Value of Ground Alfalfa Hay in the Concentrate Ration for Dairy Cows

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TABLE OF CONTENTS

INTRODUCTION

Protein supplements are normally the high cost part of the concentrate ration for dairy cattle, but during the years of World War II when the nation's farmers were concentrating their efforts toward production of food and materials for the war, high protein supplements became scarce and more costly.

Kuhlman and Cave (25) started a series of feeding trials to determine whether ground alfalfa hay would substitute successfully for part of the high protein portion of the concentrate ration.

The double-reversal design was used, consisting of three twenty-day periods with a ten-day preliminary and two ten-day change-over periods. The control cows were fed a concentrate mixture as follows: Ground yellow corn, 350 pounds; ground oats, 200 pounds; wheat bran, 200 pounds; cottonseed meal (41% protein), 250 pounds; and 10 pounds each of ground limestone, steamed bone meal, and salt. The experimental ration was the same as the above mixture, except that 30% of this mixture by weight was replaced with ground alfalfa hay.

All cows on the first three trials were fed two pounds of prairie hay per 100 pounds of body weight. In addition to this, the cows were fed enough of either the control or experimental ration to exceed Morrison's highest recommendations by 10%.

It was concluded by Kuhlman and Cave (14) that milk yield and body weight were maintained satisfactorily on the experimental mixture in these first three trials.

The fourth trial, reported by Davis (4), was conducted in the same manner as the first three trials, with the following exceptions: Long alfalfa hay was fed 2 pounds per 100 pounds of body weight instead of prairie hay and neither ration contained any cottonseed meal. The control ration was composed of two parts corn, one part oats, one part bran, 1% steamed bone meal, and 1% salt. The experimental ration was the same as the above except that 30% by weight of this mixture was replaced with ground alfalfa hay.

Davis (4) concluded that there was no significant difference in milk production or in body weight in the two rations.

With these first four trials showing no difference in milk production between the two rations, it was decided to increase the ground alfalfa in the concentrate to see if the maximum limit of ground hay in the concentrate ration could be determined.

Firestone (6) conducted the fifth trial which was conducted in the same manner as the fourth trial except that the ground alfalfa hay replaced 50% of the concentrate ration instead of 30%. He concluded that body weight and milk production were maintained satisfactorily on the experimental ration.

These first five trials were analyzed for milk production by adding milk production of Group I, period 1 and 3 to Group II, Period 2; and by adding Group I, period 2 to Group II, period 1 and 3. This gave the production of the cows on the experimental ration in comparison to cows on the control ration. This method of analysis could lead to an erroneous conclusion as group differences are confounded in the results. From unpublished data (25),

these first five trials were analyzed statistically, using the switch-back analysis of Snedecor (22), which eliminates the group difference. It was found that in the first four trials there was no significant difference between the rations, but there was a significant difference at the 1% level in favor of the control ration in the fifth trial. It should be noted also that in the first six trials the cows were fed 10% above Morrison's (18) highest recommendation for milk production and body maintenance. According to the investigators, this was done to insure a maximum milk yield and to maintain body weight. Although the first four trials showed no significant difference, it is felt that this high level of feeding tends to confound the results, obliterating any differences due to the composition of the ration.

REVIEW OF LITERATURE

Many workers have conducted experiments to determine the percentage of production that could be expected from an all alfalfa hay ration in comparison to a full or limited grain ration.

Dickson and Kopland (5) reported on the effects of a full grain ration in comparison with an all roughage ration and limited grain feeding. Holstein cows known to be capable of high production were used in this trial. The production of these cows was converted to a mature equivalent basis and compared to their previous lactations. It was found that the cows on the limited grain ration produced 92.4% as much milk as they had on the full grain ration, and 77.1% as much milk on the all roughage ration. Their conclusion was that the limited grain feeding was the most economical method of producing milk.

Others who have investigated the production of cows fed an all alfalfa hay ration in comparison to full grain feeding have found the percentage of production on the all alfalfa hay ration to be 80% (17), 65.8% (8), and 65.77% (21) of the level of production obtained when the cows were on a full grain ration. Most of these authors also noted that the cows decreased faster in their production on an all alfalfa hay ration.

Hodgson and associates (11) found that on an all alfalfa hay ration the cows produced 76% as much milk as on a full grain ration.

Graves et al (9) conducted an experiment comparing the production of dairy cows on an all alfalfa hay ration against a full grain ration. They used 15 high producing Holstein cows with one or more lactations on full grain feeding. These cows were then placed on an all alfalfa hay ration for an entire lactation period. The production was then converted to a mature equivalent basis and compared to the previous lactations. It was found that 57% as much milk was produced on the all alfalfa hay ration as was produced on a full grain ration. They also found that the cows declined more rapidly on the all alfalfa hay ration.

Carncross and Hank (3) made a comparison of cost of milk production on different levels of roughage feeding. They found that on farms where roughage supplied 75% of the TDN intake, the cost of producing milk was 46¢ less per 100 pounds than on those farms where just 53% of the TDN intake was from roughage.

Woll et al (30) studied the cost of milk production on heavy grain feeding (1:3) in comparison to light grain feeding (1:5).

Jerseys, Guernseys, Holsteins, and Ayrshires were used in this experiment. They found no significant difference in milk

production, but the cows on the heavy grain feeding increased more in body weight. It was concluded by the authors that the heavy grain feeding was unprofitable.

Others have conducted trials and concluded heavy grain feeding was unprofitable (1), (28), and (29).

Other workers conducted experiments to determine if ground alfalfa hay could substitute for bran in the concentrate ration for dairy cows. Some of these workers found alfalfa hay to be as good as or a little better than bran in the ration.

Fraser and Hayden (7) compared alfalfa hay and wheat bran. One group of cows was fed all the alfalfa hay they would consume, while another group was fed an equal amount of bran. The total ration consisted of 6 pounds of clover hay, 30 pounds of corn silage, 6 pounds of corn meal, and an average of 8 pounds of alfalfa hay or bran. Two 9½ week feeding periods were used, with the rations being reversed at the end of the first period. The production of the two groups was then analyzed, and it was found that alfalfa hay was equal to or slightly better than wheat bran.

Alfalfa meal was used to replace bran in an experiment conducted by Snyder (23). A ration of 4 parts corn, 2 parts bran, and 1 part cottonseed meal was used as a control ration. In the experimental ration the wheat bran was replaced with an equal amount of ground alfalfa hay. Six pairs of cows were used in four 15-day periods, with the rations being reversed at the beginning of each period. Snyder stated that there was a decrease of 145 pounds of milk and 7.5 pounds in fat production on the experimental ration, but the cows gained 272 pounds in body weight. He concluded that chopped alfalfa hay had the same feeding value as bran.

However, the following workers found wheat bran to be better than alfalfa hay in the concentrate ration for dairy cows.

Two experiments are reported by Hills (10): (1) Alfalfa meal versus wheat bran, and (2) Alfalfa meal versus distillers' grains. He first reported on a feeding trial where the control group of cows was fed a ration of hay and silage for the roughage and a concentrate ration made up of 5 parts of cottonseed meal, 1½ parts of linseed meal, and 1½ parts of bran. The experimental ration was the same except that alfalfa meal was substituted for the bran. There was a loss in milk production from 3 to 6 percent in 207 days by the group fed the experimental ration. In reporting on the alfalfa meal versus distillers grain experiment, after feeding for 253 days, he noted a 13% gain in milk and 18% gain in butterfat over the alfalfa meal by the distillers grain.

Lindsey (15) reported that bran furnished more digestible protein, nitrogen free extract, and fat than alfalfa. He pointed out that bran contained 100 pounds more TDN per ton, and all things being equal, should be regarded as a more economical feed for milk production.

Mairs (16) reported on an experiment which was divided into four periods of three weeks each. The design was as follows, with ten cows divided into two lots:

	Period 1	Period 2	Period 3	Period 4
Lot 1	Wheat Bran	Alfalfa Meal	Wheat Bran	Wheat Bran
Lot 2	Wheat Bran	Wheat Bran	Alfalfa Meal	Wheat Bran

The daily concentrate ration for each cow consisted of 3 pounds of corn meal, 1 pound of cottonseed meal, and 4 pounds of wheat bran or alfalfa meal. In addition to this, 30 pounds of corn

silage and 12 pounds of mixed hay were fed. He noted that in every case the cows declined in milk production when put on the experimental ration, and increased when put back on the control.

Rothwell (20) reported that 17 cows were placed on an experiment comparing alfalfa meal to wheat bran. The experiment was conducted for three two-week periods. During the first and third periods the regular concentrate ration which contained 33% wheat bran was fed, while in the second period alfalfa meal replaced the wheat bran in the ration. The roughage portion of the ration consisted of alfalfa hay and corn silage. The ration containing the alfalfa meal produced more milk and less fat than the regular ration. In two more experiments conducted in the same manner, the conclusion was reached that while alfalfa meal is a good feed, it is not as valuable as bran for milk and fat production.

Soule and Barnes (24) reported on an experiment where chopped alfalfa hay was compared to bran and cottonseed meal. Three groups of 4 cows each received the following ration for 120 days, after which the production of the three groups was analyzed: Group I, silage, wheat bran, cottonseed meal; Group II, silage, chopped alfalfa, cottonseed meal; Group III, silage, wheat bran, chopped alfalfa. Alfalfa meal was substituted for the wheat bran in Group II and for the cottonseed meal in Group III on a protein basis. He concluded that alfalfa meal could not replace cottonseed meal, and that pound for pound, alfalfa meal was inferior to bran. One and one-half pounds of alfalfa could be used to replace one pound of bran.

Several workers have reported on the use of dried or dehydrated grass to replace all or part of the concentrate ration.

In a report by Hope et al (12) a comparison was made of milk production where dehydrated grass made up part of the concentrate ration for dairy cows. The dehydrated grass was a mixture of orchard grass, ladino clover, alsike clover, and timothy, and was harvested when ten inches high, dehydrated, and finely ground. Hay was fed free choice and the dehydrated grass in the concentrate mixture was divided into three levels: 15%, 30%, and 45% of the grain was replaced in the three experimental rations. One ration containing no grass was used as a control. They concluded that the difference in milk production was statistically significant in favor of the control ration. The rate of decline in milk production was less rapid for the control group, and the finely ground state of the dehydrated grass was undesirable, since the cows receiving the 30% and 45% replacement showed varying degrees of rumen atony and anorexia.

However, others have found that dried grass could be substituted for part or all of the concentrate ration.

Knott and Hodgson (13) reported on a feeding trial where artifically dried grass was used in the concentrate mixture; and on another trial where alfalfa hay versus alfalfa hay and grass was used. In the first trial the gain in live weight was less on the experimental feed, but feed consumption per unit of production was less. The second experiment showed an increase in weight and milk production on the alfalfa hay grass ration. They concluded that artifically dried herbage could be efficiently used as part of the concentrate mixture for lactating cows.

Camburn (2) conducted an experiment comparing a dried grass ration to a grain ration. Ten cows were placed on a reversal trial consisting of five three-week periods with a seven-day change-over period. Both groups received timothy hay and corn silage for the roughage portion of the ration, and either grain or dehydrated grass for the concentrate portion of the ration. He reported that considering both milk production and body gain, the grass ration proved equal to or slightly better than the grain ration.

In an experiment designed to determine the value of dried grass in comparison to grain, Newlander (19) fed hay and silage to dairy cows at the rate of 1 and 3 pounds respectively per 100 pounds of body weight. The rest of the TDN and protein needed was supplied with dried young grass or grains. The maximum amount of grass used was 15 pounds. If additional nutrients were needed they were supplied with a commercial 20% protein mixture. A switchback design was used consisting of three four-week periods with seven-day change-over periods. He concluded 15 pounds of grass was too much bulk. More digestible protein and TDN were needed per unit of production where the grass replaced the grain. Increased production was noted on the dried grass ration when substituted on equal TDN basis. He recommended at least one-third of the concentrate ration be made up of grain.

Watson and Ferguson (26) replaced part of the concentrate ration with dried grass in a change-over type of experiment of 20 weeks sub-divided into four periods of five weeks each. In two of the periods artifically dried grass replaced a proportion of the concentrates, an average of 8 pounds of dried grass being

fed per head daily. The two rations were equal in starch equivalent and protein equivalent, but the grass ration was higher in carotene intake. A statistical analysis of the milk production revealed no significant difference between the two rations. The statistical analysis of the weights showed a significant difference in favor of the dried grass ration.

Watson (27) states that five cows were placed on a trial to determine the feeding value of dried grass. The crude protein of the grass varied from 18 to 21% of the dry matter. A balanced concentrate ration was replaced with the dried grass on an equal weight basis. Two periods of 14 days each were used with the grain being fed in the form of cubes the first period, and the dried grass replacing the grain the second period. The production of the two periods was then analyzed and the conclusion reached that the dried grass was readily eaten and that it would produce the quantity of milk for which the nutrients it supplied were theoretically capable.

EXPERIMENTAL PROCEDURE FOR TRIAL NO. 6

Selection of Cows and Formation of Groups

Nine pairs of cows were selected for this feeding trial. The pairs were then divided into two groups. The cows were paired as nearly as possible according to breed, weight, stage of lactation, and level of production. A ten-day pre-experimental period was used to aid in the final selection of the cows. Table I shows how the cows were divided. There was an attempt made to select cows that had reached their peak production and were on a normal

Table I. Group Assignment of Cows

Cow No.	Breed	Month Fresh*	Weight**	Milk** Per Day	Test***	Fat
			lbs.	lbs.	%	lbs.
Group A						
1	Holstein	Sept.	1445	58	3.2	1.856
2	Guernsey	Jan.	1225	39	4.0	1.560
4	Guernsey	Nov.	985	32	3.8	1.216
7	Holstein	Dec.	1390	65	4.3	2.795
11	Ayrshire	Oct.	1100	32	4.1	1.312
12	Jersey	Nov.	825	27	5.1	1.377
13	Guernsey	Dec.	1065	30	4.8	1.440
14	Jersey	Dec.	845	33	4.9	1.617
18	Ayrshire	Oct.	990	34	4.0	1.360
	TOTAL		9870	350		14.533
	AVERAGE		1097	38.87	4.15	1.615
Group B						
3	Holstein	Sept.	1400	48	3.7	1.776
5	Jersey	Oct.	910	29	5.0	1.450
6	Holstein	Oct.	1390	41	4.3	1.763
8	Holstein	Oct.	1380	57	3.5	1.995
9	Guernsey	Oct.	1085	27	3.8	1.025
10	Ayrshire	Jan.	1010	44	4.2	1.848
15	Jersey	Nov.	920	36	4.3	1.548
16	Ayrshire	Nov.	1040	33	3.8	1.254
17	Ayrshire	Dec.	1100	34	4.0	1.360
	TOTAL		10235	349		14.020
	AVERAGE		1137	38.78	4.02	1.558

* The cows started the first 20-day period March 21.
** Average of ten-day pre-experimental period.
*** Fat tests used were previous month test.

decline. This was difficult, due to the limited number of fresh cows available from which to choose.

Roughages and Concentrates Used

A sample of the alfalfa hay used in this feeding trial was taken in the middle of each of the three periods and sent to Washington, D. C., where it was graded by the Grain Branch of the Production and Marketing Administration. All samples graded U. S. No. 2 alfalfa hay, with two samples containing 44% of leaves and one sample containing 33% of leaves. This hay was fed free choice. The proximate analysis is shown in Table II.

Table II. Proximate Analysis of Feeds Used in Trial No. 6

Feed	Moisture	Ash	Protein	Fat	Fiber	N.F.E.	TDN*
	%	%	%	%	%	%	%
Alfalfa Hay	8.36	7.27	16.00	2.13	28.56	37.68	54.2
Bran	13.64	5.96	15.78	4.41	11.24	48.97	63.7
Ground Oats	10.65	3.49	12.72	4.60	10.50	58.04	70.2
Ground Corn	16.41	1.17	7.53	3.77	1.87	69.25	78.9
Control Mixture							71.6
Experimental Mixture**							61.2

* Morrison's digestion coefficients were used in determining TDN in the feeds.
** 1.17 pounds of experimental mixture is equal to 1 pound of control grain on TDN basis.

The control grain mixture consisted of 500 pounds of ground corn, 250 pounds of ground oats, 250 pounds of wheat bran, 10 pounds of salt, and 10 pounds of steamed bone meal. This mixture

contained 71.6% TDN and 8.8% digestible protein. The experimental mixture contained 427 pounds of the control mixture, plus 573 pounds of ground alfalfa hay, 10 pounds of salt, and 10 pounds of steamed bone meal. The TDN of this mixture was 61.2% and the digestible protein was 10.6%. On a TDN basis, 1.17 pounds of this mixture was equal to 1 pound of the control grain. The ground alfalfa hay replaced 57.3% of the concentrate in this mixture and supplied 50% of the TDN. The ground hay in this ration was from the same lot as the long hay that was fed. Table II shows the proximate analysis and calculated TDN of the feeds used in the trial.

Morrison's feeding standards for maintenance and milk production were used to calculate the daily ration for each cow. The average hay consumption on the ten-day pre-experimental period was used to determine the daily hay consumption by each cow. The ration was then completed with one of the mixtures. Following the pattern of the previous trials, the cows were fed 10% more TDN than their theoretical requirements. These rations calculated at the start of the trial were then fed at the same rate throughout the trial. It was necessary to feed 1.17 pounds of the experimental mixture to 1 pound of grain in order to get the same TDN intake on both rations. Salt and steamed bone meal were available in the dry lot.

Management of Cows

In this trial a 90-day double reversal design was used. A ten-day change-over period preceded a twenty-day experimental period. Group A received the experimental ration in periods 1 and 3, and the control ration in period 2, while Group B received

the control ration in periods 1 and 3 and the experimental mixture in period 2. In the change-over period the change from one ration to the other was made gradually in order to prevent the cows going off feed.

The cows were kept in stanchions in the barn. Sawdust was used for bedding in the front part of the stalls to keep the cows from eating any of the bedding material. Straw or prairie hay was then used in the rear portion of the stall. The cows were confined in the stanchions 20 hours a day. They were allowed to exercise in a dry lot 4 hours daily, except during inclement weather.

Alfalfa hay was weighed to the cows twice a day in amounts large enough to assure maximum consumption. The concentrate mixtures were fed twice a day, just before the cows were milked. The refused grain and hay was weighed each morning and recorded. Water was available to the cows at all times in individual drinking cups in the barn and in a tank in the dry lot.

The cows were milked twice a day in a milking parlor with milking machines, and returned to their stalls. In the middle of each experimental period six samples of milk from six consecutive milkings were taken and tested by the Babcock method. These six tests were then averaged to obtain the average test for the period.

The cows were weighed three consecutive days at the end of each change-over period and at the end of each experimental period. These three weights were then averaged. The average weight at the end of each experimental period was used in the analysis.

DISCUSSION OF RESULTS

The data obtained during the twenty-day experimental periods were used in analyzing the results of this trial.

Five of the 18 cows chosen for this feeding trial were taken off the experiment before it was concluded, and those cows' performances were not considered in the final analysis. Cow No. 1 was taken out because of a sudden drop in milk production which was judged to be due to stage of lactation rather than ration effect. Cow No. 6 was lost from the trial because of an operation for hardware. No. 4 and No. 17 were taken off because of acute mastitis, and Cow No. 18 was dropped because of an impaction. It is felt that the finely ground state of the alfalfa in the experimental ration may have caused this impaction, since another cow showed mild symptoms while on the experimental ration.

Feed Consumption

The cows on the experimental ration did not relish their concentrate as the cows did on the control ration. Many of them waited until the feeder was well past them before eating the experimental ration to be sure they would not be offered some undiluted grain. They refused a considerable amount of this ration during the change-over periods. The cows on the experimental ration received 5,073 pounds of this mixture in the three experimental periods, and refused 88.5 pounds during this time. This was a daily average intake of 12.58 pounds of experimental mixture per cow, with an average weigh back of .22 pounds per day. The cows on the control ration received 4,503 pounds of control grain during the three

twenty-day periods and refused 8.7 pounds. This was a daily average intake of 11.85 pounds of control grain per cow, with an average of 0.022 pounds a day refused.

The cows on the experimental ration consumed 10,370 pounds of long alfalfa hay during the three experimental periods, or an average of 25.9 pounds per day a cow, while the cows on the control ration consumed 9,570 pounds of long hay with an average daily consumption of 25.1 pounds per cow. When the 2,907 pounds of ground hay consumed in the experimental ration was added to the long hay, 13,277 pounds of hay was consumed by the experimental cows, or an average of 33.2 pounds of hay a day. The cows on the experimental ration had an average consumption of 3.03 pounds of hay per 100 pounds of body weight, in comparison to 2.33 pounds of hay per 100 pounds of body weight for the cows on the control ration. The cows on the experimental ration received 82% of their TDN from alfalfa hay, while the cows on the control ration received 61.7% of their TDN from alfalfa hay. Table III shows the consumption of long hay by periods.

The average expected TDN intake for each twenty-day period was calculated at the beginning of the feeding trial. The calculated average TDN intake was 452.4 pounds for Group A and 475.7 pounds for Group B. The actual TDN intake for Group A was 445.5 pounds, 436.4 pounds, and 436.9 pounds for periods 1, 2, and 3, respectively. The actual TDN intake for Group B was 458.4 pounds, 427.6 pounds, and 447.7 pounds for periods 1, 2, and 3, respectively. Both groups consumed less TDN than they should have to meet the expected intake which was 110% of Morrison's highest requirement.

Table III. Pounds of Hay Consumed by the Cows During the Experimental Periods

Cow No.	Period I	Period II	Period III
Group A*			
3	671	677	694
5	453	433	437
8	802	796	819
9	377	369	353
10	548	517	551
15	597	535	535
16	464	470	459
Average	558.7	542.4	549.7
Group B**			
2	557	483	550
7	677	669	608
11	559	440	524
12	445	354	402
13	351	353	375
14	356	305	367
Average	490.8	434.3	471.0

* Group A was on the experimental ration Periods I and III, and on the control ration Period II.

** Group B was on the control ration periods I and III, and on the experimental ration Period II.

This was due to a lowered consumption of hay by both groups after they were placed on the experiment.

Milk Production

The switchback analysis (22) was used to determine if there was a difference in the two rations. The statistical analysis is shown in Table IV. The actual milk production by periods is used in this analysis. "X" equals the milk produced on the experimental ration; "Y" equals the milk produced on the control ration.

The mean loss in milk production at the 95° level was 135.8 pounds ± 69.7.

According to the best estimate of loss in milk production, the cows produced 93.2% as much milk on the experimental ration as they would have on the control ration.

As was mentioned earlier, milk samples were taken and fat tests were made on these samples. The general trend was the same for this trial and all the other trials in the test for significance on the actual milk, as it was on fat corrected milk. For this reason, only the data on actual milk yield have been presented.

Body Weight

The average of the three days' weights at the end of each of the experimental periods was analyzed statistically to see if there was a significant difference in the body weight between the two rations. Table V shows these average weights by periods, with the deviations from the line of regression. "X" is equal to the body weight at the end of the experimental period, while "Y" is equal to the body weight at the end of the control period.

It is interesting to note that the variation within the group is greater than between the groups.

Table IV. Test of Significance on Actual Milk Production

Group A

Cow No.	X_1	Y_2	X_3	d_1
3	790.4	793.4	705.8	-90.6
5	517.0	490.0	403.7	-59.3
8	995.5	993.6	822.6	-169.1
9	444.9	488.0	416.1	-115.0
10	731.3	711.8	630.5	-61.8
15	665.5	679.3	568.8	-124.3
16	585.3	521.6	451.4	+8.5
			Sum	-611.6

Group B

Cow No.	Y_1	X_2	Y_3	d_2
2	766.5	696.7	644.9	+18.0
7	1206.3	959.0	846.9	+135.2
11	559.5	508.2	476.5	+19.6
12	525.8	421.1	420.3	+103.9
13	490.9	428.6	392.3	+26.0
14	641.7	586.6	521.9	-9.9
			Sum	+292.8

Analysis of Variance F Test

	Degrees of Freedom	Mean Square
Within Group (error)	11	3247.1
Between Groups	1	59,907.5**

Table V. Statistical Analysis on Body Weights

Group A

Cow No.	X_1	Y_2	X_3	d_1
3	1338	1337	1407	+71
5	1202	943	967	+283
8	1200	1417	1463	-171
9	1028	1105	1132	-50
10	1022	1003	1003	+19
15	857	913	918	-51
16	918	1042	1068	-98
			Sum	+3

Group B

Cow No.	Y_1	X_2	Y_3	d_2
2	1338	1178	1192	+174
7	1140	1307	1235	-239
11	1027	1060	1112	+19
12	950	958	903	-63
13	1010	1068	1073	-53
14	880	848	937	+121
			Sum	-41

Analysis of Variance

	Degrees of Freedom	Mean Square
Within Group (error)	11	21975
Between Groups	1	161

Value of Ground Alfalfa Hay in the Experimental Ration

The cost of the different constituents in the ration was as follows: Hay, $35.00 per ton; Corn, $1.73 per bushel; Oats, $1.12 per bushel; Bran, $2.60 per hundredweight. The cost of the control grain was $59.30 per ton. The cost of grain in one ton of experimental mixture was $25.32; the cost of hay in one ton of experimental mixture was $20.06; the total cost of the experimental mixture was $45.38 per ton. The cost to replace one ton of the control mixture with the experimental mixture was 1.17 times $45.38, or $53.09.

When the cost of the hay was figured at $20.00 per ton, and all other prices remained the same, the cost of the grain in one ton of the experimental mixture was $25.32, and the cost of the hay was $11.46, making a total cost of $36.78 per ton. It took 1.17 times this to equal the cost of replacing one ton of the control mixture. This made the cost of replacing one ton of the control mixture with the experimental mixture $43.03.

The cows consumed an average of 761 pounds of the experimental ration per cow over the three periods. This was equivalent in TDN to 650 pounds of the control mixture.

The cost of 650 pounds of the control mixture was $19.25. The cost of 761 pounds of the experimental mixture was $17.25 if hay was $35.00 per ton. This made a saving in feed cost of $2.00 per cow on the experimental ration over the three periods.

The cost of the experimental ration was also calculated where hay was $20.00 per ton. In this instance, there was a saving in feed costs of $5.27 per cow on the experimental ration over the three experimental periods.

If the value of milk was $5.00 per hundredweight, hay was $35.00 per ton, and the control mixture was $59.30 per ton as was the actual case in this trial, it was not economical to substitute hay for grain at this level. Using the mean loss of 135.8 pounds of milk, there was a loss of $4.75 by each cow on the experimental ration over the three twenty-day periods. If the hay cost $20.00 per ton and the other factors remained constant, there was still a loss of $1.52 per cow over the three twenty-day periods on the experimental ration.

Analyzing it another way, 436 pounds of hay replaced 325 pounds of grain. There was a total loss in milk production amounting to $6.79 per cow on the experimental ration for the three periods. This was a loss of $1.56 for every 100 pounds of hay in the experimental ration. If hay cost $20.00 per ton, this made the hay cost $2.56 per hundred pounds, or $51.20 per ton for milk loss and cost of the hay. It took 2,680 pounds of this hay to replace one ton of grain. This was a cost of $68.61 to replace grain that cost $59.30 a ton. This hay was higher in TDN than most hay, so the spread might be more unfavorable in other hays.

INTRODUCTION TO TRIAL NO. 7

On the basis of feeding trials 5 and 6, it was evident that 50% ground alfalfa hay in the concentrate mixture was too high for economical production under the conditions of these trials. Trial No. 4, however, showed no statistical difference when ground alfalfa hay was substituted for 30% of the concentrate ration. It was decided to repeat this trial with a few changes as noted under Experimental Procedure.

EXPERIMENTAL PROCEDURE

Selection of Cows and Formation of Lots

Fourteen cows were selected and paired to form two lots, as in Trial No. 6. Table VI shows the data used in forming the lots.

Roughages and Concentrates Used

The alfalfa hay used in this feeding trial was graded by the Grain Branch of the Production and Marketing Administration, Washington, D. C. All samples graded U. S. No. 2 alfalfa hay. Sample No. 1 contained 37% of leaves, sample No. 2 contained 35% of leaves, and sample No. 3 contained 36% of leaves.

The control ration for Trial No. 7 was the same as it was for Trial No. 6. The experimental mixture was made up of 70% of the control mixture, plus 30% of the ground alfalfa hay by weight. Both rations contained 1% salt, and 1% steamed bone meal. The proximate analysis and calculated TDN values are given in Table VII.

Morrison's (18) minimum requirements for maintenance and milk production were used in this trial to determine the level of nutrient intake, rather than the highest requirements as in Trial No. 6. The average hay consumption for the ten-day preliminary period was used to determine TDN received from the roughage, and the rest of the TDN was made up with one of the concentrate mixtures. One and eleven-hundredths pounds of the experimental mixture was fed to one pound of the control mixture. The rations were calculated at the start of the trial and the cows were fed at the same level for the entire trial. Salt and steamed bone meal were available in the dry lot.

Table VI. Group Assignment of Cows

Cow No.	Breed	Month Fresh*	Weight**	Milk** Per Day	Test***	Fat
			lbs.	lbs.	%	lbs.
Group A						
1	Holstein	Sept.	1505	62	3.2	1.984
2	Ayrshire	Aug.	1137	44	3.3	1.452
3	Guernsey	Aug.	1060	30	4.7	1.410
4	Jersey	Aug.	1038	32	4.3	1.376
5	Jersey	Aug.	972	28	3.9	1.092
6	Holstein	July	1227	42	3.3	1.386
7	Holstein	July	1417	41	4.0	1.640
	TOTAL		8356	279		10.340
	AVERAGE		1194	39.86	3.71	1.477
Group B						
8	Holstein	Sept.	1432	54	3.3	1.782
9	Holstein	July	1402	35	3.7	1.295
10	Guernsey	Aug.	1138	27	4.5	1.215
11	Jersey	Aug.	916	37	5.0	1.850
12	Guernsey	Sept.	887	28	4.0	1.120
13	Holstein	July	1332	34	3.3	1.122
14	Ayrshire	Aug.	1245	41	3.6	1.476
	TOTAL		8352	256		9.860
	AVERAGE		1193	36.57	3.85	1.409

* The cows started the first 20-day period November 10.
** Average of ten-day pre-experimental period.
*** Fat tests of previous month.

Table VII. Proximate Analysis of Feeds Used in Trial No. 7

Feed	Moisture	Ash	Protein	Fat	Fiber	N.F.E.	TDN*
	%	%	%	%	%	%	%
Alfalfa Hay	9.47	11.38	16.63	2.71	24.09	35.72	50.4
Wheat Bran	11.52	5.95	16.13	3.91	10.07	52.42	65.1
Ground Corn	13.12	1.24	8.38	4.17	1.95	71.14	82.1
Ground Oats	9.84	3.24	12.07	4.52	8.77	61.56	71.7
Control Mixture							73.8
Experimental Mixture							66.5

* Morrison's digestion coefficients were used in determining TDN in the feeds.
** 1.11 pounds of the experimental mixture is equal to 1 pound of the control grain on basis of TDN content.

Management of Cows

The cows were handled in the same manner as in Trial No. 6.

DISCUSSION OF RESULTS

The data gathered from the three twenty-day experimental periods were used in analyzing the results of this trial.

There were no cows lost from this trial due to abnormalities.

Feed Consumption

Both groups of cows consumed their feed much better than either group did in Trial No. 6. There were no weigh backs from either mixture at any time. The cows on the experimental ration consumed 12,087 pounds of long hay and 3,612 pounds of the experimental mixture, while the cows on the control ration consumed 11,782 pounds of long hay and 3,260 pounds of the control mixture.

Thus, the cows on the experimental ration consumed a total of 12,867 pounds of hay, which was an average of 31.36 pounds per cow a day, in comparison to an average of 26.71 pounds of hay per cow on the control ration. The cows on the experimental ration received 77.7% of their TDN from the hay, while the cows on the control ration received 71% of their TDN from the hay. Table VIII shows hay consumption by periods. It is interesting to note that the cows that started on the experimental ration consumed about the same amount of long hay in all three periods, but the group that started on the control ration in the first period had a fairly uniform drop in the middle or experimental period.

The calculated average TDN intake was 398.86 pounds for Group A, and 376.28 for Group B. The actual TDN consumption for Group A was 415.03 pounds, 417.06 pounds, and 418.06 pounds for periods 1, 2, and 3, respectively, while for Group B it was 386.8 pounds, 380.14 pounds, and 388.76 pounds for periods 1, 2, and 3, respectively. Both groups consumed more long hay after they were placed on the experiment, making the TDN intake slightly higher than expected. It is felt that placing the cows on Morrison's lower standard caused them to eat more hay.

Milk Production

The same test of significance was used as in Trial No. 6. The data and analysis of variance are shown in Table IX. In this table "X" equals the production on the experimental ration, and "Y" equals the production on the control ration. It was estimated that the cows on the experimental ration produced 92.37% as much milk as they would have on the control ration.

Table VIII. Pounds of Hay Consumed by the Cows During the Experimental Periods

Cow No.	Period I	Period II	Period III
Group A*			
1	761	742	724
2	683	685	697
3	471	486	493
4	476	480	486
5	493	491	478
6	616	645	654
7	681	680	691
Average	597.3	601.3	603.3
Group B**			
8	693	686	695
9	583	575	589
10	450	430	467
11	487	472	489
12	470	457	473
13	591	583	604
14	499	480	483
Average	539.0	526.0	542.9

* Group A was on the experimental ration Periods I and III, and on the control ration Period II.

** Group B was on the control ration periods I and III, and on the experimental ration Period II.

Table IX. Test of Significance on Actual Milk Production

Group A

Cow No.	X_1	Y_2	X_3	d_1
1	1064	1029	806	-188
2	659	628	460	-137
3	490	468	347	-99
4	530	481	426	-6
5	447	404	315	-46
6	685	693	643	-58
7	726	734	688	-54
			Sum	-588

Group B

Cow No.	Y_1	X_2	Y_3	d_2
8	1017	922	880	+53
9	586	532	539	+61
10	467	398	332	+3
11	651	572	555	+62
12	459	332	317	+112
13	578	432	382	+96
14	726	651	602	+26
			Sum	+413

Analysis of Variance F Test

	Degrees of Freedom	Mean Square
Within Group (error)	12	2617
Between Groups	1	71571**

Body Weight

There was no statistical difference in body weight between the two groups. However, there was a slight trend in favor of the group receiving the control ration.

Value of Ground Alfalfa Hay in the Experimental Ration

There was a mean loss of 143 pounds of milk per cow on the experimental ration over the three periods. If milk was $5.00 per hundredweight, this was a loss of $7.15 per cow during the sixty-day experimental period. It took 154.8 pounds of hay to replace 103.6 pounds of grain in this mixture. The hay cost $4.55 per hundredweight in terms of milk lost, so if hay was worth $20.00 per ton, the hay cost was $5.55 per hundredweight in milk loss and cost of the hay. This made the hay cost $111.00 per ton. It took 2,988 pounds of hay to equal one ton of grain; therefore, the cost to replace one ton of grain with hay was $165.83.

SUMMARY

In feeding Trial No. 6, the ground alfalfa hay made up 57.3% by weight of the experimental ration, while in feeding Trial No. 7 the ground alfalfa hay made up 30% by weight of the experimental ration.

In both trials a double-reversal design was used, consisting of three periods. Each period consisted of a ten-day change-over period and a twenty-day experimental period. Daily milk weights were kept. The cows were weighed for three days at the end of each experimental period and the average weight of these three was used in the final analysis on body weight.

The milk weights by periods and body weight at the end of the periods were analyzed statistically, with the analysis on milk production being highly significant in favor of the control ration for both trials, while the analysis on body weight showed no statistical difference in either trial.

In both trials more of the experimental mixture was fed than when the cows were on the control ration. This was done to maintain equal TDN intake between the rations.

Calculations used in determining the value of ground alfalfa hay in the experimental ration are shown. In both trials this was found to be a negative value.

CONCLUSIONS

On the basis of the results obtained in these experiments, the following conclusions seem to be warranted:

1. Replacement of 57.3% and 30% of the concentrate ration with ground alfalfa hay caused a decline in milk production.

2. Under the conditions of these trials it was unprofitable to add ground alfalfa hay in the grain ration for dairy cows.

3. The cows on the sixth feeding trial produced 93.2% as much milk on the experimental ration as they would have on the control ration, while the cows on the seventh feeding trial produced 92.37% as much milk on the experimental ration as they would have on the control ration.

4. There was no statistical difference in body weights between the rations on either trial.

5. The cows consumed more total hay per 100 pounds of body weight while receiving the experimental ration than when they received the control ration.

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