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Bin-Cured versus Field-Cured Alfalfa Hay for Dairy Heifers

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C. E. Wylie, Major Professor

We have read this thesis and recommend its acceptance:

M. H. Kerr, Eric Winters

Accepted for the Council:

Dixie L. Thompson

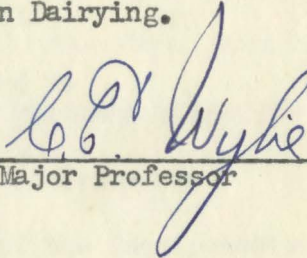
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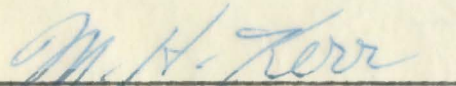
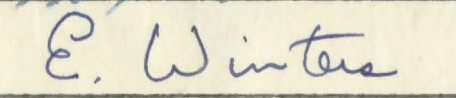
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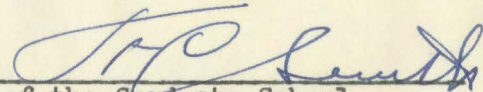
I am submitting to you a thesis written by Marshal C. Winton entitled "Bin-Cured versus Field-Cured Alfalfa Hay for Dairy Heifers." I recommend that it be accepted for 15 quarter hours credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Dairying.


Major Professor

We have read this thesis
and recommend its acceptance:

Accepted for the Committee


Dean of the Graduate School

BIN-CURED VERSUS FIELD-CURED ALFALFA HAY
FOR DAIRY HEIFERS

A THESIS

Submitted to
The Committee on Graduate Study
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Master of Science

by

Marshal C. Winton

August 1947

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M.C.W.

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CHAPTER I

INTRODUCTION

This study was undertaken for the purpose of comparing the nutritive value of bin-cured and field-cured alfalfa hay, using actual feeding trials with dairy heifers.

Any study involving the production and preservation of more and better hay has great economic importance. Shepherd and others (21), in discussing the losses of hay from a national standpoint, state that:

The uncertain weather conditions that frequently exist while hay is being made, particularly in the humid sections of the country, are responsible for variations in the quality of the hay and for large losses of nutrients during harvesting. Conservative estimates indicate that losses during harvesting amount to 15-20 percent of the dry matter and 25-30 percent of the protein, under reasonably favorable conditions. Larger losses occur when rainy weather occurs during haying or when cloudy or humid weather makes it necessary to handle the forage considerably to facilitate drying.

Allred and Luebke (2) conducted a survey of haying practices in Knox County, Tennessee, in 1942, and found that losses of hay in the field and in storage were estimated at 4.8 percent of the value of all hay harvested. A survey made by Saville (20) in 1945 of 31 farms in Rutherford County, Tennessee, indicated that 37 percent of the first-cutting alfalfa hay was damaged to some degree by rain.

Shepherd (21) points out that in recent years much work has been done to develop methods of harvesting hay crops so as to eliminate the

hazards of the weather, to reduce the harvesting losses, and to produce a higher quality feed.

This study was designed to test the comparative nutritive value of field-cured and bin-cured alfalfa hay. If the trial shows no significant difference in the nutritive value of the two hays, then the greatest economic value of bin-curing hay lies in the possibility of producing larger amounts of hay.

CHAPTER II

REVIEW OF RELATED STUDIES

Few feeding trials have been conducted to determine the nutritive efficiency of barn-cured alfalfa hay as compared to field-cured hay. Some of these trials are the three trials conducted by the University of Tennessee (23)(24), the three trials conducted by the Ohio State University (17), the survey made by Connelly in Virginia (3), the comparisons made by the U. S. Department of Agriculture (9), the preliminary work by Oregon State College (11), and a two-year feeding trial by Turk (22) at Cornell. With the exception of the work done at the University of Tennessee, none of these feeding trials have determined the feeding value of these hays for dairy heifers. The other trials have been conducted with mature producing cows.

The two feeding trials conducted at the University of Tennessee in 1938 and 1939, and reported by Weaver and Wylie (23) indicated the dairy heifers in each group made normal growth as determined by weight, height at withers, and heart-girth. The kinds of hay made little difference in growth of the two groups. In these feeding trials the alfalfa hay ration was supplemented with a concentrate mixture and corn silage. The feeding trial conducted by Wylie and others (24) at the Middle Tennessee Experiment Station indicated that groups of heifers on field-cured alfalfa hay, barn-cured alfalfa hay, and

barn-cured soybean hay all made close to normal gains in weight and height at withers. The heifers on the barn-cured hays gained a little more weight on a little less hay than did the heifers on the field-cured hay. There was no significant nutritive superiority of one hay over the other.

Any well-cured, properly handled alfalfa is highly palatable. Monroe and others (13) state that barn-curing may increase the degree of palatability, but this process is no "cure-all" for all alfalfa hay. In cases where heating and fermentations have occurred in barn-cured hay, losses will be encountered just as in storage of ordinary hay. According to Perkins (17) when an inefficient fan was operated intermittently the resulting barn-cured hay was less palatable than the field-cured hay. In another feeding trial with dairy heifers conducted by Weaver and Wylie (23) they indicate that barn-cured hay is slightly superior in palatability even when the field-cured hay has not been damaged by rain. In the feeding trial conducted at the Middle Tennessee Experiment Station (24) the amounts of hay fed, consumed, and refused indicate that both lots of alfalfa hay were satisfactory in palatability, and that there is no significant superiority of one over the other.

Eckles (5), Henderson and others (8) state that growth of various parts of the animal proceeds in rather definite ratios. Therefore, growth may be measured by combining live weight and skeleton measurement. A combination of weight and size measurement in

determining growth is more useful than either alone (12). Work along this line has been done by Ragsdale (19) at the University of Missouri. Growth standards published by the Missouri Station are based upon actual weights and measurements taken in the Missouri, Kansas, and Iowa Agricultural Experiment Station herds. Other work of recording growth averages of dairy animals for the purpose of establishing "standards" has been conducted by Espe and co-workers at Iowa (6), Moseley and others, of the U. S. Department of Agriculture (15), and Wylie and Hinton at the University of Tennessee (25). Figure 1 graphically compares these averages.

Eckles (4), from a feeding project conducted at the Missouri Agricultural Experiment Station in 1918, concluded that heifers fed a ration of first-class alfalfa hay alone will make a daily gain of 0.65 to 0.90 pound, which is somewhat below normal. He also found that different rations have a much more significant effect on weight than on skeletal growth (4)(5). Although alfalfa hay is probably the most palatable roughage used for feeding cattle, the failure to make normal gains is due to the inability to consume sufficient quantity to supply the energy needed.

From the viewpoint of conserving nutrients, artificial drying of hay comes close to being the ideal (13). Turk (22) found that barn-cured hay has a greener color, a slightly higher carotene content, and a consistently higher official grade. Wylie and Weaver (23) found that barn-cured hay is one grade or class better than the same hay dried in the field. It also averages 2.3 percent more leaves and 19

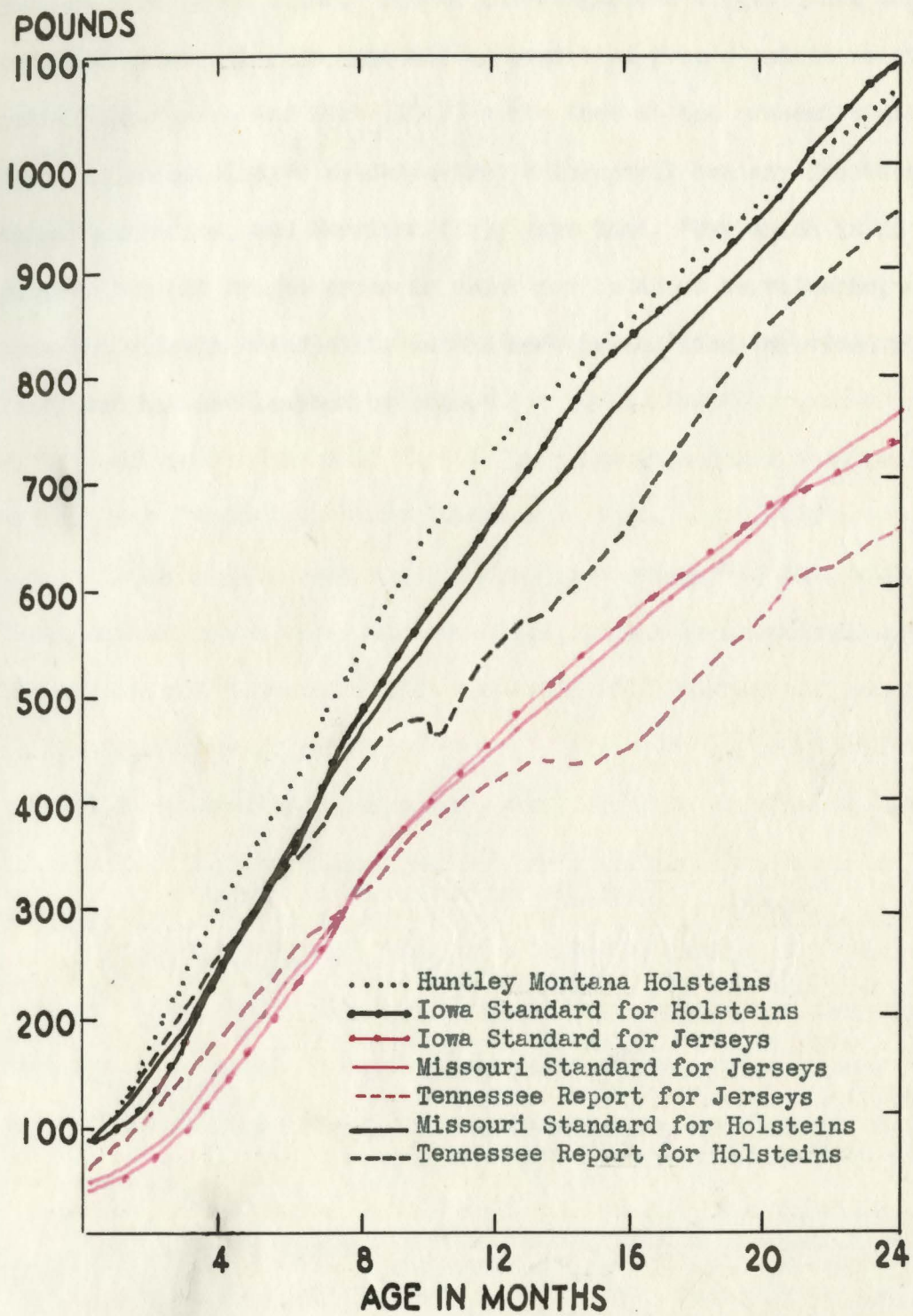


FIGURE I

COMPARISON OF GROWTH "STANDARDS" AS DETERMINED BY RAGSDALE (19), ESPE AND OTHERS (6), MOSLEY AND OTHERS (15), AND WYLIE AND HINTON (25).

percent more green color. Recent investigations suggest that the value of green color in hays may be overrated from a nutritive standpoint. Halverson and Hart (1)(7) state that at the present time there is no conclusive evidence that chlorophyll has any function in animal nutrition, and Morrison (14), says that, "Hay which is of good quality but not bright green in color may be about as valuable, except from the vitamin standpoint, as the more prized kind, provided it is leafy and has not leached by rain."

CHAPTER III

EXPERIMENTAL PROCEDURE

Animals

General. The feeding trial to determine the comparative efficiency of field-cured and bin-cured alfalfa hay for growth of dairy heifers was conducted at the Tennessee Experiment Station at Knoxville. The trial started December 4, 1946, and 16 heifers were used. These heifers were divided into two groups of 8 each with consideration being given to breed, age, weight and measurements. Each group was composed of 3 Jersey and 5 Holstein heifers ranging in age from 13 to 27 months.

The groups were designated as follows:

- Group I. Field-cured hay ad lib.
- Group II. Bin-cured hay ad lib.

Preliminary Period. During a three-day preliminary period the heifers to be used in the feeding trial were weighed and measurements were taken at height of withers and at the heart-girth. These measurements were averaged, and that average was used as the starting measurements.

Hay Feeding Period. The hay feeding period started December 4, 1946, and continued until March 13, 1947, for a total of 99 days.

Housing. During the hay feeding period, Group I and Group II were housed in an open shed at dairy barn No. 2 on Cherokee farm. Both groups had access to a dry lot (Fig. 2).

Feeding. The animals were fed twice daily. At each feeding the hay remaining in the feed rack was removed and weighed. This constituted the daily amount of refused hay. After the refused hay was removed, the hay to be fed at each feeding was carefully weighed and placed in the hay rack. The feeding throughout was ad lib. Salt and steamed bone meal were supplied to both groups in the sheds.

Water. Water was available in the shed for each group. Since an open shed was used, there was no system to keep the water from freezing during the coldest weather. This ice was broken at least at each feeding period.

Pasture Period. After the heifers were taken off the alfalfa hay ration on March 13, 1947, they were turned on pasture as it was available and as the weather permitted on the Cherokee farm. Early pasture was composed of small grain and crimson clover, and the later pasture was primarily bluegrass. The entire pasture period was 113 days. During this period both groups of heifers grazed together.

Weighing and Measuring. While the heifers were on the hay ration, a combination of weight and size measurement was taken weekly. Former investigators (5) (6) (8) (12) (15) (20), have found this the most satisfactory method of determining growth. Animals were weighed individually on American Scale Company platform scales. Immediately

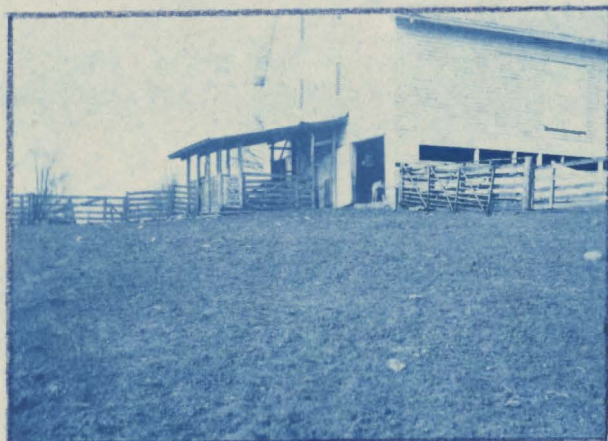
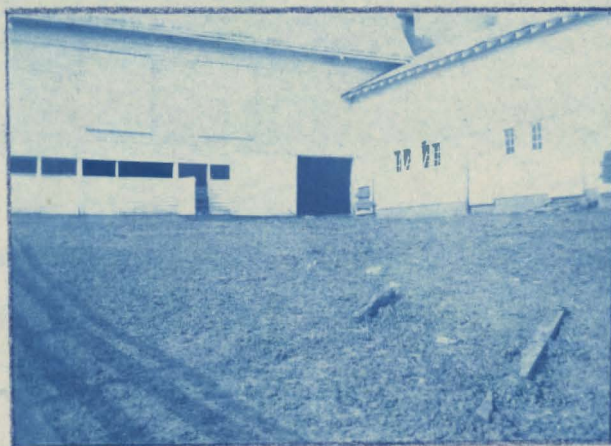


FIGURE 2

SHEDS AND DRY LOTS WHERE HEIFERS WERE HOUSED

(Top) Shed and dry lot where Group I, fed the field-cured alfalfa hay, was housed for the hay feeding period. (Bottom) Shed and dry lot used by Group II.

following weighing the heifers were measured. These measurements included height at withers and circumference of chest and heart-girth. After the heifers were turned on pasture, weights and measurements were taken once weekly for the first four weeks. After that period they were weighed and measured once each month. The heifers were measured at about 2 o'clock in the afternoon. This time was not found by Allen (1) to be the best time of day for weighing in order to arrive at a daily average in weight, but in a trial of this length it was not considered necessary to take into account variations within a 24-hour period.

Hay

The alfalfa hay used in this feeding trial was produced on the University of Tennessee Blount County farm.

Handling of the Hay. The hay used in this feeding trial was first-cutting alfalfa. At the time of harvesting it was not practical to use alternate windrows for the field-cured long hay and bin-cured chopped hay, so alternate strips through the field were used instead.

Curing. The hay fed to Group I was field-cured and baled with a pick-up baler. The hay fed to Group II was partially cured in the field, hauled to the bin, chopped and curing was completed in the bin.

Storage. When the alfalfa hay, both field-cured and bin-cured, was ready for final storage, it was stored in dairy barn No. 2 immediately above the sheds where the experimental animals were housed.

Both hays were subjected to the same storage and atmospheric conditions until they were fed.

Sampling. A composite sample of both the field-cured and bin-cured hay was obtained by taking frequent small samples at feeding time. These samples were deposited in bags until the hay feeding period was completed.

Analysis. The analysis of the chemical composition of the hay was made under the direction of K. B. Sanders, Assoc. Chemist, Tennessee Experiment Station.

Records Kept

During this feeding trial records were kept of the growth of the heifers to include weights and measurements, consumption of hay, the palatability of hay as determined by the amount of hay refused, and the composition of the hay.

CHAPTER IV

RESULTS AND DISCUSSION

Growth

Weight. Gains in weight of each heifer in the trial are recorded in Table I. Both groups of heifers made satisfactory gains in weight during the hay feeding period, during the pasture period, and during the entire feeding trial as a whole. Group I fed the field-cured hay gained 1.379 pounds daily, while on the hay ration, .916 pound while on pasture, and 1.132 pounds daily for the entire trial of 212 days. Group II fed the bin-cured hay gained 1.331 pounds daily while on the hay ration, 1.024 pounds while on pasture, and 1.169 pounds daily for the entire trial. The average daily gains are much higher than those reported by Eckles (4). The Jersey heifers fed the field-cured hay averaged 81.3 ± 13.2 pounds gain in 99 days of hay feeding, 96.6 ± 14.3 pounds on pasture, and 178 pounds during the 212-day trial. The Holsteins in this group averaged 169.8 ± 39.3 pounds gain on hay, 107.6 ± 43.5 pounds on pasture, and 277 pounds during the trial. The Jersey heifers fed the bin-cured hay averaged 65.0 ± 4.1 pounds gain on hay, 117 ± 23.5 pounds on pasture, and 182 pounds for the entire trial. The Holsteins in this group averaged 172.6 ± 29.4 pounds gain on hay, 115 ± 14.6 pounds on pasture, and 287.6 pounds during the trial.

TABLE I

GAINS IN WEIGHT OF JERSEY AND
HOLSTEIN HEIFERS

Heifer number	Initial weight (lbs.)	Hay feeding period			Pasture period		
		Ending weight (lbs.)	Gain (lbs.)	Daily gain (lbs.)	Ending weight (lbs.)	Gain (lbs.)	Daily gain (lbs.)
Group I							
T-195	652	741	89	.898	850	109	.964
T-203	507	571	64	.646	652	81	.716
T-205	487	578	91	.909	678	100	.885
Sara	971	1200	229	2.313	1300	100	.885
471	894	1049	155	1.565	1106	57	.504
472	849	996	147	1.484	1142	146	1.292
474	751	941	190	1.909	1018	77	.681
486	529	657	128	1.292	815	158	1.398
Av. Jersey	548.6	630.0	81.3	.821	726.6	96.6	.855
Standard devia.			± 13.2			± 14.3	
Av. Holst.	798.8	968.6	169.8	1.715	1076.2	107.6	.952
Standard devia.			± 39.3			± 43.5	
Group av.	705.0	841.6	136.6	1.379	945.1	103.5	.916
Group II							
T-196	559	622	63	.636	750	128	1.132
T-199	541	603	62	.626	736	133	1.177
T-202	601	671	70	.707	761	90	.796
462	985	1167	182	1.838	1280	113	1.000
Sally	953	1145	192	1.939	1237	92	.814
480	789	931	142	1.434	1050	119	1.053
482	641	845	204	2.060	964	119	1.053
487	600	743	143	1.414	875	132	1.168
Av. Jers.	567.0	632.0	65.0	.656	749.0	117.0	1.035
Standard devia.			± 4.1			± 23.5	
Av. Holst.	793.6	966.2	172.6	1.736	1081.2	115.0	1.017
Standard devia.			± 29.4			± 14.6	
Group av.	708.6	840.8	132.2	1.331	956.6	115.7	1.024

The Holstein heifers in both groups averaged approximately twice as much gain as the Jersey heifers while on the hay ration, but during the pasture period the gains of the Holstein and Jersey heifers were about equal. This suggests that Holstein heifers may be capable of better utilizing roughage than Jersey heifers. On the other hand, the rapid summer pasture gains made by the Jersey heifers indicate that Jersey heifers are capable of eliminating some of the feeding superiority of the Holsteins during the winter, when the two are turned on pasture. Figures 3 to 22 graphically portray the weight gains as compared to the Missouri "Standard" (19).

Height of Withers. Table II shows that there are considerable individual variations throughout both groups, but the total average increases in height are about the same in each case. Figures 3 to 22 compare actual increases with the Missouri "Standard" (19).

The heifers fed the field-cured hay averaged 1.25 inches increase in height during the hay feeding period, 1.36 inches for the pasture period, and 2.64 inches for the entire trial; the heifers fed the bin-cured hay averaged 1.66 inches on hay, 1.17 inches on pasture, and 2.84 inches for the entire period. The heifers in Group I increased at about the same daily rate on both the hay and pasture, but the heifers in Group II increased 1.66 inches on hay, but they increased only 1.17 inches on pasture.

Heart-girth. Table III gives the individual and average increases of the two groups, and figures 3 to 22 compare individual and group performance with the Missouri "Standard" (19).

TABLE II

INCREASE IN HEIGHT OF WITHERS OF JERSEY AND
HOLSTEIN HEIFERS

Heifer number	Initial height (inches)	Hay feeding period			Pasture period		
		Ending height (inches)	Gain (inches)	Daily gain (inches)	Ending height (inches)	Gain (inches)	Daily gain (inches)
Group I							
T-195	43.7	44.7	1.0	.0101	46.5	1.8	.0159
T-203	43.7	44.7	1.0	.0101	46.5	1.8	.0159
T-205	44.0	45.5	1.5	.0150	47.0	1.5	.0132
Sara	50.9	52.1	1.2	.0121	52.0	- 0.1	-.0009
471	49.1	50.2	1.1	.0111	51.7	1.5	.0132
472	50.0	51.8	1.8	.0180	52.7	0.9	.0079
474	48.2	49.4	1.2	.0121	51.5	2.1	.0185
486	45.1	46.5	1.4	.0141	47.7	1.2	.0106
Av. Jersey	43.8	44.9	1.16	.0117	46.6	1.70	.0150
Standard devia.			± .28			± .17	
Av. Holst.	48.8	50.0	1.34	.0135	51.1	1.16	.0103
Standard devia.			± .28			± .75	
Group av.	46.9	48.1	1.25	.0126	49.4	1.36	.0120
Group II							
T-196	43.0	44.6	1.6	.0160	46.0	1.4	.0123
T-199	42.1	43.4	1.3	.0131	44.5	1.1	.0097
T-202	46.3	46.9	0.6	.0060	48.2	1.3	.0115
462	50.1	52.3	2.2	.0222	53.0	0.7	.0062
Sally	49.7	51.3	1.6	.0160	51.7	0.4	.0035
480	48.5	49.7	1.2	.0121	51.0	1.3	.0115
482	47.4	50.1	2.7	.0271	51.2	1.1	.0097
487	45.8	47.9	2.1	.0212	50.0	2.1	.0185
Av. Jersey	43.8	44.9	1.16	.0117	46.2	1.26	.0111
Standard devia.			± .51			± .16	
Av. Holst.	48.3	50.3	1.96	.0199	51.4	1.12	.0099
Standard devia.			± .57			± .65	
Group av.	46.6	48.3	1.66	.0167	49.4	1.17	.0103

The heifers in Group I, fed the field-cured hay made slightly more gain in heart-girth than the heifers fed the bin-cured hay. For the entire period of the trial the heifers in Group I averaged 6.29 inches gain, while the heifers in Group II averaged 5.64 inches. For the hay period alone Group I gained 2.31 inches, while Group II averaged 1.80 inches. The Jersey heifers in Group II did gain slightly more than the Jerseys in Group I, but with this exception the heifers fed the field-cured hay gained slightly more in every instance.

Composition of Hay

The chemical analysis of the hay used in this trial is shown in Table IV. A chemical analysis of the hays used in this feeding trial indicates considerable superiority of the bin-cured hay over the field-cured hay. If the nutrients of the field-cured hay as fed are considered as 100 percent, then those nutrients in the bin-cured hay as fed are as follows:

Protein,	106.9 percent
Fat,	149.2 percent
Fiber,	94.4 percent
Nitrogen-free extract,	101.0 percent
Mineral matter,	95.5 percent

Hay Fed and Consumed

The amount of hay fed, refused, and consumed is shown in Table V.

The heifers in Groups I and II were fed sufficient hay during the hay feeding period to have hay before them at all times. This is shown by the amounts of hay removed at each feeding. During the entire hay feeding period both groups were fed a fairly constant amount of hay, as shown in Table V. For the period Group I was fed 23,088 pounds of long hay, refused 2701 pounds, and consumed 20,387 pounds. On the average each heifer was fed 2886 pounds, refused 337.5 pounds, and consumed 2548 pounds. The average daily amount was 29.1 pounds fed, 3.4 pounds refused, and 25.7 pounds consumed. Group II was fed 22,470 pounds of chopped hay, refused 3,255 pounds, and consumed 18,215 pounds. On the average each heifer was fed 2808.7 pounds, refused 406.8 pounds, and consumed 2401.8 pounds. The average daily amount for this group was 28.3 pounds fed, 4.1 pounds refused, and 24.2 pounds consumed.

Palatability of Hay

Group I consumed 88.3 percent of the hay fed, while Group II consumed 85.5 percent of the hay fed. Some of this variation may be due to the possibility that more of the long hay fed to Group I was wasted even with the greatest precautions being taken.

TABLE III

INCREASE IN HEART-GIRTH OF JERSEY AND
HOLSTEIN HEIFERS

Heifer number	Initial H.G. (inches)	Hay period			Pasture period		
		End H.G. (inches)	Gain (inches)	Daily gain (inches)	End H.G. (inches)	Gain (inches)	Daily gain (inches)
<u>Group I</u>							
T-195	61.6	62.2	0.6	.0060	65.5	3.3	.0283
T-203	56.9	58.2	1.3	.0131	62.0	3.8	.0336
T-205	55.9	57.0	1.1	.0111	61.5	4.5	.0398
Sara	71.0	74.5	3.5	.0352	78.7	4.2	.0371
471	67.5	69.6	2.1	.0212	72.0	2.4	.0212
472	67.0	69.5	2.5	.0251	73.5	4.0	.0353
474	62.2	66.8	4.6	.0464	70.0	3.2	.0283
486	55.8	58.6	2.8	.0282	65.0	6.4	.0566
Av.							
Jersey	58.1	59.1	1.00	.0104	63.0	3.86	.0344
Standard devia.			± .36			± .60	
Av.							
Holst.	64.7	67.8	3.10	.0313	71.8	4.04	.0357
Standard devia.			± .98			± 1.58	
Group av.	62.2	64.5	2.31	.0233	68.5	3.97	.0351
<u>Group II</u>							
T-196	55.6	58.2	2.6	.0262	61.0	2.8	.0247
T-199	57.6	58.6	1.0	.0101	62.5	3.9	.0344
T-202	59.1	59.0	- 0.1	-.0010	63.2	4.2	.0371
462	70.3	72.3	2.0	.0202	74.5	2.2	.0194
Sally	70.6	72.4	1.8	.0180	76.5	4.1	.0362
480	64.5	66.0	1.5	.0150	71.5	5.5	.0486
482	60.7	63.8	3.1	.0313	67.5	3.7	.0327
487	59.2	61.7	2.5	.0251	66.0	4.3	.0380
Av.							
Jersey	57.4	58.6	1.16	.0117	62.2	3.63	.0321
Standard devia.			± 1.27			± .74	
Av.							
Holst.	65.6	67.2	2.18	.0220	71.2	3.96	.0350
Standard devia.			± .62			± 1.19	
Group av.	62.2	64.0	1.80	.0182	67.8	3.84	.0340

Observations

Appearance of Animals. During the entire feeding trial the appearance of the heifers in both groups was good. Throughout the winter months when there was considerable rain and snow, all the heifers became dirty and manure covered, due to the close confinement to the open shed and adjacent lot, but as soon as fair weather approached the coats took on a more pleasing appearance. For the entire hay feeding period the heifers in both groups remained vigorous and thrifty. As soon as they were turned on pasture, long hair was shed and the coat took on a lustrous appearance.

Condition of the Open Sheds. During the hay feeding period there was little difference in the condition of the sheds housing the two groups. Both sheds were kept fairly well bedded with wood shavings. There was no visible difference in the manure produced by each group.

Eating Habits. Since feed was before the heifers at all times, some of the animals of both groups were always eating. There was no over-crowding at the hay racks at feeding time. It was observed that the heifers of both groups failed to drink very much water during the coldest weather when the temperature was well below freezing. This was also reflected by the lower weights during the coldest weather.

TABLE V
 AMOUNT OF HAY FED, REFUSED, AND CONSUMED
 BY TRIAL HEIFERS

Date	Fed	Refused	Consumed
		<u>Group I</u>	
December 4	1365	95	1270
December 11	1286	124	1162
December 18	1568	266	1302
December 25	1507	156	1351
January 1	1677	136	1541
January 8	1701	247	1454
January 15	1683	293	1390
January 22	1757	198	1559
January 29	1710	290	1420
February 5	1629	136	1493
February 12	1720	177	1543
February 19	1869	219	1650
February 26	1694	156	1538
March 5	1713	184	1529
March 12	209	24	185
Total	23,088	2,701	20,387
		<u>Group II</u>	
December 4	1320	124	1196
December 11	1472	148	1324
December 18	1476	169	1307
December 25	1612	122	1490
January 1	1658	227	1431
January 8	1646	261	1385
January 15	1621	215	1406
January 22	1713	170	1543
January 29	1538	300	1238
February 5	1561	275	1286
February 12	1574	314	1260
February 19	1727	296	1431
February 26	1605	269	1336
March 5	1708	315	1393
March 12	239	50	189
Total	22,470	3,255	19,215

Breeding Efficiency

At the end of the feeding trial five heifers in Group I had been bred and apparently safely settled. One heifer in this group was bred so near the end of the trial that it was not possible to determine pregnancy. Of the five heifers apparently settled, three were settled on the first service while two required two services. At the end of the trial there were four heifers in Group II bred and apparently settled. Of these four, one was settled on the first service while three required two services.

Breeding efficiency in both groups was satisfactory. There was no measurable difference.

General Discussion

Table VI is a summary of the results of this feeding trial. The amount of hay fed to the heifers in Group I was greater than that fed to those in Group II. The heifers in Group I also consumed more hay and refused less than those in Group II. Ewing (24) obtained similar results in a feeding trial with Jersey heifers at the Middle Tennessee Experiment Station. The heifers in both groups were fed more hay per animal per day than the amount recommended by Peterson (8) for normal growth.

Chemical analysis of the composition of the hay showed that the bin-cured hay was higher in protein, fat and N-free extract. Analysis of the hays used by other investigators (17) (24) (25) substantiate

TABLE VI

SUMMARY OF DATA OF FEEDING TRIAL

Item	Group I	Group II
Number of animals in trial	8	8
Hay feeding period (days)	99	99
Pasture period (days)	113	113
Total length of trial (days)	212	212
Hay fed (lbs.)	23,088	22,470
Hay refused (lbs.)	2,701	3,255
Hay consumed (lbs.)	20,387	19,215
Percent consumed	88.3	85.5
Composition of hay (moisture-free) :		
Protein (percent)	16.76	17.93
Fat (percent)	1.38	2.06
Fiber (percent)	38.97	36.79
N-free extract (percent)	36.05	36.43
Mineral matter (percent)	6.83	6.80
<u>Weight:</u>		
Hay feeding period:		
Initial weight (lbs.)	705.0	708.6
Gain (lbs.)	136.6	132.2
Average daily gain (lbs.)	1.379	1.331
Pasture period:		
Gain (lbs.)	103.5	115.7
Average daily gain (lbs.) .....	.916	1.024
Total trial:		
Gain (lbs.)	240.1	251.7
Average daily gain (lbs.)	1.132	1.187
<u>Height of withers:</u>		
Hay feeding period:		
Initial height (inches)	46.9	46.3
Gain (inches)	1.25	1.66
Average daily gain (inches) .....	.0126	.0167
Pasture period:		
Gain (inches)	1.36	1.17
Average daily gain (inches) .....	.0120	.0103
Total trial:		
Gain (inches)	2.64	2.84
Average daily gain (inches) .....	.0124	.0134

Table VI

Summary of Data of Feeding Trial
(Continued)

Item	Group I	Group II
<u>Heart-girth:</u>		
Hay feeding period:		
Initial heart-girth (inches)	62.2	62.2
Gain (inches)	2.31	1.80
Average daily gain (inches) .....	.0233	.0182
Pasture period:		
Gain (inches)	3.97	3.84
Average daily gain (inches) .....	.0351	.0340
Total trial:		
Gain (inches)	6.29	5.64
Average daily gain (inches) .....	.0297	.0266
Hay fed per heifer per day (lbs.)	29.1	28.3
Hay refused per heifer per day (lbs.).	3.4	4.1
Hay consumed per heifer per day (lbs.)	25.7	24.2
Hay consumed per pound gain during hay feeding period (lbs.)	18.65	17.68

these findings. The extent of variation in the protein content was much less than the 2.87 percent variation found by Huffman (10) in alfalfa grown in one vicinity.

The average gain in weight made by the heifers in Group I and Group II was approximately the same while on the hay ration. The daily gain of the heifers in both groups was much higher than the .65 to .90 pound which Eckles (4) concluded might be expected on a ration of alfalfa hay alone. The findings in this trial tend to disprove Eckles' (5) statement that alfalfa hay alone cannot be consumed in sufficient quantity to supply the energy needed to make normal growth. The daily gain in weight was also much higher in this trial than in the corresponding groups in the trial conducted by Ewing (24). The average daily gain of the heifers in this trial was approximately as high as those of the corresponding groups in the trial conducted by Weaver and Wylie (23) in which a supplement to the field-cured and barn-cured hay was fed.

When the heifers were turned on pasture, the heifers in Group II gained more in weight than the heifers in Group I. The average daily gain of both groups was greater than the .84 pound recorded by Nevens (16). At the end of the trial the heifers in Group II had gained a little more in weight than the heifers in Group I.

The heifers in Group II increased slightly more in height during the hay feeding period. In the trial conducted by Ewing and others (24) the heifers fed the barn-cured hay increased most in height, but in the trial conducted by Weaver and Wylie (23) opposite results were

obtained. In the present trial when the heifers were turned on pasture, the heifers in Group I increased more in height, but for the entire trial the heifers in Group II made the greatest increase.

The heifers in Group I increased more in heart-girth both while on the hay ration and while on pasture.

The heifers in Group I consumed 18.65 pounds of hay per pound of gain in weight during the hay feeding period, and the heifers in Group II consumed 17.68 pounds of hay per pound of gain in weight for the same period. The heifers in the two groups studied by Ewing (24) consumed 25.21 and 25.79 pounds of hay respectively per pound of gain in weight. This difference may be attributed to the fact that the heifers in the trial conducted by Ewing were all Jerseys, while the heifers in this trial included Holsteins as well as Jerseys.

An analysis of some of the widest variations of the average increases shows that there is no significant difference, which indicates no significant difference in the feeding value of field-cured and bin-cured alfalfa hay. Standard deviations also suggest no significant difference in the average increases in measurement of Jerseys or Holsteins of one group over Jerseys or Holsteins of the other group.

CHAPTER V

SUMMARY

This study was conducted for the purpose of determining the nutritive value of bin-cured and field-cured alfalfa hay for dairy heifers by actual feeding trials.

Group I. Eight heifers were fed field-cured long alfalfa hay.

Group II. Eight heifers were fed chopped bin-cured alfalfa hay.

Group I and Group II were fed alfalfa hay alone ad lib for 99 days and were then turned on pasture for 113 days.

The heifers in both groups maintained normal growth when wintered on alfalfa hay alone, and both continued to make satisfactory growth when turned on pasture. While on alfalfa hay ration, Group I averaged 136.6 pounds gain per heifer. The average daily gain was 1.379 pounds per heifer. For the same period Group II averaged 132.2 pounds gain per heifer. The average daily gain was 1.331 pounds per heifer. Group I on pasture averaged .916 pound gain per heifer daily and 1.132 pounds for the entire 212-day trial period, while Group II on pasture averaged 1.024 pounds gain per heifer daily and 1.171 pounds for the entire trial period. In both groups the Holstein heifers made greater gains than did the Jerseys.

The heifers fed the bin-cured hay increased slightly more in height at withers. For the hay feeding period the heifers in Group I increased 1.25 inch, while the heifers in Group II increased 1.66 inch.

The heifers in Group I increased slightly more in heart-girth than those in Group II, while on hay, on pasture, and for the entire period. Actual average gains for the heifers in Group I were 6.29 inches per heifer for the entire trial, while the heifers in Group II gained 5.64 inches per heifer.

The heifers consumed hay as follows:

Group I was fed daily 29.1 pounds per heifer, refused 2.4 pounds, and consumed 25.7 pounds.

Group II was fed 28.3 pounds per heifer, refused 4.1 pounds, and consumed 24.2 pounds.

The composition of the bin-cured hay, as compared to the field-cured hay was slightly higher in protein content, higher in fat, lower in fiber, about the same in nitrogen-free extract and mineral matter, and about the same in moisture content.

The hay consumed per pound of gain in weight for the two groups in order was 18.65 pounds and 17.68 pounds.

The palatability of the field-cured and bin-cured alfalfa hay was determined by observation and by the relative amount of hay refused. The growth made by all animals indicated that the palatability was satisfactory. Observation indicated no significant superiority of one hay over the other. The amount of hay refused was slightly greater for the groups fed bin-cured hay.

Observations of Group I and Group II indicate that either field-cured or bin-cured alfalfa hay is a satisfactory ration for wintering dairy heifers over 12 months of age. No ill effects or lowering of vigor or thriftiness was noted.

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APPENDIX

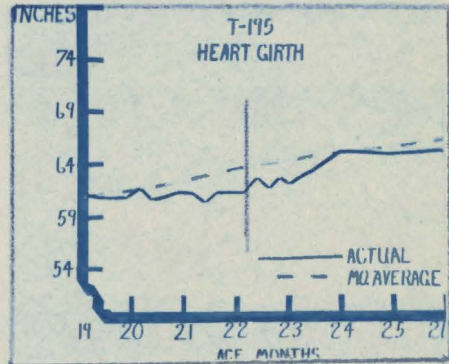
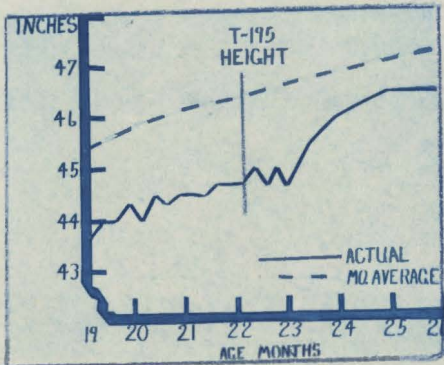
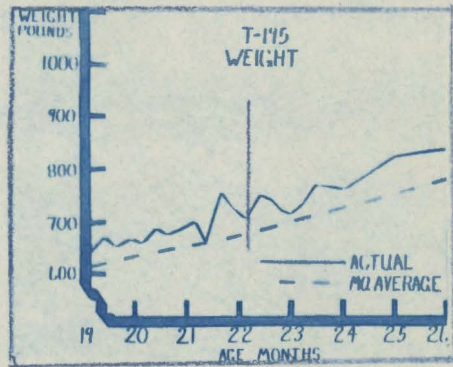


FIGURE 3

COMPARISON OF THE GROWTH MADE BY JERSEY HEIFER T-195 WITH THE AVERAGE GROWTH OF JERSEY HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINES THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.

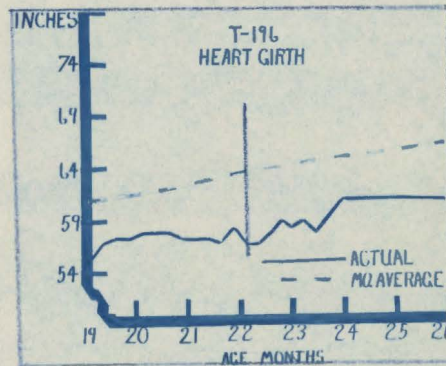
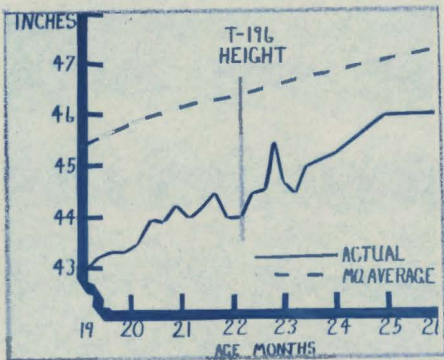
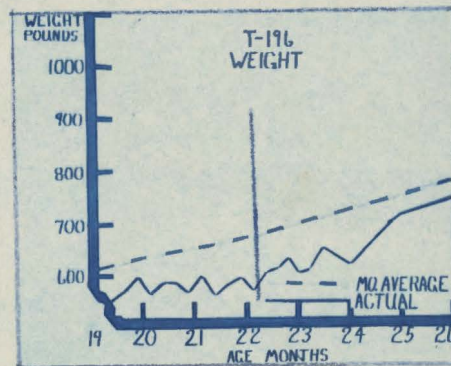


FIGURE 4

COMPARISON OF THE GROWTH MADE BY JERSEY HEIFER T-196 WITH THE AVERAGE GROWTH OF JERSEY HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINE THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.

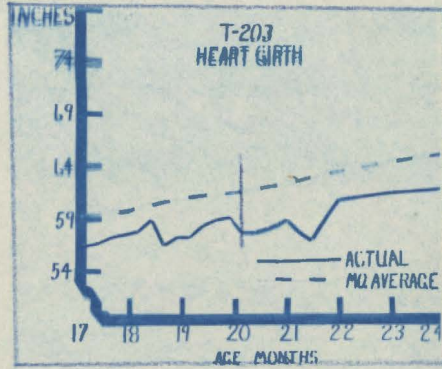
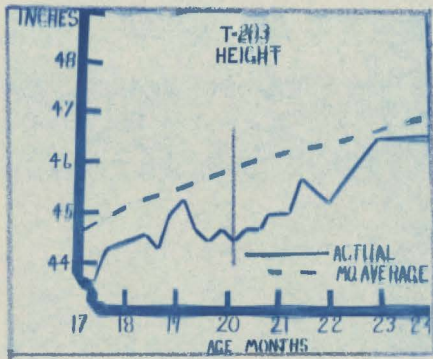
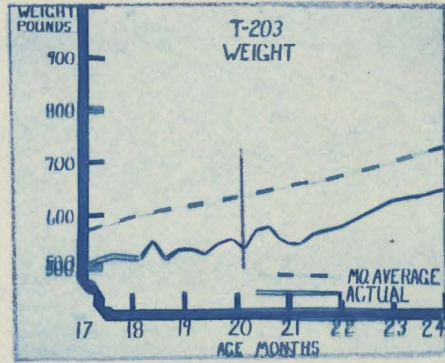
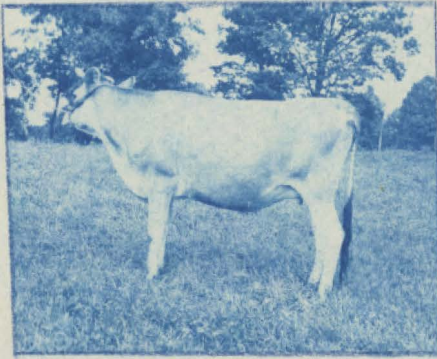


FIGURE 5

COMPARISON OF THE GROWTH MADE BY JERSEY HEIFER T-203 WITH THE AVERAGE GROWTH OF JERSEY HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINES THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.

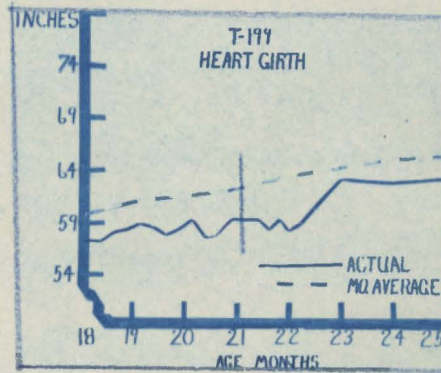
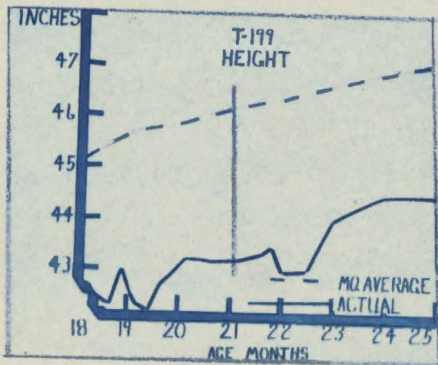
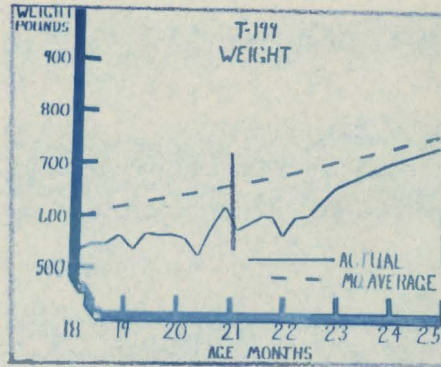


FIGURE 6

COMPARISON OF THE GROWTH MADE BY JERSEY HEIFER T-199 WITH THE AVERAGE GROWTH OF JERSEY HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINES THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.

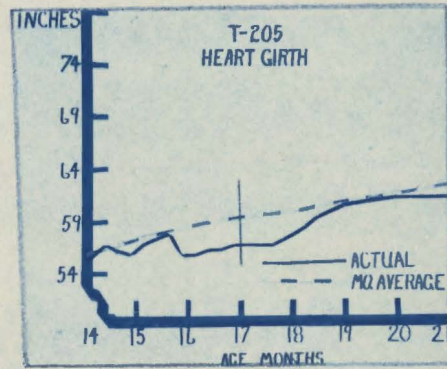
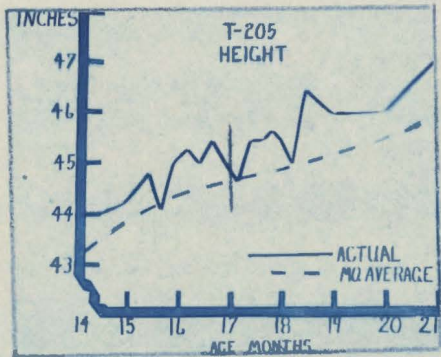
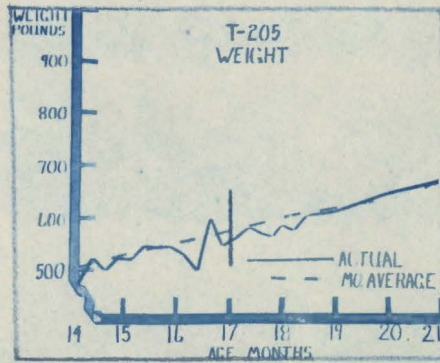
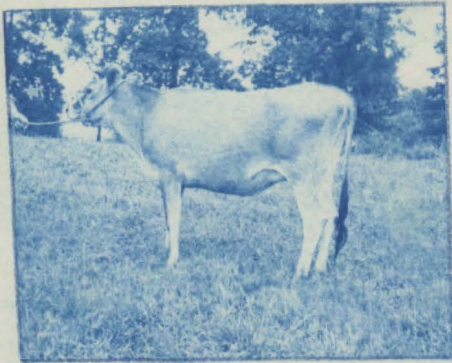


FIGURE 7

COMPARISON OF THE GROWTH MADE BY JERSEY HEIFER T-205 WITH THE AVERAGE GROWTH FOR JERSEY HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINES THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.

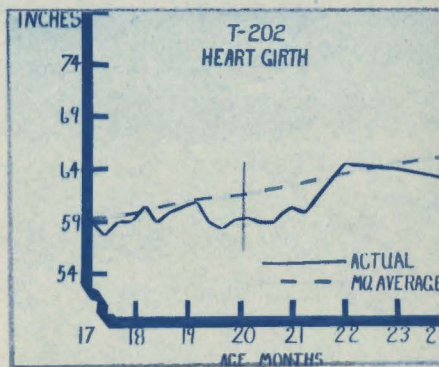
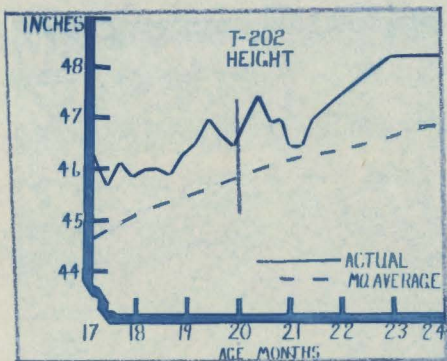
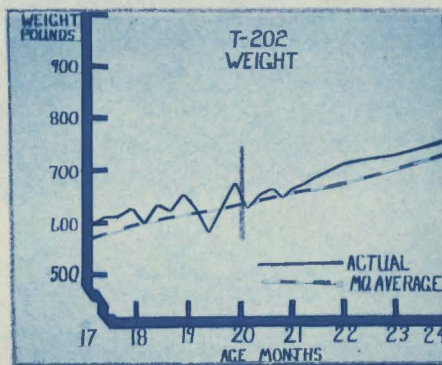


FIGURE 8

COMPARISON OF THE GROWTH MADE BY JERSEY HEIFER T-202 WITH THE AVERAGE GROWTH FOR JERSEY HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINES THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.

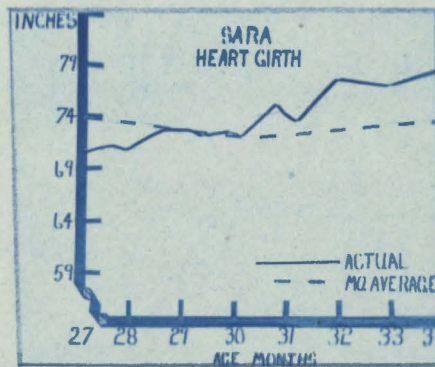
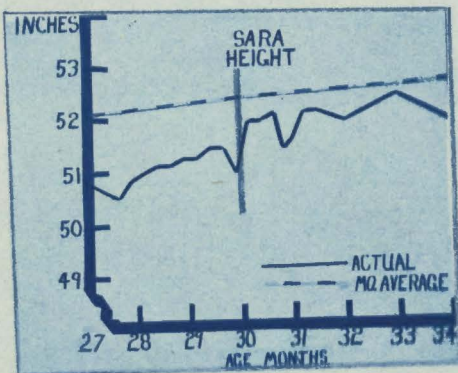
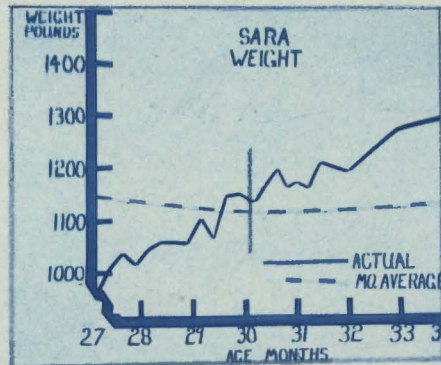


FIGURE 9

COMPARISON OF THE GROWTH MADE BY HOLSTEIN HEIFER SARA WITH THE AVERAGE GROWTH FOR HOLSTEIN HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINES THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.

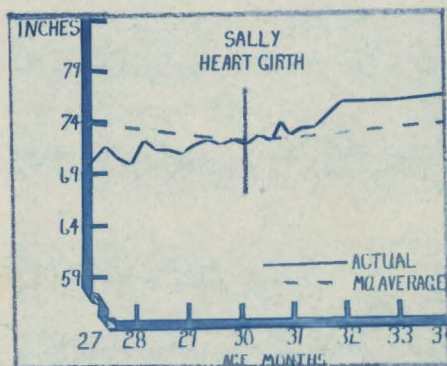
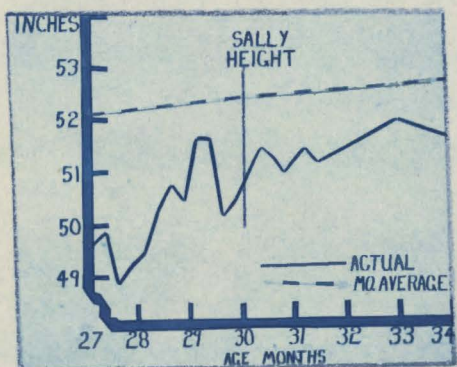
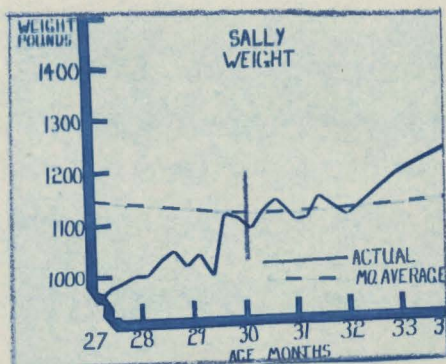
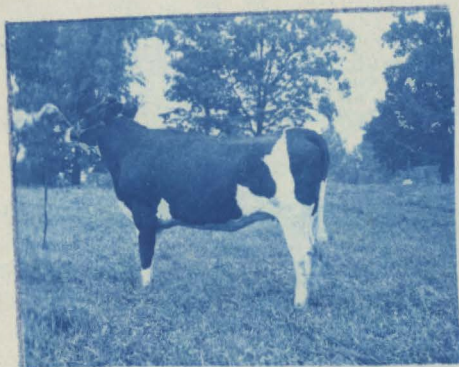


FIGURE 10

COMPARISON OF THE GROWTH MADE BY HOLSTEIN HEIFER SALLY WITH THE AVERAGE GROWTH FOR HOLSTEIN HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINES THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.

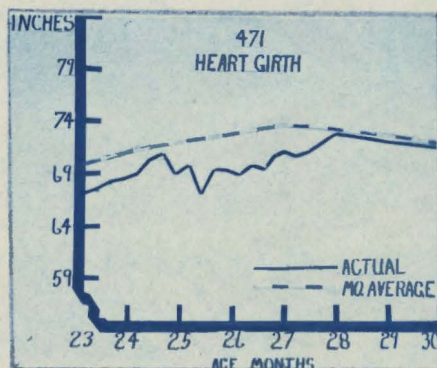
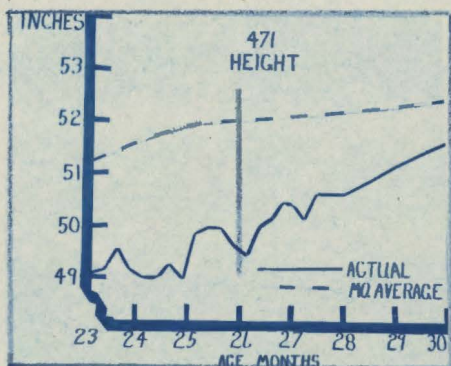
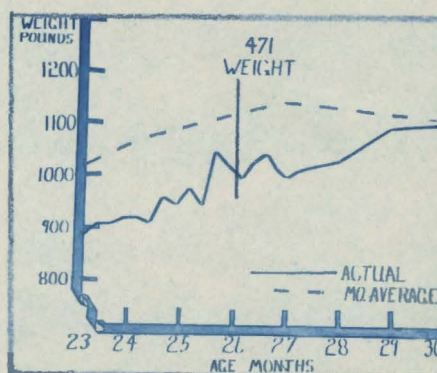


FIGURE 11

COMPARISON OF THE GROWTH MADE BY HOLSTEIN HEIFER 471 WITH THE AVERAGE GROWTH FOR HOLSTEIN HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINES THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.

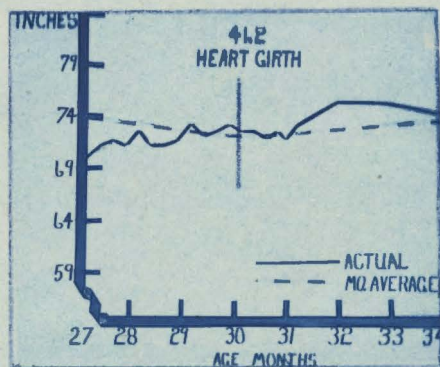
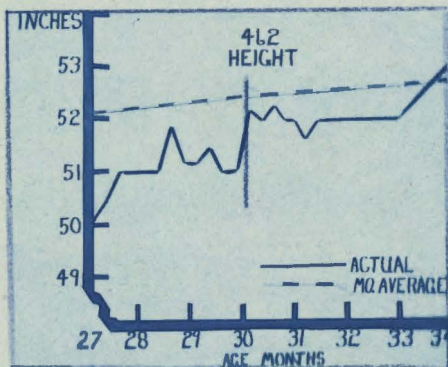
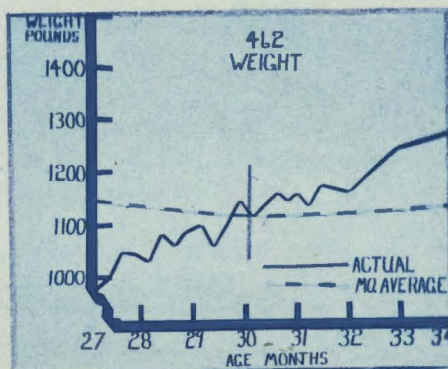


FIGURE 12

COMPARISON OF THE GROWTH MADE BY HOLSTEIN HEIFER 462 WITH THE AVERAGE GROWTH FOR HOLSTEIN HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINES THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.

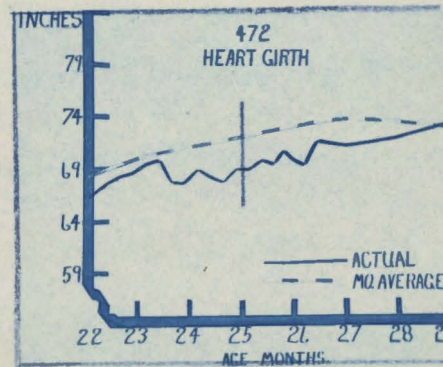
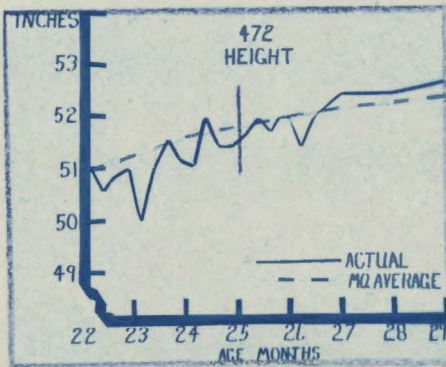
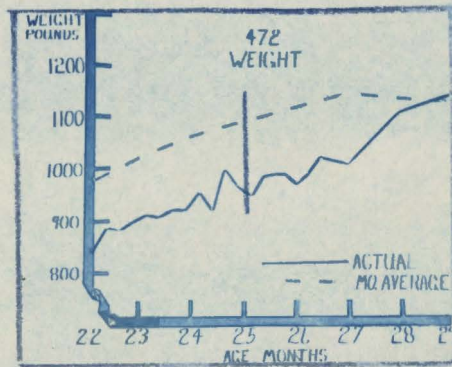


FIGURE 13

COMPARISON OF THE GROWTH MADE BY HOLSTEIN HEIFER 472 WITH THE AVERAGE GROWTH FOR HOLSTEIN HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINES THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.

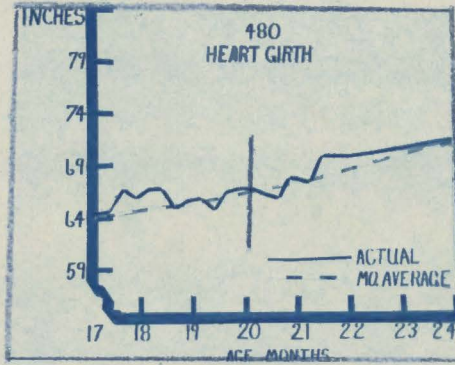
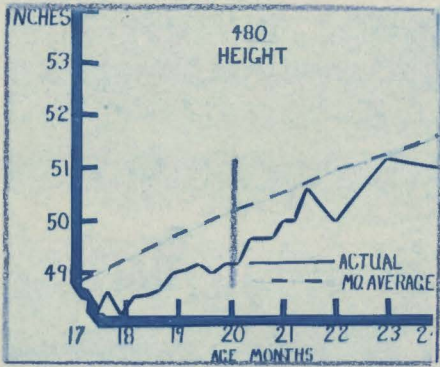
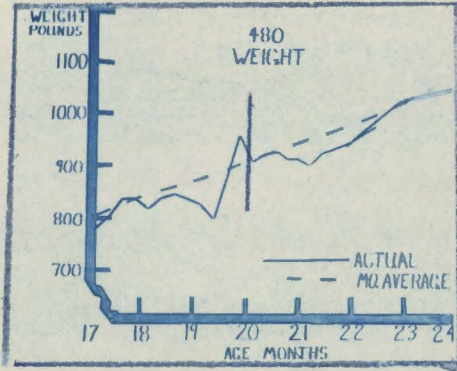


FIGURE 14

COMPARISON OF THE GROWTH MADE BY HOLSTEIN HEIFER 480 WITH THE AVERAGE GROWTH FOR HOLSTEIN HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINES THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.

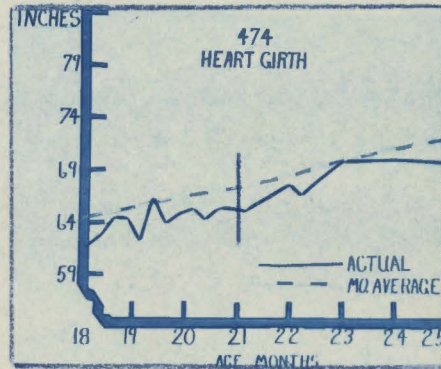
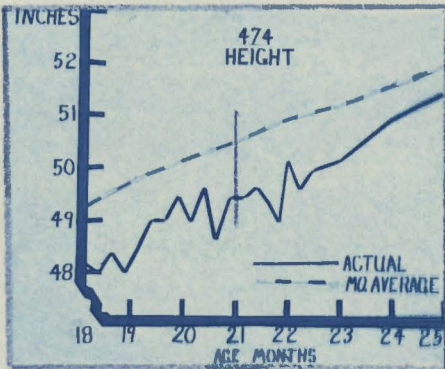
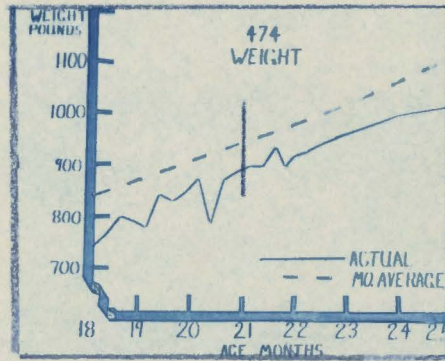


FIGURE 15

COMPARISON OF THE GROWTH MADE BY HOLSTEIN HEIFER 474 WITH THE AVERAGE GROWTH FOR HOLSTEIN HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINES THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.

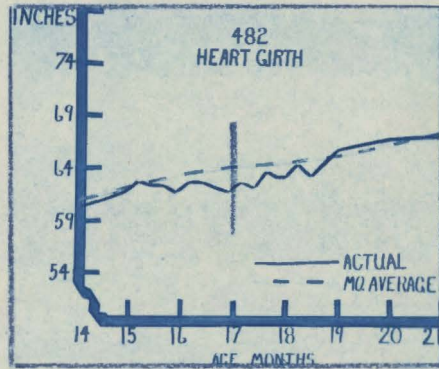
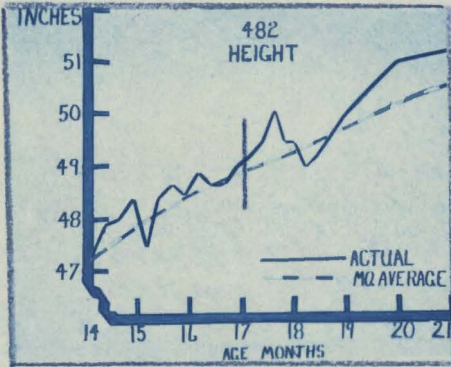
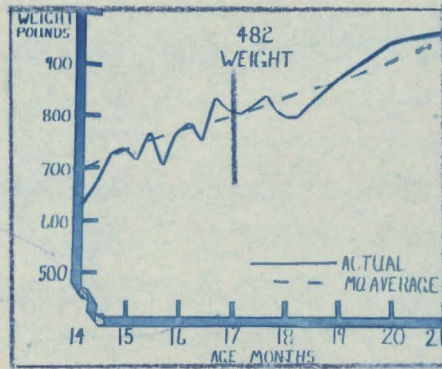


FIGURE 16

COMPARISON OF THE GROWTH MADE BY HOLSTEIN HEIFER 482 WITH THE AVERAGE GROWTH FOR HOLSTEIN HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINES THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.

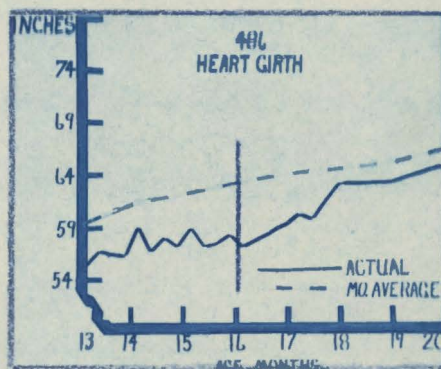
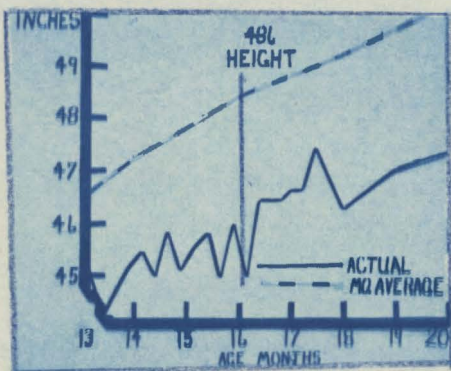
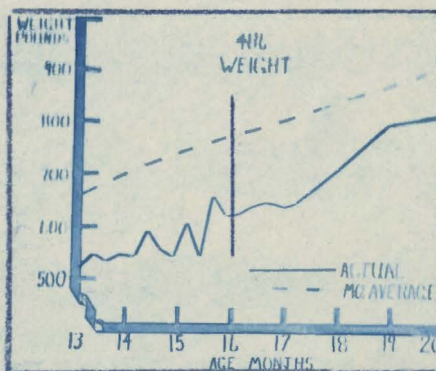


FIGURE 17

COMPARISON OF THE GROWTH MADE BY HOLSTEIN HEIFER 486 WITH THE AVERAGE FOR HOLSTEIN HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINES THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.

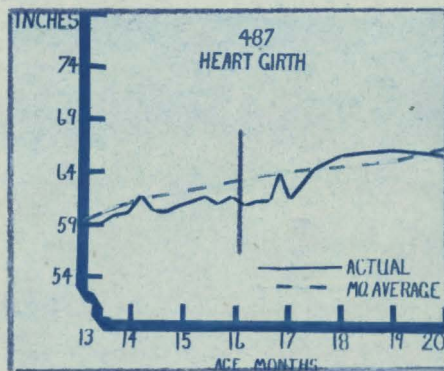
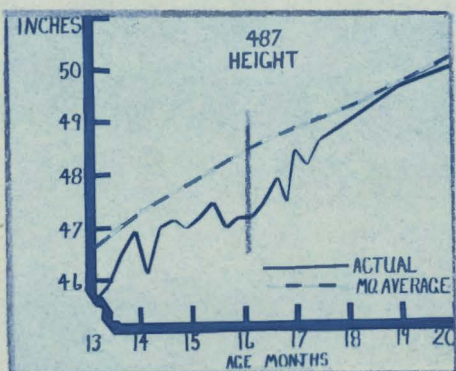
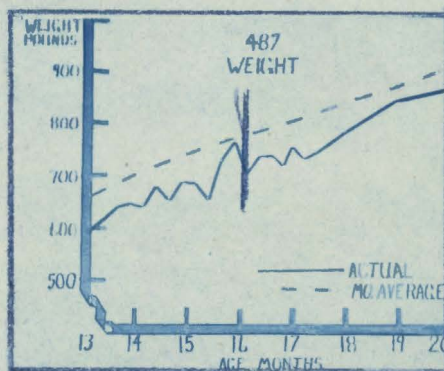


FIGURE 18

COMPARISON OF THE GROWTH MADE BY HOLSTEIN HEIFER 487 WITH THE AVERAGE FOR HOLSTEIN HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINES THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.

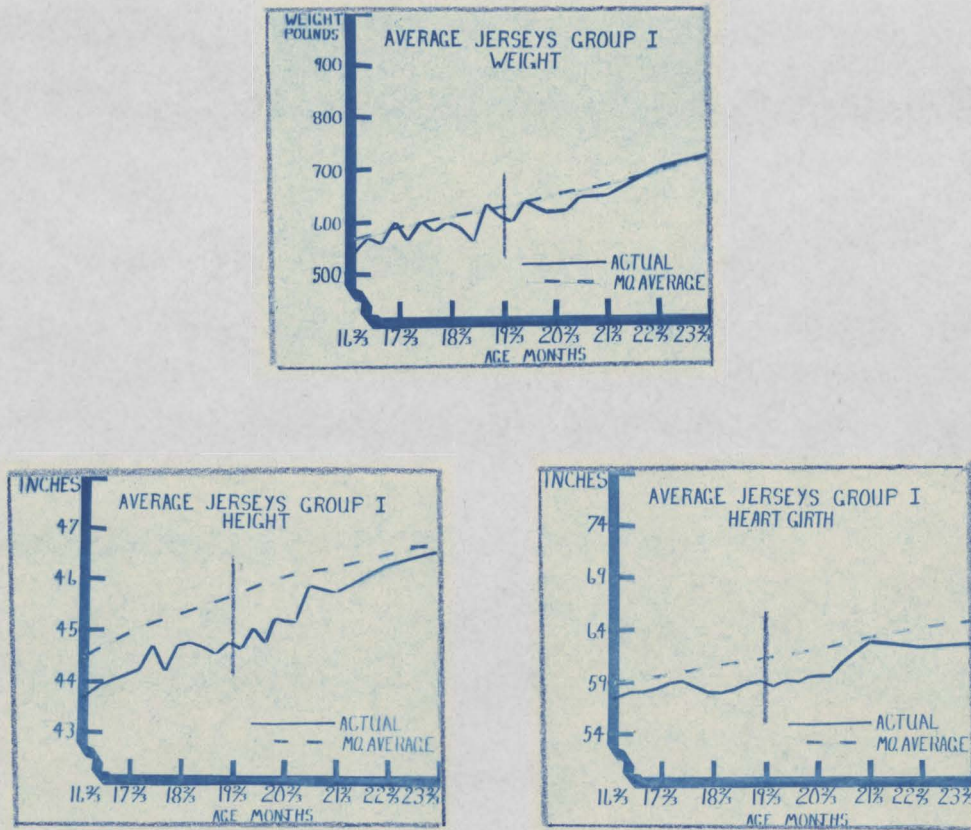


FIGURE 19

COMPARISON OF THE AVERAGE GROWTH MADE BY THE JERSEY HEIFERS FED FIELD-CURED HAY WITH THE AVERAGE GROWTH OF JERSEY HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINES THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.

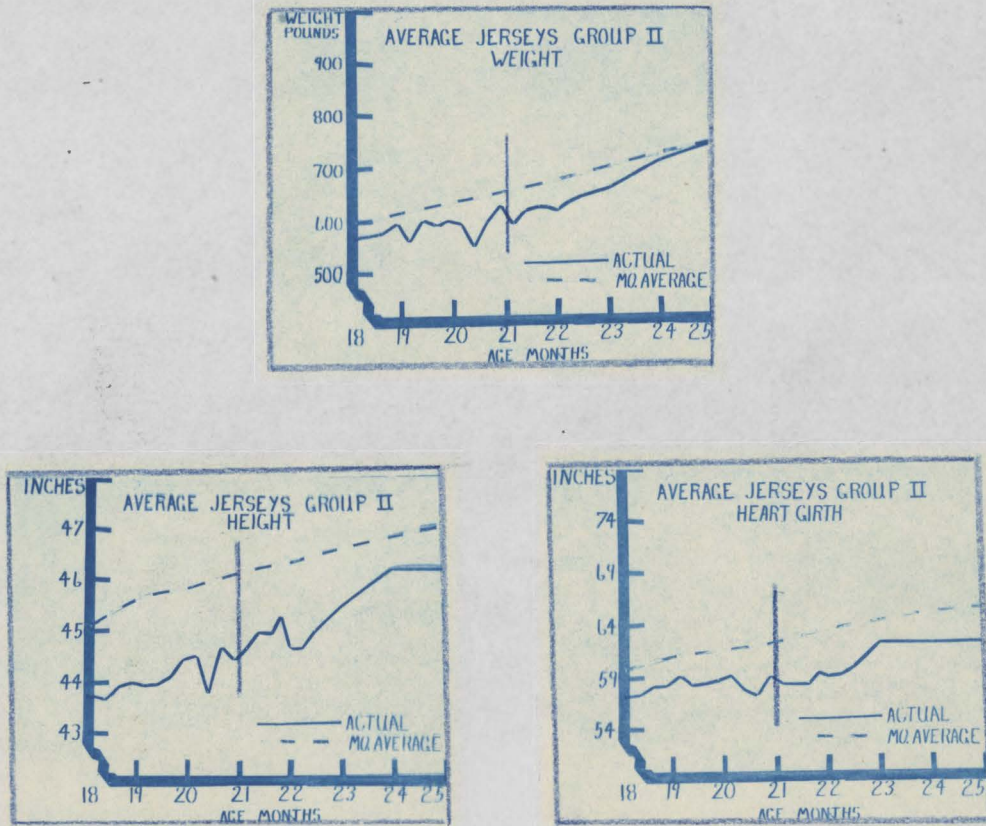


FIGURE 20

COMPARISON OF THE AVERAGE GROWTH MADE BY THE JERSEY HEIFERS FED BIN-CURED HAY WITH THE AVERAGE GROWTH OF JERSEY HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINES THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.

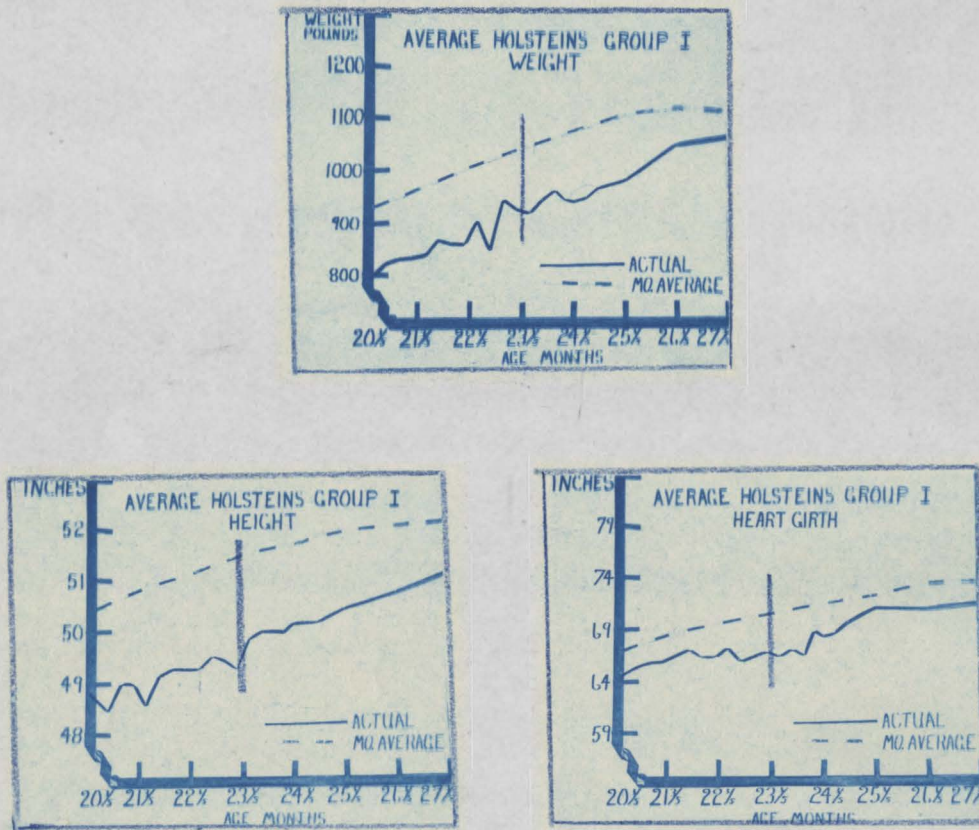


FIGURE 21

COMPARISON OF THE AVERAGE GROWTH MADE BY THE HOLSTEIN HEIFERS FED THE FIELD-CURED HAY WITH THE AVERAGE GROWTH OF HOLSTEIN HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINES THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.

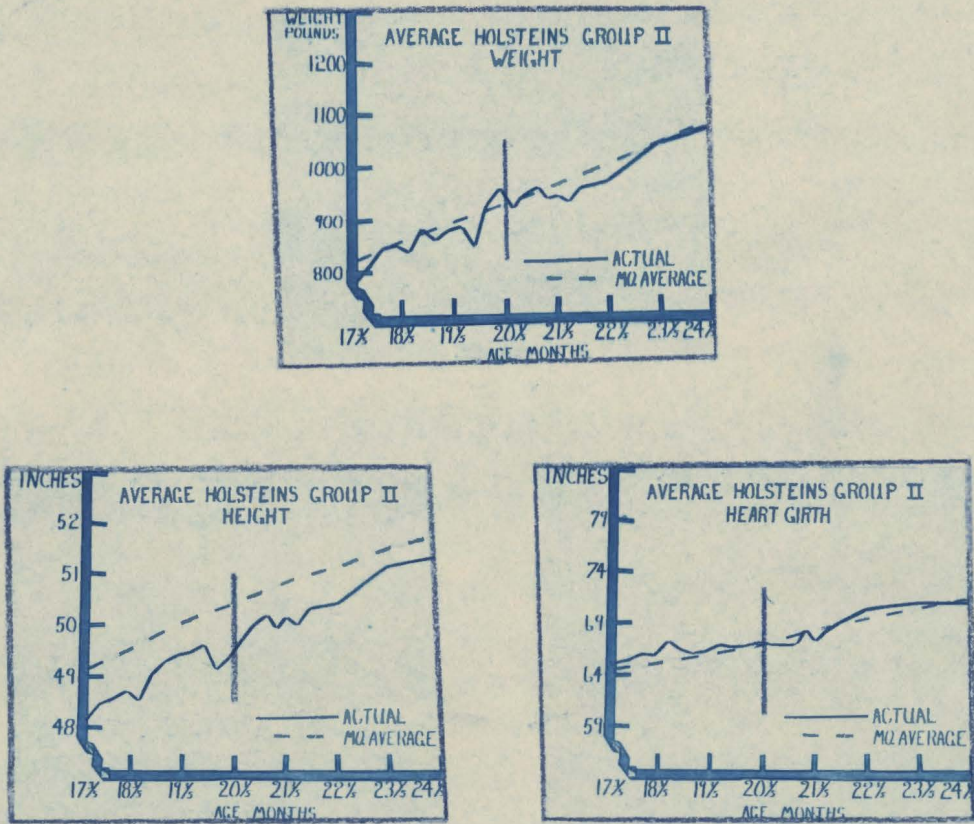


FIGURE 22

COMPARISON OF THE AVERAGE GROWTH MADE BY THE HOLSTEIN HEIFERS FED THE BARN-CURED HAY WITH THE AVERAGE GROWTH OF JERSEY HEIFERS AS SHOWN BY THE MISSOURI "STANDARD". VERTICAL LINES THROUGH CENTER OF GRAPHS INDICATE END OF HAY FEEDING PERIOD.