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TEXAS AGRICULTURAL EXPERIMENT STATION

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COLLEGE STATION, BRAZOS COUNTY, TEXAS

BULLETIN NO. 451 JULY, 1932

DIVISION OF DAIRY HUSBANDRY

THE COMPARATIVE VALUE OF COTTONSEED HULLS AND HAY AS ROUGHAGES FOR GROWING DAIRY HEIFERS

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This Bulletin reports the results of an investigation comparing cottonseed hulls with Bermuda, Sudan, and sorghum hay as the sole dry roughage for growing dairy heifers.

The Bermuda, Sudan, and sorghum hays supplemented with grain, silage, and pasturage when available, proved to be slightly superior to cottonseed hulls as the sole dry roughage for growing dairy heifers. The more rapid growth of the hay group was made during the first 18 months of age, more especially from 6 to 9 months of age. The group fed hulls made slightly greater gains from 18 to 27 months of age. These results indicate that the growth period of the group fed hulls was prolonged.

Differences in growth between the two groups of heifers can be attributed to the difference in amount of productive energy contained in cottonseed hulls and Sudan or sorghum hay, since other feed allowances and treatment of the two groups of heifers were the same.

No differences in breeding performance were observed between the two groups of heifers under the conditions of this experiment where the heifers were allowed access to pasturage more than 6 months each year.

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BULLETIN NO. 451 JULY, 1932

THE COMPARATIVE VALUE OF COTTONSEED HULLS AND HAY AS ROUGHAGES FOR GROWING DAIRY HEIFERS

O. C. COPELAND*

Large quantities of cottonseed hulls are available in the South for feeding purposes as a by-product of the cottonseed-crushing industry. There are produced in Texas annually 429,181 tons (11) of cottonseed hulls, as shown by an average of the last six years. Most of these hulls are fed near the locality where they are produced; however, some of them are shipped to the larger feeding centers.

Fraps (2) of the Texas Station has determined the chemical composition of various feeding stuffs and also the digestion coefficients of these feeds, using sheep for the digestion trials. The productive energy of feeds was calculated by multiplying the chemical composition by the production coefficient, which gives the productive energy of cottonseed hulls as 17.9 therms per 100 pounds, compared with 33.9 therms for Sudan hay and 34.8 therms for sorghum hay. He has also calculated the digestible protein for these roughages, and gives the digestible protein of cottonseed hulls as .36, of Sudan hay as 4.45, and sorghum hay as 2.95.

Most of the experimental work with cottonseed hulls has been done in connection with investigations concerning the feeding of beef cattle and as a roughage for lactating dairy cows. At the Mississippi Station, Lloyd (6) found cottonseed hulls to be slightly superior, pound for pound, to corn silage for fattening four-year-old beef steers, since the group fed cottonseed hulls made an average daily gain of 1.2 pounds per steer compared with an average daily gain of 1.0 pounds per steer for the group fed corn silage. Investigations at the Texas Station by Jones et al. (3) comparing sorgo silage, sorgo fodder, and cottonseed hulls, showed that sorgo silage and sorgo fodder were more satisfactory roughages than cottonseed hulls when fed with ground milo heads and cottonseed meal for fattening calves. The average daily gain for the group fed silage was 2 pounds per head, for the group fed fodder 1.9 pounds per head, and for the group fed cottonseed hulls 1.6 pounds per head. Jones (4) conducted a feeding experiment with beef steers comparing Sumac sorgo fodder with alfalfa hay and sorgo fodder, and alfalfa hay and cottonseed hulls. The group fed sorgo fodder made an average daily gain of 2.6 pounds, compared with 2.5 pounds daily gain per steer for the group fed alfalfa hay and sorgo fodder, and 2.7 pounds daily gain per steer for the group fed alfalfa hay and cottonseed hulls.

Michels (7) compared cottonseed hulls with an inferior quality of corn stover as a roughage for milk cows. His results show the two roughages to be equal in feeding value, since there was no appreciable difference in

*This investigation was planned and supervised by J. L. Lush, Animal Husbandman, Division of Range Animal Husbandry, and Fred Hale, Chief of the Division of Swine Husbandry, Texas Agricultural Experiment Station, until September, 1929.

body weights or milk production between the two groups. Conner (1) concludes that corn stover has a greater value than cottonseed hulls for milk cows. Moore (8) compared Johnson grass hay and cottonseed hulls for dairy cows and states that 15 pounds of well cleaned cottonseed hulls are equal to 10 pounds of prime Johnson grass hay.

It is the prevailing practice over wide regions of the cotton areas or on the marginal cotton areas, to allow the dairy cattle access to pasturage whenever available, but usually these pastures furnish only a small part of the total nutrients required by these animals. Hence, it becomes necessary to supplement the pasturage with some roughage and grain to maintain normal growth and development of the growing animals. Most of this region does not produce all of the hay or other dry roughage that is needed, and because cottonseed hulls are such a convenient and accessible form of dry roughage, they are frequently used for this purpose.

This experiment was planned to find out whether the use of cottonseed hulls in this way, instead of a dry roughage such as Bermuda grass hay, would produce any detectable differences in the development of growing dairy heifers.

PLAN OF EXPERIMENT

This feeding investigation was conducted at the Feeding & Breeding Station dairy at College Station. The experiment was begun in December 1926, and ended in June 1931, covering a period of four and one-half years. Because of the small number of heifer calves available of the same age, it was necessary to add the animals to the experiment as they became available. Therefore, during the progress of the experiment there were heifers in each group between the ages of 3 and 27 months. Some of the heifers used in this study were placed on experiment at 3 months of age. Because other of the available heifers were over 3 months of age when the experiment first started, they were not placed on experiment until 6 months of age. The heifers were weighed and measured at the time they were started on experiment and at 3-month intervals thereafter until parturition, when they were removed from the experiment. There were 13 animals which started on experiment at 3 months of age in the hay group, and 17 animals which started on experiment at 3 months of age in the cottonseed hulls group. Beginning at the 6-month-age interval and continuing through the 21-month-age interval, there were 23 heifers in each group. After the 21-month-age interval some of the heifers had freshened, so that at the 24-month-age interval there were 15 animals in the hay group and 19 animals in the hulls group, and after the 24-month-age interval more of the heifers had freshened; so there were only 8 animals in the hay group and 9 animals in the hulls group which finished through the 27-month-age interval.

Animals

All of the heifer calves from the Feeding and Breeding Station dairy herd which were suitable for experimental purposes, were

ısed in this study. Some of the calves were purebred Jerseys and some vere high-grade Jerseys. The calves comprising the hulls group averaged ınly .13 pound per calf heavier at birth than the calves in the hay group. The animals used in this study were more closely related than would ordinarily be true within a group of heifers this large. For example, 10 of he heifers were half-sisters through one sire, 9 were half-sisters through nother sire, 13 were half-sisters through another sire which was a half-rother to the sire of 12 other half-sisters. There were 5 pairs of half-sisters hrough the dam, and 4 pairs of full sisters. There were 2 dam-aughter pairs.

Feeds Used and Method of Feeding and Management

The heifers were divided into two groups, one group receiving only ottonseed hulls for the dry roughage, and the other group receiving ermuda hay during the first year of the experiment, and Sudan and orghum hays the remainder of the experiment, since Bermuda hay could ot be obtained after the first year of the experiment.

During 1927 and 1928 both groups of heifers were fed grain, silage, nd their respective roughages during the entire time. Both groups of eifers were turned together on the same pasture when pasturage was vailable. Less supplemental feeding was necessary during the late fall, pring, and early summer months when pasturage was good. The pastures onsisted of Bermuda grass, bur clover, and other native grasses. During ıe years 1929 and 1930 from March until October the heifers over 6 ıonths of age were turned on pastures without supplemental feeding. The ılves under 6 months of age were kept in separate pens and fed separately om the older heifers for both groups of heifers. These young calves were d grain at the rate of three pounds per head daily, silage at the rate of pounds per head daily, and hay and hulls ad libitum. The larger heifers ere fed grain at the rate of 3 pounds per head daily, silage at the rate 12 pounds per head daily, and hay and hulls ad libitum. The grain ixture was composed of 300 pounds of ground milo or ground kafir, 100 ounds of wheat bran, 100 pounds of 43 per cent protein cottonseed meal,) pounds of finely ground limestone, and 5 pounds of salt. The silage d during this experiment consisted mainly of sorghum silage, although small amount of corn silage was fed. Block salt and fresh water were ailable to the heifers at all times. Both groups of heifers had access shelter in disagreeable weather and had the same care and attention.

escription of Measurements and Instruments Used in Taking Measurements

Weight and measurements of various parts of the animal body have en used to a considerable extent in studies pertaining to growth (9) in th beef and dairy cattle. Weight alone is not an adequate means of scribing the growth and development of an animal, since weight is fected to such a great extent by degree of fatness. Measurements of rious parts of the animal body furnish additional means of describing e animal, and when carefully taken are reasonably accurate, but most easurements are also affected to a certain extent by degree of fatness,

while others are affected by the standing position of the animal and the pressure with which the operator applies the measuring instruments.

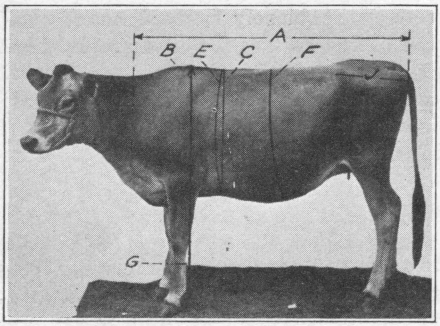

Figure 1. Side view of Jersey heifer with a diagram showing the location of the various measurements (lettering explained in the text).

The heifers were led onto a level scale platform for taking the measurements. One person did the measuring while another recorded the results. The readings were taken to the nearest millimeter on all measurements. As a precaution against the possibility that the animals would be standing in an abnormal position, each heifer was measured three consecutive times, the standing position of the heifer being changed between one set of measurements and the next; an average of the three measurements was used in the calculations. Body weight and ten different body measurements were used to determine the growth of the heifers. The measurements used were as follows:

Body Length—(Figure 1, A); This was the distance from the extreme anterior point of the shoulder to the extreme posterior point of the pin bone.

Height at Withers—(Figure 1, B); This was the vertical distance from the highest point over the withers to the ground.

Chest Depth—(Figure 1, C); This was the smallest vertical outside diameter of the chest measured with the parallel

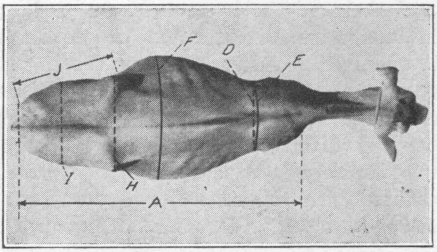

Figure 2. Top view of Jersey heifer with a diagram showing location of the various measurements (lettering explained in the text).

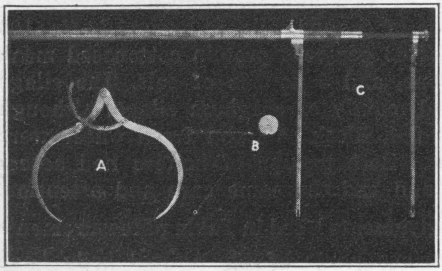

Figure 1. Instruments used in taking measurements of dairy heifers: (A) caliper used for measurements of pelvic region; (B) steel tape for measuring girths and circumferences; and (C) cattle-measuring standard with spirit level attached, Lydtin's Model.

Chest Width—(Figure 2, D); This was the greatest width of the chest just behind the shoulders.

Heart Girth—(Figure 1, E); This was measured with the steel tape drawn snugly around the body at its smallest circumference.

Paunch Girth—(Figure 1, F); This was the greatest circumference of the body.

Cannon Circumference—(Figure 1, G): The steel tape was drawn snugly around the foreleg at the smallest place between the knee and the fetlock joint to obtain this measurement.

Width at Hooks—(Figure 2, H): The caliper was placed on the extreme

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lateral point of the hooks on one side and on the corresponding point at the other side for the measurement.

Width of Pelvis—(Figure 2, I): The points of the caliper were placed snugly just lateral to the hip joint on each side of the pelvis for this measurement.

Length of Pelvis—(Figure 2, J): This was the distance from the extreme posterior point of the pin bone to the extreme anterior point of the hook bone on the same side, so far as that could be located definitely on the animal. The caliper was used.

EXPERIMENTAL RESULTS

Body Weight

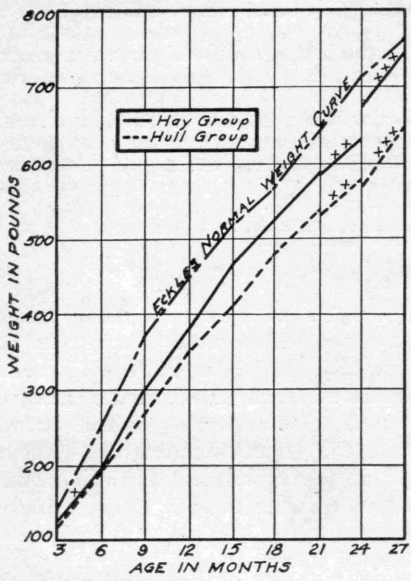
A statistical analysis of the body weights of both groups of heifers is shown in Table 1. As already mentioned, there were changes in the number of animals on experiment at the 6, 21, and 24-month-age intervals. The first 6-month age-interval shown in the tables for the statistical analysis of body weights and measurements, applies to the group which started on experiment at 3 months of age, and the second 6-month-age interval applies to the animals which were added to the experiment at the 6-month-age interval in addition to the animals which were already on experiment. The first 21-month-age interval applies to the animals which finished through that age interval, and the second 21-month-age interval applies to the animals which remained on experiment after the 21-month-age interval. The first 24-month-age interval gives the results for the animals which finished through that age interval, and the second 24-month-age interval gives the results for the animals which remained on experiment after that age interval.

Table 1. Statistical Analysis of Body Weights in Pounds

Age	Hay Group			Hulls Group			Difference and Probable Error
	No. of Animals	Mean and Probable Error	Standard Deviation	No. of Animals	Mean and Probable Error	Standard Deviation	
3 Mo.	13	115.1± 3.01	16.07	17	111.5± 2.37	14.47	3.6± 3.83
6 Mo.	13	191.9± 6.93	37.04	17	190.1± 4.00	24.48	1.8± 8.00
6 Mo.*	23	192.2± 5.07	36.02	23	191.0± 3.31	23.55	1.2± 6.05
9 Mo.	23	296.7± 6.74	47.93	23	268.2± 5.99	42.58	28.5± 9.02
12 Mo.	23	377.7± 7.70	54.75	23	344.1± 8.69	61.79	33.6±11.61
15 Mo.	23	457.3± 7.92	56.29	23	411.9± 9.63	68.46	45.4±12.47
18 Mo.	23	524.2±10.67	75.90	23	470.0±11.64	82.74	54.2±15.79
21 Mo.	23	588.5±10.50	74.64	23	538.5±12.74	90.56	50.0±16.51
21 Mo.**	15	582.9±12.81	73.55	19	527.5±12.88	83.21	55.4±18.16
24 Mo.	15	637.2±12.76	73.25	19	583.2±14.50	93.69	54.0±19.31
24 Mo.**	8	675.1±18.87	79.13	9	567.3±21.45	95.41	107.8±28.57
27 Mo.	8	756.9±24.99	104.80	9	653.4±29.47	131.05	103.5±38.64

*Increase in number of animals on experiment.
**Decrease in number of animals on experiment.

The mean body weights of both groups of heifers at the different age intervals are shown in Figure 4, along with Eckle's normal weights for Jersey heifers. As shown in the graph, both groups of heifers are below Eckle's normal weights for Jerseys; however, the group fed hay more nearly approaches the normal weight at each age interval than does the hulls group. At 21 months of age, before some of the animals were removed from the experiment, the hay group was 90.7 per cent of the normal weight, and the hulls group was 83.0 per cent of the normal weight.



× increase in number of animals on experiment
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Figure 4. Body Weight in Pounds

The average gains in body weights between each age interval are shown in Figure 5. The group fed hay made larger gains from the 6-month-age interval through the 18-month-age interval, after which time the gains made by the group fed cottonseed hulls slightly exceeded the gains made by the group fed hay. The largest difference between the average gains between the two groups of heifers was from the 6- to the 9-month-age interval, when the mean gain of the group fed hay was 27.3 pounds more than the mean gain of the group fed hulls. It can be seen from Figure 5 that during the last age interval there was a decided increase in the rate of gain for both groups of heifers. This age interval consisted of the last three months of the gestation period for most of the heifers, when we expect a more rapid increase in weight due to fetal development.

There was considerable variation in body weight and measurements among the animals in the same group. It was believed that a considerable part of this variation within each group was due to seasonal variation. For example, we would not expect a heifer to make as rapid growth when started on experiment in July or August when the weather was hot and dry and the pasture rather poor, as a heifer which started on experiment in March, April, or May when the pasturage was good and the weather cooler. In view of this seasonal variation, as many of the heifers as possible were paired as to the month and year of starting on experiment, in calculating the results of body weight. Ten pairs of heifers were suitable for pairing as to the time of going on experiment.

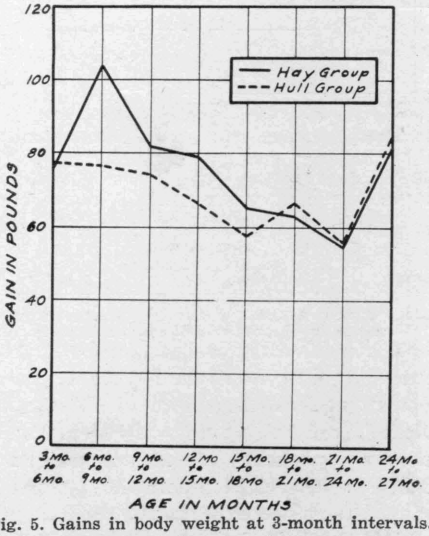

Fig. 5. Gains in body weight at 3-month intervals.

The gains in body weight from the 3-

month-age interval through the 21-month-age interval gave odds of about 163:1 against the difference shown in favor of the hay group being a chance difference when subjected to Students' Method (10) for interpreting paired experiments. When the gains in body weight from the 3-month-age interval through the 18-month-age interval were calculated, the odds were more than 10,000:1 against the difference shown in favor of the hay group being a chance difference. In calculating the gains in body weight between each successive age interval by Students' Method for the ten pairs of heifers, it was found that the only interval where significant odds resulted was from the 6- to the 9-month-age interval, when the odds were about 1,428:1 in favor of the hay group. These results are very similar to the results given in Figure 5, where the greatest difference in mean gains between the two groups of heifers was from the 6- to the 9-month-age interval.

Body Length

A statistical analysis for the body length is given in Table 2. Unlike the results shown for body weight, there was not a significant difference in the mean body lengths between the two groups of heifers until the 15-month-age interval. There is a striking similarity in the increase shown for body length and body weight at the 9-month-age interval, as shown in Tables 1 and 2. The size of the mean differences from one age interval to another are quite irregular and as a whole not as significant as the differences shown for body weight. However, from the 15-month-age interval through the 24-month-age interval, the difference in body length between the two groups of heifers were significant, in favor of the group fed hay. Body length is affected only slightly by degree of flesh carried by the animal; hence this measurement gives a good indication as to skeletal growth of the animal.

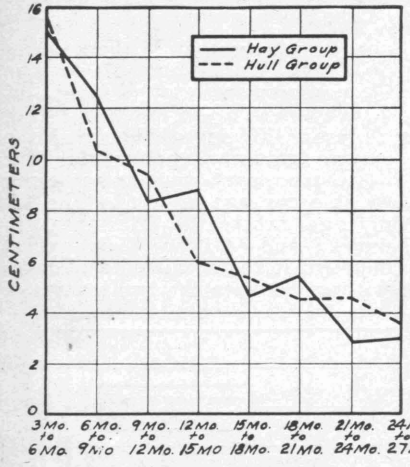

Figure 6. Gains in Body Length at Three-month Intervals.

Figure 6 shows the gains in body length made by each group of heifers between age intervals. It is shown in this graph that gains in body length decreased

Table 2. Statistical Analysis of Body-Length Measurements in Centimeters

Age	Hay Group			Hulls Group			Difference and Probable Error
	No. of Animals	Mean and Probable Error	Standard Deviation	No. of Animals	Mean and Probable Error	Standard Deviation	
3 Mo.	13	72.3±0.80	4.27	17	71.1±0.74	4.55	1.2±1.09
6 Mo.	13	86.8±1.15	6.15	17	86.7±0.88	5.38	0.1±1.45
6 Mo.*	23	87.1±0.83	5.91	23	87.2±0.74	5.27	−0.1±1.11
9 Mo.	23	99.7±0.72	5.14	23	97.5±0.88	6.26	2.2±1.14
12 Mo.	23	108.1±0.73	5.15	23	106.8±1.05	7.45	1.3±1.27
15 Mo.	23	116.9±0.60	4.28	23	112.8±0.96	6.85	4.1±1.14
18 Mo.	23	121.7±0.67	4.79	23	118.0±1.07	7.58	3.7±1.26
21 Mo.	23	127.0±0.70	4.99	23	122.7±1.09	7.72	4.3±1.29
21 Mo.**	15	127.6±0.89	5.11	19	122.0±1.12	7.26	5.6±1.43
24 Mo.	15	130.5±0.79	4.51	19	126.7±1.01	6.53	3.8±1.28
24 Mo.**	8	132.9±1.15	4.82	9	126.4±1.50	6.67	6.5±1.89
27 Mo.	8	135.3±1.45	6.06	9	129.7±1.62	7.22	5.6±2.17

*Increase in number of animals on experiment.
**Decrease in number of animals on experiment.

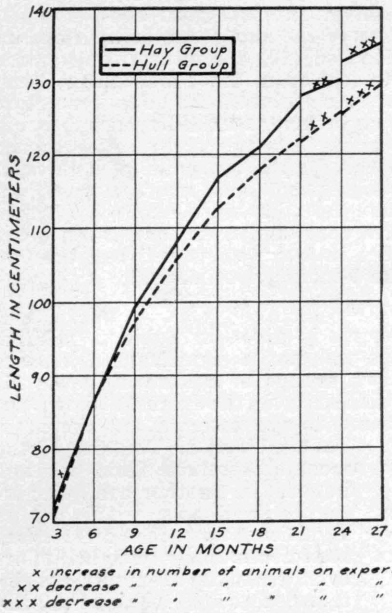

Figure 7. Body Length in Centimeters

with age in both groups of heifers. There was great irregularity in raté of gain in body length for both groups of heifers, and a greater irregularity in rate of gain for the hay group than for the hull group.

Figure 7 represents the mean body length for both groups of heifers at the various age intervals. At the 6-month-age interval the mean body length of the hulls group was slightly greater than the mean body length of the hay group; however, from the 6-month-age interval thru the remainder of the experiment, the mean body lengths of the hay group were greater than the mean body lengths of the hulls group.

Height at Withers

A statistical analysis for the measurements of height at withers is given in Table 3. The mean differences between the two groups of heifers for this measurement were rather small at every age interval. The 12- and 15-month-age intervals were the only ages where the difference approached significance, the differences being 2.8 and 3.2 times their respective probable errors. Hence, it is very doubtful if there existed a statistically significant difference in height at withers between the two groups of heifers.

As shown in Figure 8, the mean gains in height at withers were greater for the hay group between four of the age intervals and greater for the hulls group between the remaining four age intervals. However, the larger gains made by the hay group were made from the 6- through the 15-month-age intervals, which corresponds to the gains in body weight and body length as to the age of the heifers when the hay group made the more rapid gains.

The means for height at withers are shown in Figure 9 for both groups of heifers at each age interval. With the exception of the 6-month-age interval, the means for height at withers were greater for the hay group than for the hulls group at every age interval, al-

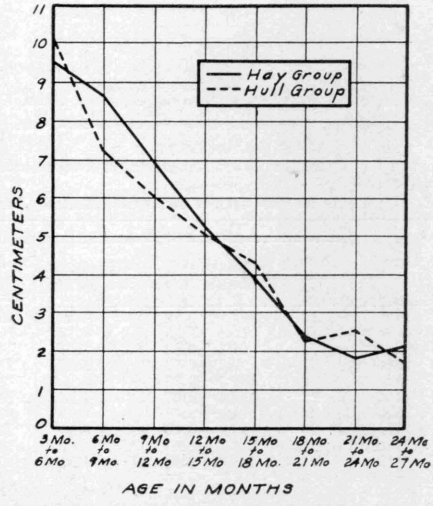

Figure 8. Gains in Height at Withers at Three-month Intervels.

though this mean difference was small, and very likely not significant, as shown in Table 3.

Table 3. Statistical Analysis of Height-at-Withers Measurements in Centimeters

Age	Hay Group			Hulls Group			Difference and Probable Error
	No. of Animals	Mean and Probable Error	Standard Deviation	No. of Animals	Mean and Probable Error	Standard Deviation	
3 Mo.	13	76.1±0.76	4.05	17	75.6±0.49	3.00	0.5±0.92
6 Mo.	13	85.7±0.74	3.95	17	85.7±0.53	3.21	0.0±0.91
6 Mo.*	23	85.4±0.57	4.05	23	85.7±0.41	2.91	−0.3±0.70
9 Mo.	23	94.1±0.39	2.78	23	92.9±0.58	4.13	1.2±0.70
12 Mo.	23	101.0±0.45	3.23	23	98.9±0.59	4.16	2.1±0.74
15 Mo.	23	106.2±0.23	1.61	23	104.0±0.65	4.63	2.2±0.69
18 Mo.	23	110.1±0.44	3.10	23	108.4±0.57	4.03	1.7±0.72
21 Mo.	23	112.5±0.42	3.00	23	110.6±0.55	3.94	1.9±0.70
21 Mo.**	15	112.6±0.52	3.00	19	110.2±0.56	3.59	2.4±0.76
24 Mo.	15	114.5±0.54	3.12	19	112.8±0.55	3.55	1.7±0.77
24 Mo.**	8	115.8±0.79	3.33	9	113.4±0.57	2.54	2.4±0.98
27 Mo.	8	118.0±0.93	3.90	9	115.1±0.81	3.61	2.9±1.23

*Increase in number of animals on experiment.
**Decrease in number of animals on experiment.

Other measurements

Eight other measurements were taken of the heifers in measuring the growth and development of the animals. These measurements were as follows: chest depth, chest width, heart girth, paunch girth, cannon circumference, width at hooks, width of pelvis, and length of pelvis. The data on these measurements were analyzed in the same manner as those already given for body weight, body length, and height at withers. There was a statistically significant difference in the means for these measurements between the two groups of heifers in favor of the group fed hay, with the exception of paunch girth and canon circumference.

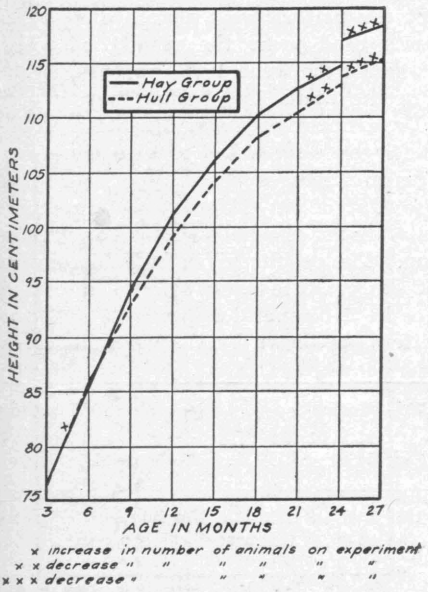

Figure 9. Height at Withers in Centimeters.

Summarizing the results of all measurements studied in an attempt to detect any noticeable differences in growth and development between the two groups of heifers, there were seven of the body measurements and body weight which showed statistically significant differences in favor of the group fed hay and three measurements that did not show statistically significant differences. However, the mean differences for these three measurements were in favor of the group fed hay.

Feed Consumed

During the entire experiment there were 102,301 pounds of hay fed compared with 97,829 pounds of hulls. There was considerable more waste

in feeding the hay than hulls. During the years 1930 and 1931 the sorghum hay fed was produced in 1928 and was of a rather poor quality, since it was not baled and many of the leaves had shattered off. It is estimated that of this hay weighed in to the heifers, at least 25 per cent was refused. From our observations it is believed that the cottonseed hulls were just as palatable as the hay and can be fed with less waste.

Breeding Performance

Breeding records were kept for both groups to find out whether or not the use of cottonseed hulls as the only dry roughage for dairy heifers would have any effect on reproduction. Twenty heifers out of a total of 23 in the hay group calved normally and required an average of 1.15 services per conception. Three heifers were sold as nonbreeders from the hay group. Twenty-two out of 23 heifers in the hulls group calved normally and required 1.18 services per conception. The other heifer in this group has been bred two times and has not conceived. These results indicate that under the conditions of this experiment, where the heifers were allowed access to pasturage, which consisted of Bermuda, some bur clover, and native grasses, more than half of each year, the breeding performance of the heifers was not impaired by using cottonseed hulls as the sole dry roughage.

Placings and Scorings

In connection with another project the heifers were placed and scored according to type and condition twice each year, the results of which are given in Table 4. This was not begun until June 1928, and the results of six different scorings are given in the table. The heifers were placed and scored by professors from the Department of Dairy Husbandry, who are recognized dairy cattle judges, and who were asked to give more consideration to condition and thriftiness and less to breed type than when animals are placed in the show ring. Out of six different scorings there were two scorings in which the mean score for the hulls group was greater than the mean score of the hay group. The results given in Table 4 show that so far as recognized judges of dairy cattle were able to determine there was not a significant difference in the general appearance and condition between the two groups of heifers, as shown by the average scores.

Table 4. Results of Scoring

		June 1928 Scoring		November 1928 Scoring
Hay-fed Heifers	(21 head)	73.0±0.96	(24 head)	80.7±1.01
Hull-fed Heifers	(18 head)	66.3±1.86	(22 head)	77.0±1.12
Difference		6.7±2.09		3.7±1.51
		June 1929 Scoring		**November 1929 Scoring**
Hay-fed Heifers	(17 head)	76.4±1.45	(14 head)	75.1±1.44
Hull-fed Heifers	(17 head)	72.2±1.91	(17 head)	75.7±1.19
Difference		4.2±2.40		−0.6±1.87
		June 1930 Scoring		**November 1930 Scoring**
Hay-fed Heifers	(11 head)	68.1±2.07	(11 head)	69.3±1.81
Hull-fed Heifers	(13 head)	74.5±1.79	(11 head)	68.6±1.51
Difference		−6.4±2.74		0.7±2.36

DISCUSSION

In this study to determine the value of cottonseed hulls as compared with hay as the dry roughage for growing dairy heifers, weight and ten body measurements were taken at 3-month intervals to measure the growth of the heifers. After the 6-month-age interval the average weights and measurements of the hay group were greater at each age interval than the average weights and measurements of the hulls group. The group fed hay averaged 50 pounds heavier per heifer than the group fed hulls at 21 months of age, a difference which is 5.5 per cent of the average weight of a mature Jersey cow, and 7.7 per cent of the normal weight of Jersey heifers 21 months of age. The more rapid gains made by the group fed hay in body weight and most of the body measurements were made from 6 to 9 months of age. This is the age when calves first begin to eat any appreciable quantities of roughage. The larger gains (in body weight and body measurements) made by the group fed hay were cumulative up to 18 months of age, after which time the group fed hulls made slightly greater gains.

The productive energy of cottonseed hulls is somewhat lower than the productive energy of Sudan and sorghum hays, as shown by figures given in the introduction. The differences in growth between the two groups of heifers can be attributed to the difference in amount of productive energy contained in cottonseed hulls and Sudan or sorghum hay, since the other feed allowances and treatment of the two groups of heifers were the same. From these results we may assume that cottonseed hulls may be used as the sole dry roughage for growing dairy heifers when a more liberal supply of grain is fed to provide the required amount of productive energy for normal growth, under the conditions of this experiment where the animals are allowed access to pasturage at least six months each year.

Since the group fed hay made slightly greater gains in body weight and measurements during the first 18 months of age, after which time the gains made by the hulls group were slightly greater, we may conclude that the growing period of the hulls group was prolonged. It has been shown by Waters (12) that young animals may reach normal size by prolonging the growth period, caused by short periods of undernourishment of the growing animals. However, if these undernourishment periods extend for a year or more, Moulton et al. (9) have shown that the skeletal growth, with the exception of height at withers, of the animals is permanently below normal, even though followed with a long period of heavy feeding.

The most important result of feeding liberal rations to growing dairy heifers is early maturity. From the results of this investigation we conclude that when cottonseed hulls are used as the only dry roughage for growing dairy heifers, it will be necessary to supply a more liberal grain ration than when Bermuda, Sudan, or sorghum hay is used as the roughage to maintain normal growth of the animals. When hulls are used as the only dry roughage with a limited amount of grain feeding, the growth period is prolonged. Further investigations are necessary to find at what age maturity is reached or whether normal size can ever be reached.

SUMMARY

Two groups of Jersey heifers, consisting of 23 animals each, were used in this study to determine the value of cottonseed hulls compared to Bermuda, sorghum, and Sudan hay as the sole dry roughage for growing dairy heifers. Body weight and ten body measurements were taken at 3-month intervals to measure the growth of the animals.

The group of heifers fed hay averaged 50 pounds heavier at 21 months of age than the group fed hulls. There were significant differences in body measurements, with the exception of height at withers, paunch girth, and cannon circumference, in favor of the group fed hay.

The more rapid growth of the hay group was made during the first 18 months of age, especially from 6 to 9 months of age. The hulls group made slightly greater gains from 18 to 27 months of age. These results indicate that the growth period of the group fed hulls was prolonged.

The differences in growth between the two groups of heifers can be attributed to the difference in amount of productive energy contained in cottonseed hulls and Sudan or sorghum hay, since the other feed allowances and treatment of the two groups of heifers were the same.

Under the conditions of this experiment, where the heifers were allowed access to pasturage, more than 6 months each year, the breeding performance of the heifers was not impaired by using cottonseed hulls as the sole dry roughage.

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