4,186.0	14.8	175.25	141.62	19.2

DISCUSSION OF EXPERIMENTAL RESULTS

Table XIX shows the amount of milk and butterfat produced by the individual cows of the two groups together with the percentage of decrease from one period to the next. All of the cows of each group decreased in milk production, the range of decrease being from about 8

percent to about 27 percent. The average decrease for Group A was 17.3 percent and for Group B 14.8 percent. This difference between the groups is not significant. The three Holstein cows of Group A increased in butterfat percentage enough in the second period to cause an increase in the amount of butterfat in that period even though there was a decrease in the amount of milk. It is thought that there may have been some temporary condition causing a variation in the percentage of butterfat in the milk of the three cows since the three Jersey cows of the same group showed about the same percentage of butterfat in the second period as they did in the first period.

In Group B, four of six cows showed a greater percentage decrease in butterfat than in milk, the average difference being 4.4 percent. This is not considered sufficient to say that rolled barley will cause a higher percentage of butterfat in milk than will ground yellow corn.

TABLE XX.—SUMMARY OF PRODUCTION OF MILK AND BUTTERFAT.

Rations	Milk yield	Butterfat yield
	Pounds	Pounds
Ration 1:		
Group A, Period 1.....	4,898.3	165.7
Group B, Period 2.....	4,186.0	141.6
Total for Ration 1.....	9,084.3	307.3
Ration 2:		
Group B, Period 1.....	4,916.0	175.2
Group A, Period 2.....	4,050.1	154.7
Total for Ration 2.....	8,966.1	329.9
Difference in favor of Ration 1.....	118.2	22.6

The yields of milk and butterfat, by the two groups when fed Ration 1, as shown in Table XX, were 9,084.3 pounds and 307.3 pounds respectively, while the yields from Ration 2 were 8,966.1 pounds of milk and 329.9 pounds of butterfat. This makes a difference of 118.2 pounds of milk, or 1.3 percent in favor of the corn ration. The difference in yield of butterfat is in favor of the barley ration. As stated before, it is thought that the difference is due to a temporary condition that caused a wide variation in the butterfat test of three of the cows of Group A. The results of this test would indicate that ground yellow corn and rolled barley are of about equal value in feeding dairy cattle, provided they are fed in a reasonably well-balanced ration including alfalfa hay, corn silage, and wheat bran.

TABLE XXI.—BODY WEIGHTS OF COWS.

Weighing dates Group A	Name of Cows						
	Theresa Belle	Rox-anna	Orms-by	Myrtle	No. 19	Noble Eminent	Group total
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Feb. 28, Mar. 1, 2..	1,271	1,229	1,123	1,115	877	942	6,557
Mar. 28, 29, 30.....	1,318	1,269	1,160	1,161	914	949	6,771
Gain during Period 1..	47	40	37	46	37	7	214
April 4, 5, 6.....	1,290	1,283	1,153	1,132	898	953	6,709
May 2, 3, 4	1,305	1,293	1,167	1,117	907	924	6,713
Gain during Period 2..	15	10	14	-15	9	-29	4
Group B	Joseph-ine	Noen-sje	De-Vries	Lass	No. 20	Topsy	Group total
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Feb. 28, Mar. 1, 2..	1,366	1,173	1,454	900	1,000	1,139	7,032
Mar. 28, 29, 30.....	1,405	1,216	1,483	936	1,031	1,172	7,243
Gain during Period 1..	39	43	29	36	31	33	211
April 4, 5, 6.....	1,380	1,182	1,481	915	1,018	1,158	7,144
May 2, 3, 4	1,402	1,190	1,515	908	1,042	1,152	7,209
Gain during Period 2..	12	8	34	-7	24	-6	65

SUMMARY

The average decrease in milk production for Group A when changed from ground yellow corn to rolled barley was 17.3 percent while the average decrease for Group B in changing from rolled barley to ground yellow corn was 14.8 percent.

Group A gave 6.7 percent less butterfat when fed rolled barley than when fed ground yellow corn, while Group B produced 19.2 percent less butterfat when fed ground yellow corn than when fed rolled barley. This difference may be accounted for by an unexplained variation in butterfat percentage of the milk of some of the cows.

The combined production of milk of Group A and Group B when fed Ration 1 was 9,084.3 pounds while the production of milk from Ration

2 was 8,966.1 pounds, a difference of 1.3 percent in favor of Ration 1. The combined production of butterfat by the two groups was 329.9 pounds when fed Ration 2 as compared with 307.3 pounds when fed Ration 1.

The feeding values of ground yellow corn and rolled barley as feeds for dairy cows are about equal.

The cows gained more in body weight when fed Ration 1 containing ground yellow corn than when fed rolled barley. These weights are tabulated in Table XXI.