A COMPARISON OF THE INFLUENCE OF BARN-CURED AND FIELD-CURED ALFALFA HAY ON MILK PRODUCTION

by

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II. INTRODUCTION

Hay is one of the main crops for Virginia farmers and is common to all sections of the state. According to the United States Bureau of Agricultural Economics[24], there were 1,351,000 acres of hay harvested in Virginia during 1947 producing a total yield of 1,438,000 tons. Approximately 54 per cent of this hay crop was legume hays, 35 per cent was mixed legume hays, and the remaining percentage was other hays. Figures from the Virginia Dairy Extension Office show that for approximately 32,000 dairy cows on Dairy Herd Improvement Association test in 1947, the average hay consumption was 2,610 pounds per cow when silage was fed in the rations. Using this average hay consumption per cow and the estimated 436,000 cows in the state that produced milk during 1947, it can be calculated that nearly 40 per cent of this hay crop was fed to dairy cows alone, excluding that fed to dairy heifers. While actual figures are not available, the above estimates indicate the significance of Virginia's hay crop and especially its relationship to dairying.

The problem of curing hays varies in different sections of the country. Wide variations in weather conditions affecting hay curing exist in Virginia. The western half of the state is characterized by cool nights accompanied by high humidity and heavy dews. There is considerable variation in the seasonal rainfall from year to year. These conditions greatly lengthen the curing period and

frequently result in damage and even loss of much of the hay crop.

The problem of partially curing hay in the field and completing the curing process in the barn received attention by the Tennessee Valley Authority in cooperation with the University of Tennessee in 1934. After much experimental work the first satisfactory barn hay drier was installed on the University of Tennessee farm in 1935. The barn hay drier (figure 1) comprises a duct system built on the hay mow floor through which atmospheric air is forced by an electrically driven fan installed in the mouth of the main duct. Partially cured hay is distributed evenly over this system and dried by forced air ventilation to a moisture content low enough for safe storage. Intensive studies by agricultural engineers have resulted in making this system of drying hays readily adaptable to any size barn. This method of drying takes advantage of the limited field curing and makes possible the storage of hay with a moisture content of about 40 per cent as compared to a moisture content of 20 per cent or below for safe storage in the mow without the use of a hay drier. Completion of the curing period on barn hay driers shortens the exposure time of hay to unfavorable weather conditions and, therefore, enables farmers to improve the quality of their hay.

The installation of forced air ventilation hay driers has increased rapidly in recent years and has been stimulated by workers of the Tennessee Valley Authority and cooperating colleges of agriculture. In Virginia the number of hay driers installed

increased from 245 in 1945 to 413 by the end of 1947, an increase of 59 per cent for a two year period. Dairy farmers are installing hay-driers to be able to save a larger portion of their hay from exposure to adverse weather conditions and are making higher quality hays through barn-curing.

Few experiments have yet been reported in which the actual feeding value of barn-cured hay for the various classes of livestock has been determined in comparison with that of field-cured hay made from the same crop. Especially limited is data from experiments with dairy cows in which barn-cured and field-cured hay of the same crop were compared for milk production.

III. OBJECTIVE

The objective of this study is to compare the influence of barn-cured and field-cured alfalfa hay on:

1. Milk production,
2. Changes in liveweight.

IV. REVIEW OF LITERATURE

The results of a limited amount of research have been reported in which the feeding values of hays cured by various methods were compared. In view of the limited experiments in which barn-cured and field-cured hays were compared, especially in comparison for milk production, it is deemed feasible to review, also, some of the feeding work done with dehydrated hays. These experiments with hays have given some information on growth, gains in live-weight, and milk production. The results of studies on the carotene and vitamin D contents of barn-cured and field-cured hays have been reported.

Caine and Culbertson[3] reported results from the Iowa Station showing that weanling and yearling colts made greater gains on barn-cured hays than on field-cured hay. Ten colts were fed for two 45-day periods. The colts gained a total of 510 pounds when fed barn-cured hay as compared to 439 pounds when fed the field-cured hay. Three years' results at the Tennessee Station reported by Wylie et al[23] indicate that when barn-cured and field-cured hays were fed to two groups of dairy heifers, each group made normal growth with no marked difference in either hay with respect to height at withers and heart girth, but the groups fed barn-cured hay gained slightly more in each case. Similar feeding trials were conducted at the Middle Tennessee Station and the West Tennessee Station with Jersey heifers. However, in this experiment the heifers

fed barn-cured hay showed no significant difference in rate of growth as compared with those heifers fed field-cured hay, cured under good conditions. Feeding trials with pregnant and lactating ewes were conducted at the Kentucky Station(1) for a period of 153 days. Both lots of ewes were fed daily one-half pound of shelled yellow corn per ewe before lambing and one pound of shelled yellow cown per ewe after lambing. One lot of ewes was fed three and one-half pounds per ewe of barn-cured alfalfa hay per day while the other lot of ewes was fed four pounds per ewe of field-cured alfalfa hay per day. In yield of fleece, gain in weight, lambing record, and lamb gains there were no significant differences between the two lots. Only 87 per cent as much barn-cured hay as field-cured alfalfa hay was needed to produce comparable results. The barn-cured alfalfa was graded U.S. No. 1 extra green, and the field-cured hay was graded U.S. No. 1.

Similar results have been obtained with dehydrated hay. Two trials with beef cattle carried out at the Louisiana Station are reported by Snell(19). In both cases machine dried soybean hay gave greater gains than field-cured soybean hay when fed to yearling and weanling steers. Gorden and Hurst(8) in feeding trials with beef cattle have shown that as compared to sun-cured immature pasture herbage, the dehydrated product produced slightly greater gains in weight and was more palatable. Five years' results at Pennsylvania Station are reported by Bechdel et al(2). In their experiments with dairy heifers direct comparisons were

made with various dehydrated and field-cured hays. The dehydrated hays gave greater gains in all cases except one. The sun-cured hay in all cases was cured without rain; however, its average carotene content was lower than the corresponding average for the dehydrated hays.

The results of investigations with lactating cows have been reported in which barn-cured and field-cured hays were compared. Turk et al[20][21] and Morrison and Turk[12][13] in three years' work at the Cornell Station compared the feeding value of barn-cured hay, field-cured hay stored loose, and field-cured windrow-baled hay cut from the same field. The hays compared were mixed timothy hay, alfalfa hay, and mixed hay. In feeding trials with Holstein cows, grain was fed at the same rate to each group of cows. Hay was fed as the only source of roughage, and the cows were fed all the hay they would consume at two feedings per day. Results show that there was no measurable or consistent advantage for any one method of curing in the amount of hay consumed per day, changes in body weight, or in the average daily production of four per cent fat-corrected milk. The barn-cured hay averaged one grade higher based on federal grades. At the time of feeding the average micrograms of carotene per gram of dry matter were 6.8 for the barn-cured, 5.6 for the field-cured baled, and 5.5 for the field-cured stored loose. Recent investigations by the Bureau of Dairy Industry are reported by Shepherd et al[17]. In feeding trials conducted with dairy cows the quantity of barn-cured and

field-cured alfalfa hay from the same field was adjusted so that the cows received equal amounts of dry matter in each kind of hay along with corn silage and concentrates. The two groups of cows produced equally well. Liveweight gains were slightly in favor of the field-cured hay. Carotene content was higher in the barn-cured hay at the time of feeding. The field-cured hay was stored without rain each year. There was more dry matter lost during harvesting and curing by the field-cured hay than was lost by the barn-cured hay. The per acre production of milk was 7.6 per cent greater when the hay was cured in the barn.

The results of the comparison of digestion coefficients of sun-cured and barn-cured hays from the same field are reported by Camburn(4) of the Vermont Station. Nine comparisons were made over a three year period 1944-1946. Each year the barn-cured hay, as fed, was higher in crude protein and nitrogen, free extract, and the sun-cured hay was higher in crude fiber content. The ether extract contents were similar. An average of the three years' results indicates that the digestible protein and the total digestible nutrients were similar for hays cured by the two methods.

Artificially dried or dehydrated hays and grasses have also been fed to lactating cows. Bechdel et al(2) compared dehydrated and field-cured alfalfa hay for milk production. Rations, consisting of concentrates, a limited amount of silage, and the two types of hay were fed to two groups of Holstein cows so that each group consumed equal amounts by weight of the respective rations.

The cows consistently produced more milk when fed the dehydrated alfalfa hay. The dehydrated hay was higher in carotene content and, also, superior in palatability. Newlander and Jones[15] found artificially dried young grasses to be highly digestible when compared with freshly cut green grasses. The results of further studies by Newlander[14], Knott and Hodgson[9], and Camburn and Jones[5] indicate that artificially dried young grass may be substituted for at least a part of the concentrate mixture for lactating cows.

V. THE INVESTIGATION

A. Experimental Procedure:

In this experiment a feeding trial of three 31 day periods was conducted to compare the milk producing properties and the effect on liveweight of barn-cured and field-cured alfalfa hay. The double reversal feeding method was followed.

The hay fed was alfalfa hay harvested from one field at V.P.I. It was cut and when partially cured, raked with a side delivery rake. By taking alternate windrows, half of this hay was placed on the barn hay drier (of the type shown in figure 1) while it was only partially cured. Its curing process was then completed for forced air ventilation. The other half of the hay was cured in the field until it was dry enough to store safely in the barn. A small part of the field-cured hay had a slight sprinkle of rain on it. Both batches of hay remained loose in the barns until early January when it was baled for the convenience of handling during feeding. The hays received similar treatment except for the method of curing.

Twelve Holstein cows from the Virginia Experiment Station herd were used in the milk production trial. The cows had been fresh from 59 to 209 days at the beginning of the trial. All cows were past their peak production, and none were beyond their fifth month of gestation at the end of the trial. These were selected and paired with respect to age, stage of lactation and gestation,

body weight, and levels of production.

An equalization and standardization period of two weeks preceded the feeding trial. The cows were shifted to new positions in the barn for convenience in feeding. Over a period of three days silage was gradually eliminated from the ration, and alfalfa hay, other than the experimental hay, was fed as the only source of roughage to all of the cows. The amounts of hay fed were adjusted several times until the level of consumption for each pair of cows had been determined. The grain ration was fed according to the various levels of milk production, and no adjustments were made during this two weeks period.

The feeding trial consisted of three 31 day periods. The first three days of each experimental period were used as a transition period. At the end of the standardization period and just prior to the first transition period, the cows were paired and divided into two groups of six cows each. One cow from each pair was allotted at random to each group. Group I received the barn-cured hay first and Group II the field-cured hay. Abrupt changes from one ration to the other were made in all cases. Barn-cured and field-cured alfalfa hay were fed as the only source of roughage, in order to have a higher per cent of the total nutrients coming from the experimental hays. The rate of feeding these hays was based on the amount the pairs of cows consumed daily during the standardization period and was approximately two pounds per each 100 pounds of liveweight; the cow consuming the least amount

determined the rate of feeding for the pair. The amount of hay fed ranged from 20 pounds to 26 pounds per day throughout the trial, and each group of cows received the same amount of hay. Grain was fed at first at rates based on Appendix Table IXa in Morrison's Feeds and Feeding, 20th Edition[11] for cows receiving the two-pound hay equivalent per 100 pounds of liveweight, but adjustments were made so as to maintain production at approximately the level previous to the adjustment period.

During the first period, the cows maintained their levels of production fairly well and no adjustments were made in the amounts of grain fed. At the beginning of the second and third periods, adjustments were made according to Appendix Table IXa in Morrison's Feeds and Feeding, 20th Edition[11] using as a basis the average daily milk production for the preceding week. In all cases adjustments in the amounts of grain fed were made with respect to the pairs of cows so that the total consumption of grain would remain the same for each group.

The grain ration fed consisted of 300 pounds of yellow corn and cob meal, 150 pounds of ground oats, 300 pounds of wheat bran, eight pounds of steamed bone meal and eight pounds of iodized salt.

Both hay and grain for each cow were weighed and placed in individual feed mangers at each feeding throughout the trial. The cows were fed and milked in the stanchion barn. At other times they were maintained in a tramp shed where sawdust was used for bedding to eliminate the possibility of their consuming additional

roughage. At the end of each 24 hour period any feed refused by the cows was weighed and recorded.

Samples of milk, hay, and grain were taken at regular intervals throughout the feeding trial. Milk production weights were recorded at each milking. Each week a single day's composite milk sample was prepared from each cow's milk. The butterfat percentage for each of these samples was determined by the Babcock method and was used for calculating the weekly four per cent fat-corrected milk equivalent after the method of Gaines and Davidson[7]. Hay samples were taken from all the bales opened Monday, Wednesday, and Friday of each week. The sampling was done with a core bale sampler, as described by Pratt[16], which samples the full length of the bale. This allowed for sampling of approximately half of the bales of each of the hays fed. Grain samples were taken at random from each batch of grain mixed. All samples were stored in moisture proof containers. At the end of each period, these samples of hay and grain were composited and samples taken by quartering for proximate analyses.

Liveweights were taken at the beginning of the first period and at the end of each of the three periods. These weights were an average of three day weights taken on the last day of the preceding period, the day of the change over and the following day. These weights were taken so that any change in body weight might be noted for each respective period. The cows were weighed at 2:00 P.M. on the weighing days. They did not receive any feed

after the morning feeding. They did not have access to water on weighing days for six hours previous to weighing.

The plan of experiment as set up allows for statistical analysis of the data.

B. Results:

Milk Production:

The results of comparing barn-cured and field-cured alfalfa hay for milk production were measured on the basis of four per cent fat-corrected milk equivalent. These data are presented in tables 1 and 2 and in figure 2. The average daily production for each group of six Holstein cows is listed in table 1 by weekly intervals. These are listed, also, with respect to the kinds of hay consumed during the three respective periods in order that direct comparisons may be made for each weekly sub-period. It will be noted that the averages shown for the adjustment period represent the average daily group production for the second week of this period when both groups of cows received equal amounts of the same kind of hay. Three day averages are shown for each transition period. In order to show a clearer picture of the changes that occurred in the trend of production for each group of cows, the data are plotted out as shown in figure 2. The beginning of these curves represents the average daily production of the two groups of cows for the second week of the adjustment period. With the dotted line representing the production from the field-cured hay and the solid line representing the production from the barn-cured hay, the trend of production for each group of cows is plotted for the three feeding periods and transition periods. The data show that for each feeding period more milk was produced by the group

of cows that consumed the barn-cured hay. The differences between each of the weekly comparisons appear to be small. Table 2 shows the total production by periods for both groups of cows when they consumed the two kinds of hay as indicated. The differences between the averages of periods 1 and 3 and period 2, when the hays were reversed, are shown for each group. The sum of these differences indicate that 315 pounds more four per cent fat-corrected milk were produced from the barn-cured hay.

Liveweight:

The liveweight of each cow was recorded, as previously described, at the beginning of the first period and at the end of each of the three experimental periods. Changes in liveweights were noted as gain or loss in pounds per cow during each feeding period. The data for each weighing are presented in table 3 as the average weight in pounds per cow for each group of cows. This enables a more direct comparison to be made between the barn-cured and field-cured hay consumed and liveweight changes. There were small differences between the average gain or loss in liveweight of the respective groups of cows during each period. When these data are plotted, as in figure 3, they show a trend of gain in weight for each group of cows when they consumed the field-cured hay and a trend of loss in weight when they consumed the barn-cured hay. These differences were not significant.

Feed Consumed:

Presented in tables 4 and 5 are summaries of the amounts of hay and grain consumed during the feeding trial. Equal amounts of hay were fed to each group of cows. Practically all of the hay was eaten. On a few occasions small amounts of hay were weighed back. A total of five pounds of barn-cured hay were refused and a total of 19 pounds of field-cured hay were refused. Part of these hays that were weighed back appeared to be the courser stems of the hay and some appeared to be weed stems. Equal amounts of grain were fed and all grain was consumed. None of the cows were off feed during the trial.

Chemical Analysis of Hays and Grain Fed:*

The results of the chemical analysis for composite samples of each of the hays and of the grain ration, as fed for each period, are shown in tables 6 through 9. Each of these samples was analyzed separately for moisture, protein, fat, fiber, ash, and nitrogen-free extract. There was very little difference in the chemical composition of the grain; the barn-cured hay; or the field-cured hay fed in each of the three periods. The barn-cured hay averaged 19.84 per cent protein, and the field-cured hay averaged 17.21 per cent protein. The data in table 8 show a comparison of the average

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* The chemical analyses incident to this trial were made by W.N. Linkous and J.F. Eheart of the Agricultural Chemistry Department, Virginia Agricultural Experiment Station.

of the three composite samples for each of the hays. The barn-cured hay contained .36 per cent more moisture, 2.63 per cent more protein, .26 per cent more fat, 1.20 per cent less fiber, and 2.26 per cent less nitrogen-free extract, and .66 per cent more ash than did the field-cured hay. The average protein content of the grain ration was 11.86 per cent.

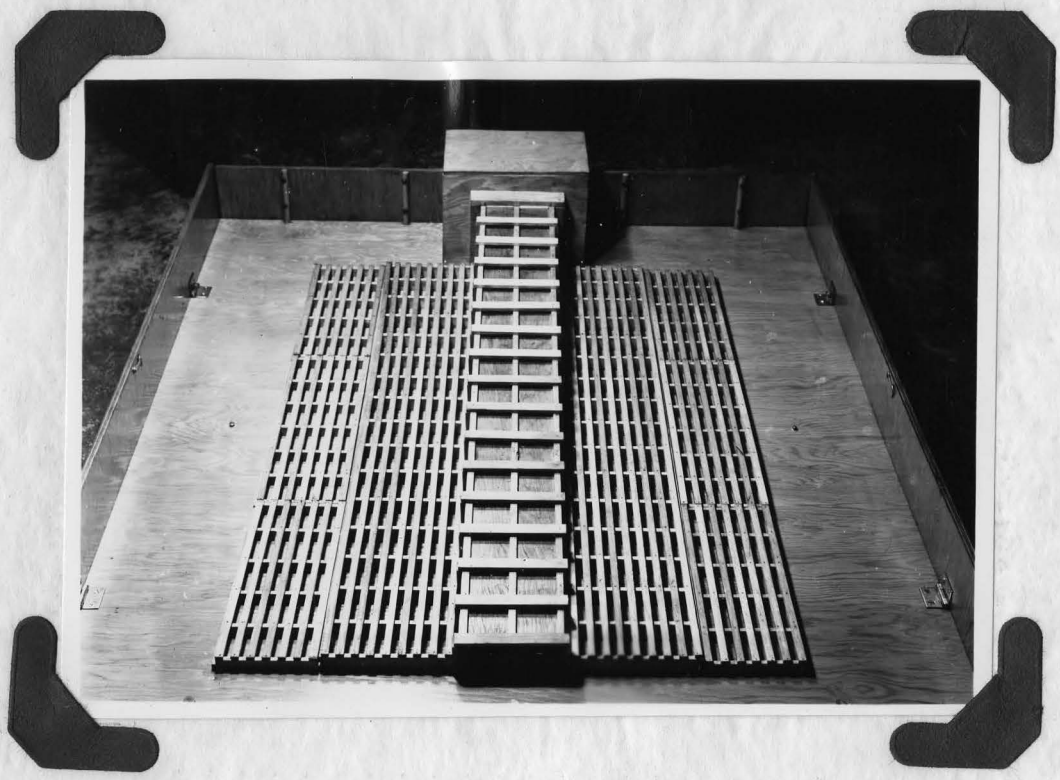

Figure 1. A Model of the Slotted Floor Type of Hay-Drier as Installed on the Barn Floor. This Type is recommended by the Agricultural Engineering Department, V.P.I. (Photograph courtesy of Virginia Agricultural Extension Service).

Table 1

Comparison of the Average Daily Milk Production in Pounds of Four Per Cent Fat-Corrected Milk From Two Groups of Cows Fed Barn-Cured and Field-Cured Alfalfa Hay.

PERIOD	GROUP I		GROUP II	
Adjustment Second Week	192.3		192.4	
	Barn-Cured	Field-Cured	Barn-Cured	Field-Cured
Transition	188.0			187.5
Period One				
First week	198.9			198.0
Second week	199.1			193.7
Third Week	194.5			190.0
Fourth week	198.4			189.2
Transition		195.5	190.5	
Period Two				
First week		181.4	185.9	
Second week		181.2	182.7	
Third week		176.3	182.1	
Fourth week		175.4	177.1	
Transition	168.3			173.9
Period Three				
First week	179.5			170.0
Second week	177.9			165.7
Third week	173.2			163.8
Fourth week	172.0			160.3
Average per day per group	185.9	178.6	181.9	178.9
Average per day of the two groups		Barn-Cured 183.9		
		Field-Cured 178.75		

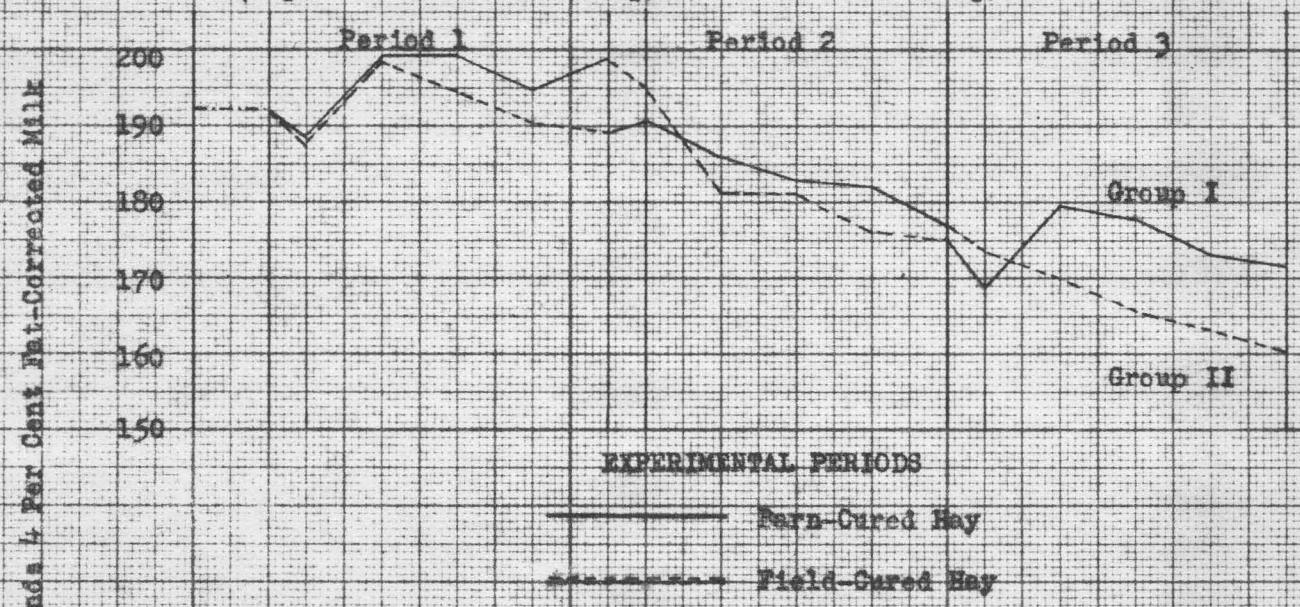

Figure 2. Curves Showing Trends of Milk Production for Two Groups of Sows Fed Fern-Cured and Field-Cured Alfalfa Hay

Table 2

Comparison of Total Milk Production in Pounds of Four Per Cent Fat-Corrected Milk From Two Groups of Cows Fed Barn-Cured and Field-Cured Alfalfa Hay

PERIOD	GROUP I		GROUP II	
	Barn-Cured	Field-Cured	Barn-Cured	Field-Cured
1	5537			5397
2		5001	5096	
3	4919			4619
Average per period	5228	5001	5096	5008
Difference	+227		+88	

Table 3

Comparison of Liveweight Changes in Pounds Per Cow for Two Groups of Cows Fed Barn-Cured and Field-Cured Alfalfa Hay

	GROUP I		GROUP II		Average Gain Per Period	
Average Weight at Beginning of Trial	1115		1141			
Average Weight at End of Each Period When Fed Hay As Indicated	Barn-Cured	Field-Cured	Barn-Cured	Field-Cured	Barn-Cured	Field-Cured
1	1123			1156	+8	+15
2		1129	1147		-9	+6
3	1118			1151	-11	+4
Average Gain in Liveweight					-12	+25

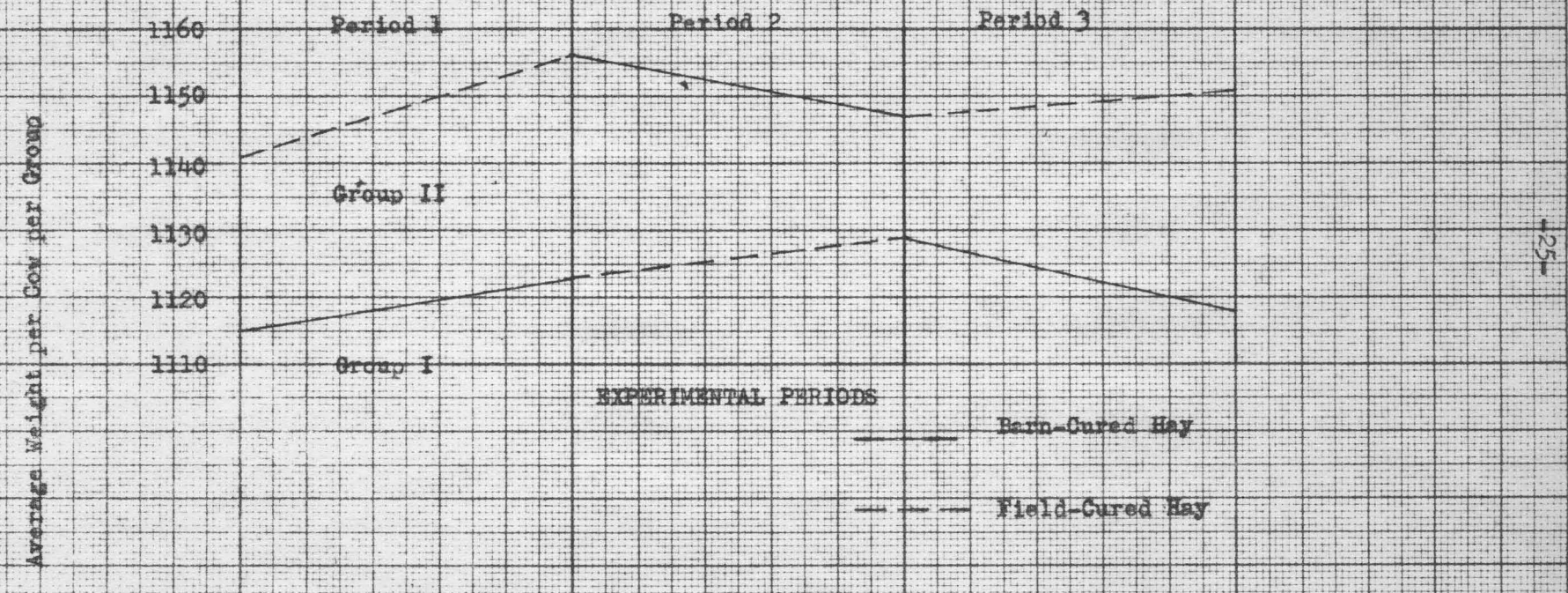

Figure 3. Changes in Liveweight of Cows while receiving Barn-Cured and Field-Cured Hay

Table 4

Comparison of Barn-Cured and Field-Cured Hay Consumed in Pounds Per Group

PERIOD	GROUP I		GROUP II	
	Barn-Cured	Field-Cured	Barn-Cured	Field-Cured
1	3974			3976
2		3968	3974	
3	3975			3965

	Barn-Cured	Field-Cured
Total Consumption for each kind of hay	11,923	11.909
Difference	/14	
Average daily consumption per cow	23.66	23.63

Table 5

Summary of Grain Ration Consumed in Pounds Per Group

PERIOD	GROUP I	GROUP II
1	2296	2296
2	2184	2184
3	2060.8	2060.8
Total Consumed per Group	6540.8	6540.8
Average Daily Consumption per Cow	12.98	12.98

Table 6

Chemical Analyses of Barn-Cured Hay as Fed*

PERIODS	MOISTURE %	PROTEIN %	FAT %	FIBER %	N.F.E. %	ASH %
1	8.76	19.94	2.00	24.38	37.84	7.08
2	9.04	20.19	2.02	23.56	37.92	7.27
3	9.89	19.38	2.25	23.95	37.64	6.89
Average	9.23	19.84	2.09	23.96	37.80	7.08

* Chemical Analyses were made by personnel of the Agricultural Chemistry Department, Va. Agr. Exp. Sta.

Table 7

Chemical Analyses of Field-Cured Hay As Fed*

PERIODS	MOISTURE %	PROTEIN %	FAT %	FIBER %	N.F.E. %	ASH %
1	8.43	16.81	1.82	26.32	40.31	6.31
2	8.64	16.88	1.82	25.72	40.78	6.16
3	9.55	17.91	1.86	24.79	39.07	6.79
Average	8.87	17.21	1.83	25.61	40.06	6.42

* Chemical Analyses were made by personnel of the Agricultural Chemistry Department, Va. Agr. Exp. Sta.

Table 8

A Comparison of Average Chemical Analysis of Barn-Cured and Field-Cured Alfalfa Hay as Fed*

TREATMENT	MOISTURE %	PROTEIN %	FAT %	FIBER %	N.F.E. %	ASH %
Barn-Cured	9.23	19.84	2.09	23.96	37.80	7.08
Field-Cured	8.87	17.21	1.83	25.16	40.06	6.42
Difference	+.36	+2.63	+.26	-1.20	-2.26	+.66

* Chemical Analyses were made by personnel of the Agricultural Chemistry Department, Va. Agr. Exp. Sta.

Table 9

Chemical Analyses of Grain as Fed*

PERIODS	MOISTURE %	PROTEIN %	FAT %	FIBER %	N.F.E. %	ASH %
1	9.15	11.38	3.90	9.32	61.13	5.12
2	10.20	11.81	3.97	8.98	60.02	5.02
3	10.51	12.38	4.17	9.58	58.25	5.11
Average	9.95	11.86	4.01	9.29	59.81	5.08

* Chemical Analyses were made by personnel of the Agricultural Chemistry Department, Va. Agr. Exp. Sta.

VI. DISCUSSION OF RESULTS

A comparative study of the effect of barn-cured and field-cured hay on milk production and on changes in liveweight was made for three experimental periods.

The data in table 1 show that for each experimental period the greater milk production correlates with the barn-cured hay consumed. Group I produced an average of 5228 pounds of four per cent fat-corrected milk for each period when they consumed barn-cured and 5001 pounds for the period on field-cured hay. Group II produced 5096 pounds of four per cent fat-corrected milk on the barn-cured hay as compared to an average of 5008 pounds for the two periods when on field-cured hay. This is clearly indicated in figure 2 by the distinct crossing over in the trends of production for the two groups of cows when the hays were reversed at the end of periods 1 and 2. It is of interest to note that these trends of production cross just after the second and third transition periods. This may indicate that the carry over effect of the two hays was longer than three days. It will be noted that a definite increase in milk production is apparent for both groups of cows when switched to the experimental hays at the beginning of period 1. This increase may be in part accounted for by the fact that the hay fed during the adjustment period did not appear to be of as good a quality as either of the experimental hays; however, no analysis was made on this hay. The two groups of cows consumed the same

amounts of grain. The same amount of hay was fed to each group. There was only 19 pounds of hay refused by the cows while on the field-cured hay and five pounds refused while on barn-cured hay for the three periods. The dry matter content of the field-cured hay was 90.77 per cent and 91.13 per cent for the barn-cured hay. Therefore, the intake of dry matter from the two hays was practically the same.

The data obtained for the 12 Holstein cows used in this experiment were statistically analysed, and the results indicate highly significant differences at the one per cent level in favor of the barn-cured hay.

Liveweight changes were noted and were compared as the group average per cow for each group of six cows(table 3). When these data were plotted (figure 3) they reveal a general trend of gain for each group of cows during the periods when they received the field-cured hay and a loss of weight in two of the three periods when they received barn-cured hay. While these gains and losses were not great within the limits of this trial, the effect on liveweight may tend to be greater when either barn-cured hay or field-cured hay, similar in composition to that fed in this trial, is fed continuously for a longer period of time. The data representing the changes in liveweight were analyzed statistically. The results nearly approached the level of significance at the five per cent level; however, according to this analysis, these differences were not significant.

Chemical analysis (tables 6, 7, and 9) show small differences in the composition of the composite samples of each of the hays and of the grain ration fed during each experimental period; however, there were noted differences between the average chemical compositions of the barn-cured hay and field-cured hay (table 8). Of these differences probably the most important is that the barn-cured hay contained 2.63 per cent more protein than the field-cured hay. Since the grain ration fed was low in protein (average 11.87 per cent), this higher protein percentage may have contributed to the greater milk production from the barn-cured hay.

The results of this study can hardly be compared directly with the results of similar studies without noting the differences in the method of feeding in each case. Shepherd *et al*[17] fed corn silage as part of the roughage and, also, adjusted the amounts of hay so that each group of cows received the same amount of dry matter in each kind of hay. The measure of differences were not reported in terms of daily milk production, but rather as more milk produced per acre based on the conservation of dry matter stored from the two methods of harvesting. On this basis the barn-curing method produced a 7.6 per cent advantage over the field-curing method in the amount of milk produced per acre. Slight gains in liveweight were reported in favor of the field-cured hay. The greater milk production from the barn-curing method and the slight increase in liveweight in favor of the field-cured hay, reported by these authors, correlates with the results of the present

experiment. However, no contrast can be made as to the milk production resulting from feeding equal weights of the two kinds of hay to cows.

Morrison and Turk[12][13] and Turk *et al*[20][21] fed hay as the only source of roughage but allowed the cows to consume all of the hay they would consume at two feedings per day. They noted no significant differences in the amounts of each kind of hay consumed, changes in liveweight, or in the production of four per cent fat-corrected milk. These results are not in agreement with those of the present experiment where an increase in milk production was noted in favor of the barn-cured hay, but they are in agreement on liveweight changes where no significant differences were noted in either case.

In light of the limited information available on the comparison of barn-cured and field-cured hay, further work would be desirable to give more data regarding the effects of the two methods of curing hay on milk production and on changes in liveweight.

Barn hay driers have proved extremely valuable for curing hay that would otherwise be lost because of unfavorable weather conditions. In view of this fact their continued use as a means of conserving hay is to be strongly recommended.

VII. SUMMARY

A controlled feeding experiment was conducted to compare the influence of barn-cured and field-cured alfalfa hay cut from the same field on milk production and liveweight of dairy cows. Twelve Holstein cows were used in this trial. The double-reversal feeding method was followed. Grain was fed at the same rate to each group of cows. Hay was fed as the only source of roughage, and equal amounts of the two kinds of hay were fed to the two groups of cows. There was practically no difference in the total consumption of the two kinds of hay. Analysis of variance on the amounts of four per cent fat-corrected milk produced revealed highly significant differences at the one per cent level in favor of the barn-cured hay. The hays were sampled at regular intervals for proximate analysis. At the time of feeding the barn-cured hay contained .36 per cent more moisture, 2.63 per cent more protein, .26 per cent more fat, 1.20 per cent less fiber, 2.26 per cent less nitrogen-free extract, and .66 per cent more ash. The cows gained slightly in liveweight when they received the field-cured hay and lost slightly in liveweight when they received the barn-cured hay. Liveweight changes were not significant when analyzed statistically.

VIII. CONCLUSIONS

1. The results of this feeding trial indicate that dairy cows when fed alfalfa hay cured in the barn by forced air ventilation may produce more milk than when they are fed the same hay cured in the field.
2. There were no significant differences in the liveweight changes of the cows fed barn-cured and field-cured alfalfa hay from the same field.

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X. APPENDIX

Appendix

TABLE I

Weekly Milk Production in Pounds of Four Per Cent Fat-Corrected Milk From Each Cow on Barn-Cured and Field-Cured Alfalfa Hay Experiment

GROUP I

Cows	1	2	3	4	5	6
Weeks		Period 1 Barn-Cured Hay				
1	345.3	237.0	225.0	210.5	192.7	182.0
2	344.1	248.2	235.7	216.2	177.1	172.7
3	325.0	248.9	229.3	198.2	180.4	179.8
4	338.5	234.4	232.5	216.7	185.6	181.0
		Period II Field-Cured Hay				
1	316.7	214.9	200.1	199.7	173.5	165.2
2	313.3	223.2	210.6	199.2	164.2	157.8
3	305.8	220.8	200.0	191.2	158.2	158.3
4	301.1	212.6	206.5	191.5	159.0	157.2
		Period 3 Barn-Cured Hay				
1	317.9	216.7	198.5	192.4	169.7	161.6
2	288.2	209.0	213.8	193.4	173.2	167.9
3	281.7	199.8	206.4	189.4	178.6	156.4
4	283.5	207.7	196.9	191.7	171.2	153.1

GROUP II

Cows	7	8	9	10	11	12
Weeks		Period 1 Field-Cured Hay				
1	312.0	256.6	229.9	204.3	193.5	189.8
2	296.7	258.2	233.7	196.3	190.6	180.3
3	297.2	250.8	231.2	184.2	186.6	180.6
4	297.3	258.8	225.3	183.4	188.2	171.4
		Period 2 Barn-Cured Hay				
1	305.8	237.7	221.0	183.8	185.3	168.0
2	284.3	245.0	223.6	177.4	181.7	167.5
3	288.8	225.2	222.8	183.2	188.2	166.9
4	270.3	216.7	221.5	179.7	184.4	167.1
		Period 3 Field-Cured Hay				
1	267.0	212.3	206.8	172.3	171.4	160.3
2	258.6	203.7	196.6	178.6	163.8	158.7
3	260.1	197.2	193.3	177.6	159.9	158.7
4	253.3	195.6	175.3	174.9	167.3	155.9

Appendix

TABLE II

Average Weights[(1)] of Cows for Each Weighing as Indicated, While Fed Barn-Cured and Field-Cured Alfalfa Hay

GROUP I

Cows	1	2	3	4	5	6	Ave
Ave Weight Beginning Period 1	1177	1196	1235	1001	1023	1059	1115
	Period 1 Barn-Cured Hay Fed						
End Period 1	1175	1201	1243	1022	1036	1071	1123
	Period 2 Field-Cured Hay Fed						
End Period 2	1189	1191	1250	1034	1042	1069	1129
	Period 3 Barn-Cured Hay Fed						
End Period 3	1159	1186	1238	1006	1043	1075	1118

GROUP II

Cows	7	8	9	10	11	12	Ave
Ave Weight Beginning Period 1	1210	1299	1270	1082	944	1029	1141
	Period 1 Field-Cured Hay Fed						
End Period 1	1240	1314	1384	1107	943	1045	1156
	Period 2 Barn-Cured Hay Fed						
End Period 2	1210	1298	1288	1105	947	1033	1147
	Period 3 Field-Cured Hay Fed						
End Period 3	1232	1301	1295	1100	940	1038	1151

(1) Average of three day weights in pounds per cow.

Appendix

TABLE III

Amount of Hay and Grain Fed Daily to Each Cow in Each Experimental Period

	GROUP I							GROUP II				
Cows	1	2	3	4	5	6	7	8	9	10	11	12
Period					Grain (Pounds)							
1	18	15	13	12	12	12	18	15	13	12	12	12
2	18	14	12	12	12	10	18	14	12	12	12	10
3	17	13	11.4	11.4	11.4	9.4	17	13	11.4	11.4	11.4	9.4
					Hay (Pounds)							
1	26	26	26	22	20	22	26	26	26	22	20	22
2	26	26	26	22	20	22	26	26	26	22	20	22
3	26	26	26	22	20	22	26	26	26	22	20	22

Appendix

TABLE IV

Chemical Composition of Composite Samples[1,2] of the Hays as Fed Throughout the Milk Production Trial

(Dry Basis)

	Barn-Cured	Field-Cured
Dry Matter	9077 %	91.13%
Protein	21.89%	18.69%
Ether extract	2.30%	2.01%
Crude fiber	26.40%	28.10%
N-free extract	41.64%	43.94%
Ash	7.77%	7.26%

1) The composite samples were collected by the core sampler and the bales of hay fed Monday, Wednesday and Friday of each week were sampled.

2) Proximate analyses were made by personnel of the Agricultural Chemistry Department, Virginia Agr. Exp. Sta.

Appendix

TABLE V

Chemical Composition (Dry Basis) of Barn-Cured and Field-Cured Alfalfa Hay[1,2)]

Bale No.	Sample No.	Dry Matter Per Cent		Protein Per Cent		Ether Extract Per Cent		Crude Fiber Per Cent		Ash		N-Free Extract Per Cent	
		Barn	Field	Barn	Field	Barn	Field	Barn	Field	Barn	Field	Barn	Field
1	1	88.7	89.6	22.8	18.5	2.8	2.0	26.2	28.6	8.5	6.8	39.7	44.1
	2	88.3	89.2	23.1	18.4	2.4	2.0	25.9	28.1	8.4	6.7	40.2	44.8
2	3	88.1	89.5	22.6	19.4	2.3	1.7	26.2	29.6	8.1	6.8	40.8	42.5
	4	87.8	89.4	22.7	19.4	2.3	1.7	26.0	29.7	8.0	6.7	51.0	42.5
3	5	88.5	89.9	23.5	19.6	2.5	1.9	24.8	28.0	8.2	7.3	41.0	43.2
	6	87.9	89.0	23.4	20.1	2.5	1.8	24.7	27.4	8.2	7.4	41.2	43.3
4	7	88.1	89.6	23.9	20.8	2.4	1.9	25.7	26.7	8.6	7.7	39.4	42.9
	8	88.2	89.8	23.7	20.6	2.3	2.0	25.5	26.9	8.6	7.7	39.9	42.8
5	9	88.6	89.4	22.8	19.3	2.1	2.0	25.8	27.0	8.4	8.5	40.9	43.2
	10	88.4	89.3	22.9	19.2	2.2	2.0	26.0	26.6	8.6	8.7	40.3	43.5
6	11	88.4	89.3	23.2	20.7	2.5	2.4	25.9	24.9	8.5	8.1	39.9	43.9
	12	88.6	89.2	23.4	20.4	2.5	2.3	24.6	25.4	8.5	8.3	41.0	43.6
7	13	88.3	89.5	22.9	21.1	2.3	2.1	26.6	26.4	8.4	9.2	39.8	51.2
	14	88.0	89.5	22.4	20.9	2.3	2.1	27.2	27.8	8.6	9.3	39.5	40.9
8	15	88.1	88.2	22.6	20.3	2.6	2.0	25.4	27.0	7.9	8.9	41.5	41.8
	16	88.6	88.6	22.9	20.7	2.4	2.0	26.2	26.8	8.1	9.0	40.4	41.5
9	17	88.5	89.5	21.4	20.8	2.0	210	28.2	27.5	8.6	9.2	39.8	40.5
	18	88.5	89.2	21.8	19.9	2.1	1.9	27.7	28.3	8.7	9.9	39.7	40.0
10	19	89.3	89.4	22.2	16.9	2.1	2.4	25.3	28.3	7.9	7.1	42.5	45.3
	20	89.2	89.4	22.1	16.9	2.1	2.4	25.8	27.9	8.1	7.4	41.9	45.4
Mean		88.4	89.3	22.8	19.7	2.3	2.0	26.0	27.4	8.3	8.0	40.5	43.8

1) Ten bales of each kind of hay were selected at random, and two samples were taken from each bale with a core sampler; all samples were taken the same day. The bales were selected from the lots of hay fed in the milk production experiment.

2) Proximate analyses were made by personnel of the Agricultural Chemistry Department, Virginia Agr. Exp. Sta.

Appendix

TABLE VI

Carotene Content in Hay (Micrograms Per Gram)[1,2)]
(Two samples from each bale)

Barn-Cured			Field-Cured		
	Sample			Sample	
Bale	A	A'	Bale	A	A'
1	31.15	29.15	1	16.80	17.80
2	30.65	38.95	2	18.05	14.65
3	39.90	40.70	3	12.00	12.20
4	28.15	29.40	4	19.50	17.60
5	31.95	40.90	5	19.95	24.80
6	37.10	31.95	6	21.90	27.40
7	30.90	29.15	7	21.10	19.75
8	31.70	28.75	8	23.45	26.20
9	33.60	68.50	9	18.05	17.45
10	33.30	30.90	10	21.00	21.90
Average	32.84	36.835	Average	19.18	19.98
Average 20 samples	34.84		Average 20 samples	19.58	

1) Ten bales of each kind of hay were selected at random, and two samples were taken from each bale with a core sampler. All samples were taken on the same day. The bales were selected from the lots of hay fed in the milk production trial.

2) Carotene determinations were made by personnel of the Dairy Research Laboratory, Virginia Agr. Exp. Sta.

Appendix

TABLE VII

Digestibility Coefficients for Barn-Cured and Field-Cured Hay[1,2)]
(Five-day trials)

Trial 1

Hay	Dry Matter	Protein	Ether Extract	Crude Fiber	N-free Extract
Cow 1 Barn-cured	60.75	74.19	16.41	56.59	59.66
Cow 2 Barn-cured	59.96	73.15	21.83	54.61	59.04
Cow 3 Field-cured	59.33	69.00	24.42	57.33	59.16
Cow 4 Field-cured	60.27	70/76	27.16	58.72	59.40

Trial 2

Cow 1 Field-cured	58.55	71.30	22.41	57.48	56.30
Cow 2 Field-cured	58.78	72.18	26.68	54.73	56.93
Cow 3 Barn-cured	60.29	74.84	18.67	57.08	58.02
Cow 4 Barn-cured	60.88	75.18	14.41	61.69	56.93

Average for four cows[3)], two five-day trials

Field-cured	59.23	70.81	24.92	56.90	57.95
Barn-cured	60.47	74.34	17.83	57.49	58.41

1) The experimental hays constituted the ration; no grain was fed.

2) The digestion trial was conducted jointly by the Agricultural Chemistry Department, Virginia Agr. Exp. Sta. and the Dairy Husbandry Department, V.P.I.

3) Four Holstein cows were used.