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Comparative Feeding Value of

Different Silages

for the

Production

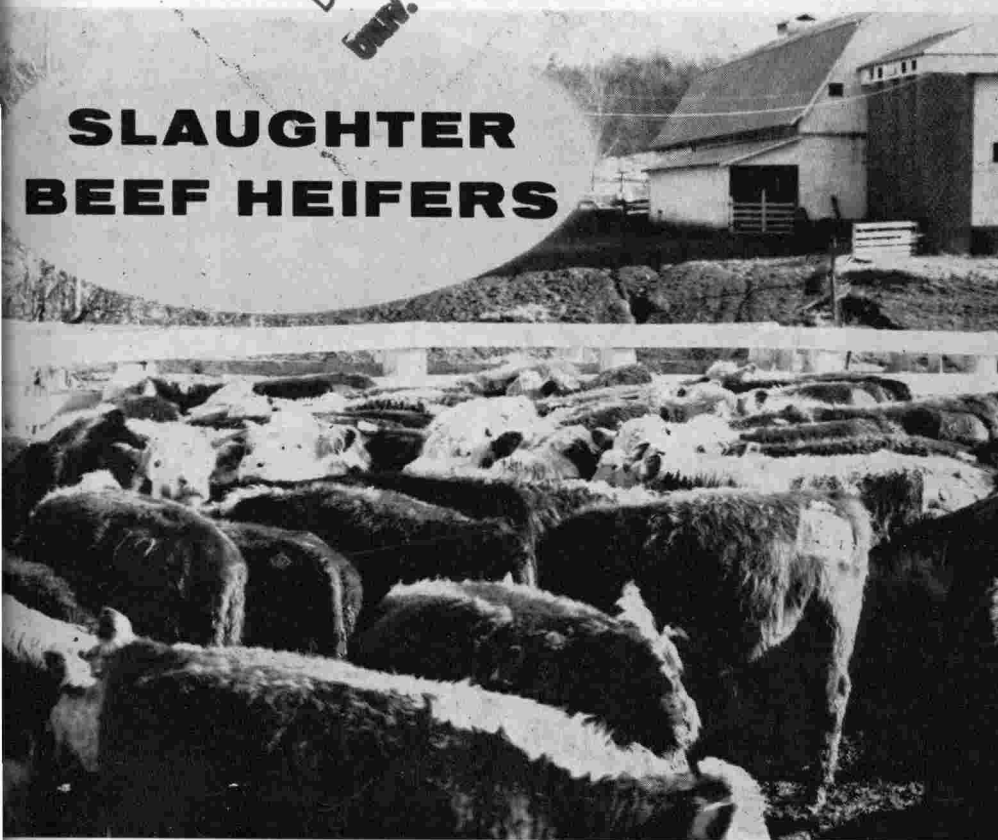
of

by

O. Glen Hall

J. Hugh Felts

SLAUGHTER BEEF HEIFERS



THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXPERIMENT STATION
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Cover:

Beef heifer calves used in one of the experiments reported in this bulletin. The barn and small silos used in the experiments are shown in the background.

SUMMARY

SIX EXPERIMENTS involving 264 beef heifer calves were conducted at the Tobacco Experiment Station to determine the comparative feeding value of different silages when supplemented with a limited amount of concentrates for the production of slaughter beef heifers. The heifers were fed a high silage—low concentrate ration for about 120-140 days during the fall and winter, followed by a full-feed of concentrates for 56-90 days. The heifers were sold for slaughter in early May, generally, when they graded Good in condition and had attained a weight of 750-800 pounds.

● In the first series of three experiments, corn, sorghum, orchardgrass-ladino clover (preserved with molasses), and small grain silages were compared. In the second series of three experiments, alfalfa, orchardgrass-ladino clover (chemically preserved), orchardgrass-ladino clover (preserved with molasses), and small grain silages were fed to the heifers. The major results may be summarized as follows:

1. In the first series of experiments - - -
 - a. Daily gains of calves fed corn silage and orchardgrass-clover silage rations averaged about 1.70 pounds per head for the three experiments. Slightly over 700 pounds of air-dry feed were required per hundredweight gain and feed costs were only 11.3-11.6 cents per pound of gain. The performance of the calves fed the orchardgrass-clover silage ration was consistently equal to that of calves fed the corn silage ration.
 - b. Calves fed the sorghum silage ration gained 0.1 pound per head daily less than those fed corn and grass silage rations, but this difference was not statistically significant.
 - c. Performance of the calves fed the small grain silage ration was significantly inferior to that of the other groups of calves. These calves averaged only 1.23 pounds gain per head daily, and they required 868 pounds of air-dry feed per hundredweight gain.
2. In the second series of experiments - - -
 - a. Calves fed the alfalfa silage ration gained significantly faster and required less air-dry feed per

hundredweight gain than did calves fed orchardgrass-clover silage and small grain silage rations.

- b. Calves fed orchardgrass-clover silage rations gained only slightly more than 1 pound per head daily, as compared to an average daily gain of 1.70 pounds for calves fed this kind of silage ration in the first series of experiments. Visual observations and chemical analyses of the silages used in both series of experiments did not indicate marked differences in the quality of the silages.
 - c. Performance of calves fed orchardgrass-clover silage preserved with 30 to 35 pounds of dried molasses per ton was not significantly different from that of calves fed orchardgrass-clover silage preserved with a chemical preservative (sodium metabisulfite). However, some difficulty was encountered with apparent cases of botulism in 2 of the 3 years in which the chemically-preserved grass silage was fed.
 - d. Differences in the digestibility (as determined with beef steer calves) of the dry matter, crude protein, and nitrogen-free extract of the alfalfa, orchardgrass-clover, and small grain silage rations fed during the last two experiments were not statistically significant. However, the crude fiber in the alfalfa silage was significantly less digestible than the crude fiber in the other silages.
3. During the full-feeding phase, the heifers averaged 2.24 pounds gain per head daily and 839 pounds of feed were required per hundredweight gain. About 68 days were required to raise the condition grade of the heifers from Standard to Good.
 4. Based on all groups of heifers fed different silages, the returns per head over feed costs ranged from a low of \$21.63 in 1960-61 to a high of \$49.85 in 1958-59.
 5. The data indicate that the best animal performance was obtained with corn silage followed closely by sorghum, then alfalfa, and perhaps orchardgrass-clover in some instances. The data also indicate the need for determining the factors other than the amount and digestibility of proximate principles in grass silages that affect feeding value.

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Comparative Feeding Value Of Different Silages For the Production Of Slaughter Beef Heifers

by

O. Glen Hall and J. Hugh Felts¹

INTRODUCTION

BEEF heifer calves generally are cheaper in the fall than are steer calves of comparable weight and grade. This is particularly true in years when cattle numbers are stationary or are declining. This, coupled with the fact that the spring market for slaughter beef has been strong during the past several years, indicate that many farmers in Tennessee could profit by feeding beef heifer calves for the spring slaughter market.

Also, such an enterprise would be carried out during the winter and early spring months when demands for labor by other farm enterprises are at a minimum. Thus such an enterprise would complement other farm enterprises and might increase net farm income substantially.

Large quantities of good quality roughages (particularly pastures and silages) are generally considered essential for producing beef at low-cost in Tennessee. Thus the degree of success of the above feeding program could be influenced greatly by the amount, kind, and quality of roughage fed to the heifers. Since several different silage crops can be produced on many farms, the question as to the relative feeding values of these silages for this particular feeding program naturally arises.

Although various crops have been ensiled and fed to livestock for many years, crop production practices have changed recently. Possibly these changes could have significant effect on performance of livestock. The experiments reported in this bulletin were designed to compare the performance of beef heifer calves fed various silages commonly grown in Tennessee, namely, corn, sorghum,

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orchardgrass-ladino clover, alfalfa, and small grain silages. An additional objective of the experiments was to obtain data which would be helpful in determining if the feeding of beef heifers for the spring slaughter market would be a desirable enterprise for Tennessee farmers.

REVIEW OF LITERATURE

According to Snapp and Neumann (1960), corn silage is the standard to which all other silages are compared. They stated that results of most experiments show a distinct advantage of corn silage over sorghum silage for beef cattle. Results of experiments by Perry *et al.* (1958) support this statement. In their experiments, individual lots of 12 beef heifers weighing 570 pounds each were full-fed either corn silage or Atlas sorghum silage and 3.0 pounds Purdue Supplement A per head daily. During a 98-day period, calves fed corn silage gained 1.53 pounds per head daily as compared to only 1.17 pounds per head daily by calves fed sorghum silage. During a subsequent 84-day period both groups of heifers were fed an additional 3.3 pounds of crimped corn per head daily. Average daily gains of calves fed corn silage during this phase were 1.73 pounds as compared to 1.60 pounds for the calves fed the sorghum silage ration.

Livesay and Cunningham (1953) concluded that grass-legume and corn silages were nearly equal on a dry matter basis for wintering beef cows in West Virginia. Their conclusion was based on results of 5 years' work in which development of the cows and weight of calves at weaning time were used as criteria to evaluate the silages.

Minnesota workers, Burson *et al.* (1961), compared the performance of beef steer calves fed various silages during the wintering period. Based on results of two experiments, they concluded that alfalfa, alfalfa-brome, and oat silages were about 75-80% as efficient as was corn silage for producing wintering gains in beef steer calves. In experiments conducted at Illinois by Neuman *et al.* (1958), beef steer calves fed regular corn silage, shelled corn, hay, and protein supplement gained 2.54 pounds per head daily during a 224-day fattening test as compared to 2.49 pounds per head daily by calves fed alfalfa silage containing 40% corn added when the forage was placed in the silo. Calves fed oat silage with 40% added corn gained only 2.12 pounds per head daily.

Perry *et al.* (1957) used 72 beef steer calves in an experiment to compare alfalfa, wheat, and oat silages. The calves were fed

the silages *ad libitum*, 3.0 pounds of corn, and 1.0 pound of protein supplement per head daily. During a 158-day test period, calves fed alfalfa silage gained 1.96 pounds per head daily as compared to 1.40 to 1.50 pounds per head daily by calves fed the small grain silages. These workers reported that oat and wheat silages were about equally palatable to beef calves and both small grain silages were significantly less palatable than alfalfa silage. When grass-legume and oat silages preserved with molasses were fed on an equal dry matter basis in West Virginia experiments (Livesay *et al.*, 1943), performance of growing beef heifers fed the two silages was not significantly different.

Results of extensive studies of the digestibilities of various silages have been reported by Garrigus (1951). In these experiments 2-year old beef steers were used in conventional digestion trials to determine the total digestible nutrient content of corn, ladino clover, and various grass silages. The results showed that the total digestible nutrient content of excellent quality ladino clover silage equalled that of corn silage, and that very good bluegrass silage compared very favorably with corn silage in total digestible nutrient content. As a general rule, good grass silages or mixtures of grasses and legumes would be expected to have more digestible protein than would corn silage. However, good corn silage, due to its content of grain, would be expected to contain more digestible calories than would grass silages.

As indicated by the above work and by other work (Baird *et al.*, 1958), the quality of specific silages is influenced by many factors such as stage of maturity of the crop, amount of grain, ensiling conditions, etc. Many other factors, little understood as yet, also affect the quality of silages as indicated by the variation in performance of animals fed the silages.

EXPERIMENTAL PROCEDURE

Silages

Series 1. Corn (Dixie 17), sorghum (Atlas), small grain, and orchardgrass-ladino clover silages were compared in the first series of three experiments conducted at the Tobacco Experiment Station during the fall and winter of 1956-57, 1957-58, and 1958-59. In the first experiment, a mixture of barley, oats, and vetch made up the small grain silage. In the second experiment, a new variety of rye (*Tetra Petkus*) was used and in the third experiment, Balbo rye was used. In this series of experiments, dried molasses—about 35

pounds per ton of forage—was added to the orchardgrass-ladino clover silages as a preservative.

Series 2. Three experiments were conducted during 1959-1962 in which four additional silages were compared. In the first experiment, orchardgrass-ladino clover, alfalfa (Buffalo), oat, and rye (Balbo) silages were compared. Sodium metabisulfite was used as a preservative (6-8 pounds per ton) for all silages in this test. After the results of the first experiment were analyzed, the rye silage treatment was discontinued and an additional orchardgrass-ladino clover silage, preserved with dried molasses, was included in the last two experiments. Kylage (8 pounds per ton) was added to the other forages used in these two experiments.

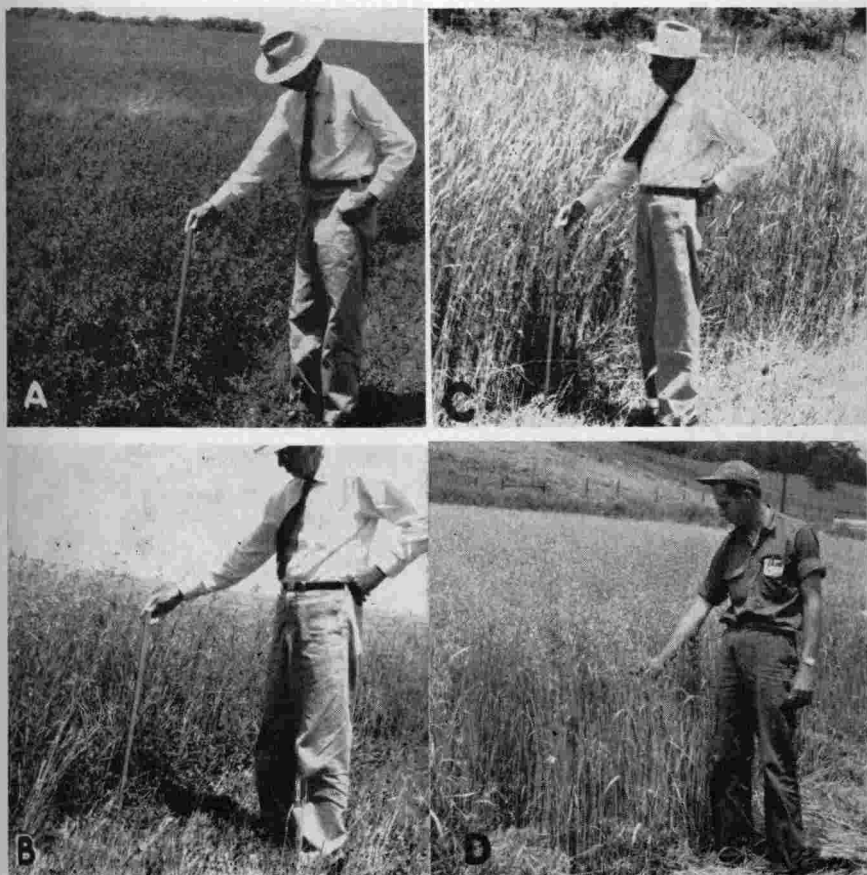


Figure 1. The various forages tested in the experiment conducted in 1959-60 are shown above: A, alfalfa; B, orchardgrass-ladino clover; C, Balbo rye; and D, oats.

All silage crops in both series of experiments were grown on land areas that are recommended for such crops, and other recommended production practices were followed. Fertilizer applications were made according to needs as indicated by results of soil tests. The station superintendent estimated the acre yields of fresh forage from each crop to be as follows: corn, 16-18 tons (expected grain yield, 75-80 bushels per acre); sorghum, 16-18 tons; small grain, 9-12 tons, orchardgrass-ladino clover and alfalfa, 6-9 tons.

Only the first cuttings of orchardgrass-ladino and alfalfa were ensiled. These forages were "direct cut" and put in the silos without being wilted. An attempt was made to harvest the crops at the following stages of maturity: corn—early dent; sorghum—late



Figure 2. Forages were "direct-cut," chopped, and blown into the silos without being wilted.

dough; small grain—late milk to early dough; orchardgrass-ladino clover—when most orchardgrass stems were headed; alfalfa—one-tenth to one-fourth bloom. Each silage used in experiment was stored in two upright silos with a capacity of about 10 tons each. Eight of these silos were available for each experiment.

Samples of all the silages fed in each experiment were taken for chemical analyses at the start of the experiment and at periodic intervals throughout the feeding period. Usually about five sets

of samples were obtained for each experiment. All chemical analyses were conducted according to A.O.A.C. (1955) methods.

Experimental Animals

Weanling beef heifer calves (Herefords) bought at various feeder calf sales in the East Tennessee area and purebred Hereford heifer calves raised on the station were used as the experimental animals. In the first experiment, calves weighing about 430 pounds each were used; in later experiments calves weighing 450 to 475 pounds each were used. The calves were divided into comparable lots of 5 to 6 head per lot on the basis of weight, grade, and origin. Two lots of calves, selected at random, were then assigned to each of the four silages being studied.

The calves were started on experiment about November 1 each year and were fed for about 120 to 140 days, depending upon the amount of silage available. The calves were fed twice daily all the silage they would consume without excessive waste: about 4 pounds of ground ear corn with shuck, 1 pound of cottonseed meal, and in most experiments 2 pounds of fair-quality grass hay per head daily. Water, salt, and a mineral mixture (two parts phosphate supplement and one part salt) were accessible at all times.

An average of two weights taken on consecutive days was used as the beginning and ending experimental weights. The calves were also weighed at 28-day intervals throughout the experimental period. All calves were graded by at least two qualified graders of the Animal Husbandry-Veterinary Science Department at the beginning and end of the experiment. In some experiments the heifers were appraised as slaughter stock at the end of the silage feeding period. Heifers not retained as herd replacements that graded Good at the end of the silage feeding period were sold for slaughter. The remaining heifers were full-fed a concentrate ration for 56 to 90 days before they were sold. Carcass grades were obtained whenever possible when the heifers were sold.

In considering the performance of the calves used in these experiments, it should be kept in mind that long transition periods were not generally used at the beginning of the experiments and between the silage-feeding and concentrate-feeding phases. Thus calves were started on the experiments immediately after being weaned and/or after they were bought at Feeder Calf sales. Following the completion of the silage-feeding phase, those heifers which were to be marketed were taken up to a full-feed of concentrates as rapidly as possible. This procedure might have resulted in somewhat lower gains than would have resulted had

transitional periods been used.

The data obtained in these experiments were analyzed statistically by analysis of variance techniques (Snedecor, 1956), and by the multiple range test as described by Duncan (1955) using the critical values reported by Harter (1960).

RESULTS AND DISCUSSION

Chemical Composition of the Silages

The chemical composition of the silages fed during the first series of three experiments (1956-59) is shown in Table 1. The dry matter content of the individual silages varied considerably from year to year, but on the average the values ranged from about 24% to 25% for the small grain and orchardgrass-clover silages to 26% to 30% for the sorghum and corn silages, respectively.

There were significant differences in both the percentage of crude protein and nitrogen-free extract in the various silages. Thus the orchardgrass-clover silage contained 3.83% crude protein as compared to values of 2.53%, 2.33%, and 1.88% for the corn, small



Figure 3. Preservatives were added to the forages at the blower.

grain, and sorghum silages, respectively. Corn and sorghum silages contained significantly more nitrogen-free extract than did the orchardgrass-clover and small grain silages. This would be expected since the former silages contained more grain.

As shown in Table 2, orchardgrass-clover silages fed in the second series of experiments contained slightly less total dry matter, less crude protein, and slightly more crude fiber than did the orchardgrass-clover silages fed in the first series of experiments. The chemical composition of orchardgrass-clover silage preserved with a chemical preservative was not very different from orchardgrass-clover silage preserved with dried molasses.

Table 1
Chemical composition of the silages fed during 1956-59
(As fed basis)

Silage	Year	Dry matter	Crude protein	Crude fiber	Nitrogen-free extract	Ether extract	Ash
		%	%	%	%	%	%
Corn	1956-57	33.54	2.89	7.42	20.20	0.90	2.13
	1957-58	28.00	2.34	5.32	18.17	0.66	1.51
	1958-59	29.85	2.37	7.04	17.98	0.98	1.48
	Av.	30.46	2.53	6.59	18.78	0.85	1.71
Sorghum	1956-57	28.76	2.15	6.98	17.04	0.72	1.87
	1957-58	25.00	1.81	5.25	16.10	0.67	1.17
	1958-59	24.99	1.68	5.84	15.72	0.38	1.38
	Av.	26.25	1.88	6.02	16.29	0.59	1.47
Orchardgrass-ladino clover	1956-57	21.40	3.39	5.91	9.17	1.02	1.91
	1957-58	34.20	5.45	8.82	13.92	2.94	3.07
	1958-59	21.07	2.65	5.99	9.51	0.81	2.14
	Av.	25.56	3.83	6.91	10.87	1.59	2.37
Small grain	1956-57	26.70	2.84	7.26	14.13	0.82	1.65
	1957-58	20.80	1.81	6.42	10.16	0.76	1.65
	1958-59	24.77	2.33	8.27	11.29	0.74	2.14
	Av.	24.09	2.33	7.32	11.86	0.77	1.81

Table 2
Chemical composition of the silages fed during 1959-62
(As fed basis)

Silage	Year	Dry matter	Crude protein	Crude fiber	Nitrogen-free extract	Ether extract	Ash
		%	%	%	%	%	%
Alfalfa	1959-60	21.39	4.41	5.92	7.61	1.01	2.44
	1960-61	29.04	5.33	5.16	11.87	1.32	3.09
	1961-62	25.28	4.65	6.21	8.89	1.20	2.86
	Av.	25.24	4.80	5.76	9.46	1.18	2.81
Orchardgrass-clover (chemical present)	1959-60	22.53	2.66	9.23	9.21	0.79	2.15
	1960-61	23.55	1.75	6.85	10.74	0.76	2.16
	1961-62	22.97	2.87	6.82	9.05	0.98	2.07
	Av.	23.02	2.43	7.63	9.67	0.84	2.13
Orchardgrass-clover (molasses)	1960-61	27.34	2.25	7.48	12.47	0.73	2.46
	1961-62	21.78	2.60	6.55	8.30	0.99	2.14
	Av.	24.56	2.42	7.02	10.38	0.86	2.30
Oats	1959-60	27.11	2.05	9.23	12.70	1.22	1.91
	1960-61	24.03	1.72	6.80	11.34	0.72	1.77
	1961-62	20.58	1.66	7.11	8.14	0.70	1.81
	Av.	23.91	1.81	7.71	10.73	0.88	1.83
Rye	1959-60	23.38	1.91	10.32	8.74	0.61	1.80

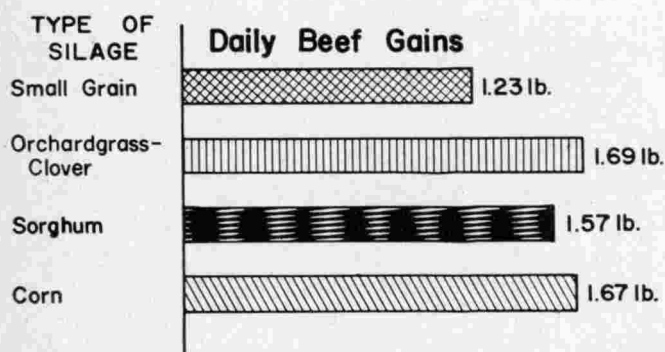


Figure 4. Average daily gains of beef heifers fed different silages (average of three experiments).

The alfalfa silage fed in the second series of experiments contained 4.80% crude protein which was significantly higher than for any of the other silages. The crude fiber content was slightly lower in the alfalfa silage than it was in the other silages (Table 2).

Animal Performance

Series 1. Feedlot performance of beef heifer calves fed the various silages for the 3-year period, 1956-59, is summarized in

Table 3. Daily gains, feed efficiency, and feed costs per pound of gain are shown in Figures 4 and 5. The results of the three experiments were summarized separately and are given in Appendix Tables 1, 2, and 3.

As shown by the data in Table 3 and Figure 4, beef heifer calves fed orchardgrass-clover silage free choice, 3.8 pounds of ground ear corn, and 1.1 pounds of cottonseed meal per head daily gained 1.69 pounds per head daily. Thus these calves gained equally as fast as did comparable calves fed the corn silage ration in these experiments. Generally, corn silage is considered to be much superior to grass-clover silage as a feed for beef cattle. However, in these particular experiments in which both silages were supplemented with about 5 pounds of concentrates per head daily, daily gains by calves fed both silage rations were the same. The fact that the

Table 3

Performance of beef heifer calves fed different silages and a limited amount of concentrates
(Average results of three experiments—
see Appendix Tables 1, 2, and 3)

	Corn silage	Sorghum silage	Small grain silage	Orchardgrass- clover silage
No. of calves/treatment	34	34	34	34
Av. weight and gain/head, lb.				
Initial weight	449	450	454	449
Final weight	655	643	605	657
Total gain	206	193	151	208
Daily gain	1.67	1.57	1.23	1.69
Av. daily ration, lb.				
Silage	19.5	21.7	18.1	25.0
Mixed hay	1.3	1.3	1.3	1.3
Cottonseed meal	1.1	1.1	1.1	1.1
Ground ear corn	3.8	3.8	3.8	3.8
Air-dry feed req./cwt. gain, lb.				
Silage	360(1168) ¹	377(1376) ¹	364(1497) ¹	372(1468) ¹
Hay	78	83	106	77
Cottonseed meal	66	70	89	65
Ground ear corn	228	242	309	225
Total	732	772	868	739
Feed costs/lb. gain ²	11.6¢	12.2¢	15.3¢	11.3¢
Av. initial type grade	G. +	G. +	G. +	G. +
Av. initial slaughter grade	H. Std. —	H. Std. —	H. Std. —	H. Std. —
Av. final slaughter grade	L.G. —	L.G. —	Std. +	L.G. —

¹ Silage—wet basis.

² Costs based on following prices: Corn and small grain silages, \$8/ton; sorghum silage, \$7/ton; grass silage, \$6/ton; ground ear corn, \$1.25/bu.; cottonseed meal, \$65/ton; and hay, \$25/ton.

results were consistent in all three experiments is significant (See Appendix Tables 1, 2, and 3).

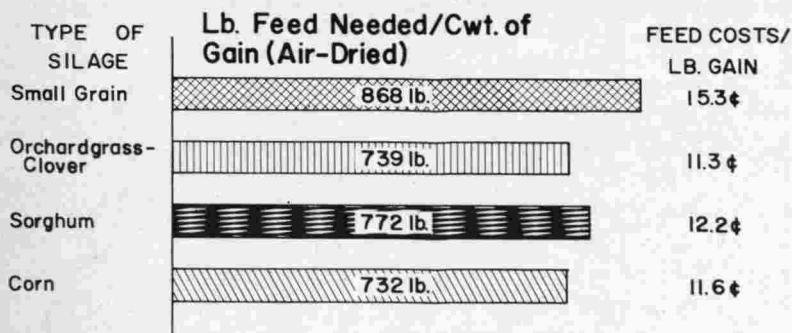


Figure 5. Average amount of air-dry feed required per 100 pounds of gain and feed costs per pound of gain of beef heifers fed silages (average of three experiments).

Daily rate of gain of beef heifer calves fed the sorghum silage ration averaged 1.57 pounds for the three experiments. Although this was 0.1 pound per head daily slower than for calves fed the corn and orchardgrass-clover silages rations, the difference was not statistically significant. In two experiments calves fed the corn silage ration apparently gained faster (not statistically significant) than did calves fed the sorghum silage ration, but in one experiment the trend was reversed.

Beef heifer calves fed the small grain silage ration gained 1.23 pounds per head daily, which was significantly less ($P < .05$) than the daily gains of the other groups of heifers. These results were consistent in all three experiments.

Very efficient and economical gains were made by the beef heifers as shown by the data in Table 3 and Figure 5. Thus the groups of heifers fed corn, orchardgrass-clover, and sorghum silage rations required less than 800 pounds of air-dry feed per hundred-weight gain and feed costs for these groups were about 12 cents for each pound of gain. Although the amount of feed required and feed costs per unit of gain were higher for the calves fed the small grain silage ration than for the other groups, the differences were not statistically significant.

The various silage rations used in this series of experiments were rated on the basis of the amount of total digestible nutrients required by the heifers per hundredweight of gain. Values for TDN for apparently comparable feeds as given in Morrison (1956)

were used in calculating the TDN requirements and the corn silage ration was used as the standard ration. On this basis the rations rated as follows: corn silage, 100; orchardgrass-clover silage, 98; sorghum silage, 92; and, small grain silage, 86.



Figure 6. These are the eight lots of beef heifer calves used in the 1957-58 experiment. The eight small upright silos that held the experimental silages are located at the end of the alley-way.

Series 2. Results of the experiment conducted in 1959-60 in which beef heifer calves were fed alfalfa, orchardgrass-clover, rye, and oat silage rations are summarized in Table 4. Calves fed alfalfa silage and 5.0 pounds of concentrates per head daily gained 1.53 pounds per head daily; this was significantly greater ($P < .05$) than for any of the other groups.

The beef heifers fed the orchardgrass-clover silage ration in this experiment gained only 1.18 pounds per head daily whereas in three previous experiments calves fed this kind of silage ration gained 1.69 pounds per head daily. Two calves fed the orchardgrass-clover silage ration in this experiment died during the course of the test and the treatment had to be discontinued after 84 days. Results of a complete post mortem examination of one of these calves by the station veterinarian strongly indicated the cause of

death was due to botulism. Visual observations and chemical analyses of the silage used in this experiment did not indicate major quality differences in the grass silages used in the two series of experiments.

Table 4
Performance of beef heifer calves fed different silages and a limited amount of concentrates
(November 7, 1959 to February 19, 1960—135 days)

	Alfalfa silage	Orchardgrass- clover silage	Rye silage	Oat silage
No. of calves/lot	6	6	6	6
No. of calves/treatment	12	10 ¹	12	12
Av. wt. and gain/head, lb.				
Initial wt.	468	469	466	469
Final wt.	674	568	586	619
Total gain	206	99	120	150
Daily gain	1.53	1.18	0.89	1.11
Av. daily ration, lb.				
Cottonseed meal	1.0	1.0	1.0	1.0
Corn, cob and shuck meal	4.0	4.0	4.0	4.0
Silage	25.4	15.2	13.0	13.6
Hay	2.0	2.0	2.0	2.0
Air-dry feed/cwt. gain, lb.				
Cottonseed meal	65	85	112	90
Corn, cob and shuck meal	261	339	449	360
Silage	386(1660) ²	309(1288) ²	369(1461) ²	378(1225) ²
Hay	131	169	225	180
Total	843	902	1155	1008
Feed cost/lb. gain ³	13.4¢	14.8¢	20.3¢	16.5¢
Av. initial type grade	L.G.	L.G.	L.G.	L.G.
Av. initial slaughter grade	L.G.—	L.G. +	L.G.	L.G.
Av. final slaughter grade	H. Std. +	—	Std. —	H. Std. —

¹ This treatment discontinued at 84 days because two heifers died due to attack of botulism.

² Silage—wet basis.

³ Costs based on following feed prices: Small grain silages, \$8/ton; alfalfa and grass-clover silages, \$6/ton; corn, cob and shuck meal, \$1.25/bu.; cottonseed meal, \$65/ton; hay, \$25/ton.

Based on daily gains and the amount of feed required per 100 pounds of gain, the oat silage ration appeared to be superior to the rye silage ration. However, the variation between the lots of calves on the same ration was of such magnitude that the differences were not statistically significant.

One obvious difference between the orchardgrass-clover silage

used in the present experiment, and that used in the previous experiments was that a chemical preservative (sodium metabisulfite) was used as a preservative rather than dried molasses. To see if the type of preservative used was responsible for the marked difference in performance of the heifers, in the next two experiments the rye silage ration was discontinued and an orchardgrass-clover silage (preserved with dried molasses) ration was added. The results of these two final experiments were combined and are shown in Table 5 and Figures 7 and 8.

Table 5

Performance of beef heifer calves fed different silages and a limited amount of concentrates
(Average results of two experiments—see Appendix Tables 4 and 5)

	Orchardgrass- clover silage (chemical pres.)	Orchardgrass- clover silage (molasses)	Alfalfa silage	Oat silage
No. of calves/treatment	17	20	20	20
Av. wt. and gain/head, lb.				
Initial wt.	462	464	469	472
Final wt.	617	630	682	636
Total gain	155	166	213	164
Daily gain	1.11	1.19	1.52	1.17
Av. daily ration, lb.				
Silage	19.8	21.0	22.8	22.6
Hay	2.0	2.0	2.0	2.0
Cottonseed meal	1.0	1.0	1.0	1.0
Corn, cob and shuck meal	4.0	4.0	4.0	4.0
Air-dry feed/cwt. gain, lb.				
Silage	415(1759) ¹	439(1764) ¹	422(1536) ¹	446(1914) ¹
Hay	179	168	132	171
Cottonseed meal	89	84	66	85
Corn, cob and shuck meal	357	336	263	342
Total	1040	1027	883	1044
Feed costs/lb. gain ²	16.6¢	15.8¢	12.8¢	18.2¢
Av. initial type grade	G. +	G. +	G. +	G. +
Av. initial slaughter grade	L.G.	L.G.	L.G.	L.G. +
Av. final slaughter grade	Std. +	H. Std.	L.G. —	H. Std.

¹ Silage—wet basis.

² Costs based on following feed prices: Oat silage, \$8/ton; alfalfa and grass silages, \$6/ton; ground ear corn, \$1.25/bu.; cottonseed meal, \$65/ton; and hay, \$25/ton.

The daily gains of the calves fed both orchardgrass-clover silages were very low and not significantly different. Some trouble with what again appeared to be botulism was encountered in the 1960-61 experiment and two of the calves fed the chemically preserved orchardgrass-clover silage died. Another calf on this same treatment was found to be pregnant and she was removed. Botulism was not a problem in the experiment conducted during 1961-62.

The calves fed the alfalfa silage ration gained 1.52 pounds per head daily, which was significantly greater ($P < .05$) than for any

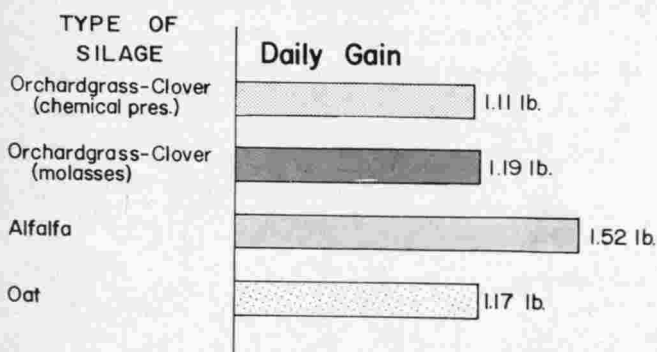


Figure 7. Average daily gains of beef heifers fed different silages (average of two experiments).

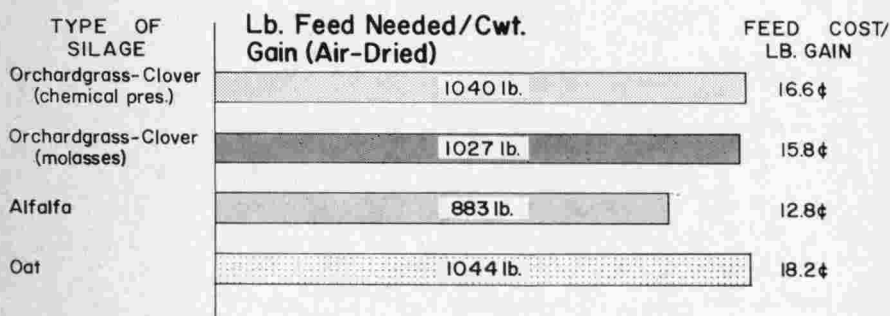


Figure 8. Average amount of air-dry feed required per 100 pounds of gain and feed costs per pound of gain of beef heifers fed different silages (average of two experiments).

of the other groups of heifers. These calves also required less feed per hundred pounds of gain and feed costs per pound of gain were lower than for any of the other groups. The comparative value

of the rations used in this series of experiments—based on TDN required per hundredweight of gain and on the alfalfa silage ration as the standard ration—were as follows: alfalfa silage, 100; oat silage, 83; orchardgrass-clover (preserved with dried molasses) 82; and orchardgrass-clover (chemical preservative), 79.

In an attempt to help explain differences in performance of beef heifers fed various silages, the digestibility of the silages used in the last two experiments in this series was determined with beef steer calves. During the course of the digestion trials, the calves were fed silage free choice, 2 pounds of ground shelled corn, and 1 pound of cottonseed meal per head daily. Each digestion trial consisted of a 10-day preliminary period and a 7-day collection period. Three calves were fed each kind of silage in each of the trials.

Results of the two trials (see Table 6) revealed no significant differences among alfalfa, orchardgrass-clover (molasses), orchardgrass-clover (chemically preserved), and oat silage rations in di-

Table 6
Digestibility of silage-concentrate rations by beef calves
(Average results of two experiments)

	Orchardgrass-clover silage (chemical pres.)	Orchardgrass-clover silage (molasses)	Alfalfa silage	Oat silage
No. of calves	6	6	6	6
Av. daily ration, lb.				
Silage	18.1	16.6	16.8	18.0
Ground shelled corn	2.0	2.0	2.0	2.0
Cottonseed meal	1.0	1.0	1.0	1.0
Digestibility, %				
Dry matter	64.2	62.0	63.0	65.1
Crude protein	61.0	54.7	60.2	58.0
Crude fiber	62.3	62.6	41.5	64.4
Nitrogen-free extract	67.8	66.7	70.5	68.8

gestibility of the dry matter, crude protein, and nitrogen-free extract. The digestibility of the crude fiber in the alfalfa silage ration was significantly lower ($P < .05$) than for any of the other rations. Thus digestibility coefficients were of no help in explaining why calves fed the alfalfa silage ration gained faster and more efficiently than the calves fed the other silage rations.

It is generally believed that quality of direct-cut grass silages is variable and difficult to control. Certainly the results of the experiments reported herein would support this supposition. Thus in the first series of experiments calves fed orchardgrass-clover silages and a limited amount of concentrates gained 1.69 pounds per head daily. However, in the second series of three experiments, calves of comparable weight and grade to those used in the first series of experiments and fed orchardgrass-clover silage and concentrates gained only slightly more than 1 pound per head daily.

As pointed out previously, visual observations and chemical analyses of the silages used in both series of experiments did not indicate major differences in the qualities of the silages. Therefore, it is apparent that many factors little understood as yet affect the feeding value of silages.

Grass silages have been used extensively during the past 15 years by the Agricultural Experiment Station with no apparent difficulty with botulism. Yet in two of these six experiments suspected cases of botulism occurred. Due to the small size of the silos used in these experiments, possibly the silages were not packed firmly enough in some instances. Thus in small areas in the silage, the degree of acidity apparently was not reached at which the microorganisms that produce toxins were killed. It was observed that only small isolated portions of the silages were toxic in both instances.

Full-Feeding Phase. Following the silage-limited concentrate feeding experiments, beef heifers which were not retained as herd replacements and those which would not grade Good in condition were full-fed concentrates for 56-90 days before they were sold for slaughter. The performance of 171 of the heifers during the full-feeding period is summarized in Table 7.

The average length of time required to raise the slaughter grade of these heifers from Standard to Good was 68 days. This time for a given group of calves depended largely on the kind and quality of the silage fed before. During the 68-day period, the heifers consumed an average of 13.5 pounds of ground ear corn, 2.0 pounds of cottonseed meal, and 3.3 pounds of mixed grass-legume hay per head daily. Since the calves gained 2.24 pounds per head daily, the gains were very efficient. Thus only slightly more than 800 pounds of feed were required per hundred pounds of gain and feed costs per pound of gain were less than 16 cents.

Table 7

**Performance of beef heifers full-fed concentrates
(Average length of feeding period—68 days)**

No. of animals	171
Av. wt. and gain/head, lb.	
Initial wt.	590
Final wt.	742
Total gain	152
Daily gain	2.24
Av. daily ration, lb.	
Ground ear corn	13.5
Cottonseed meal	2.0
Hay	3.3
Feed required/cwt. gain, lb.	
Ground ear corn	603
Cottonseed meal	89
Hay	147
Total	839
Feed costs/lb. gain ¹	15.8¢
Av. initial slaughter grade	Std.
Av. final slaughter grade	G.
Av. sale price/cwt.	\$24.18

¹ Feed costs based on following prices: Ground ear corn, \$1.25/bu.; cottonseed meal, \$65/ton; and hay, \$25/ton.

When the heifers graded Good in condition they were sold to local packers in the Greeneville and Knoxville areas. Sale prices per hundredweight ranged from about \$19.65 in 1957 to \$26.85 in 1959. As shown in the table the average sale price was \$24.18 per hundredweight for the 6-year period.

Financial Results. The returns per head *over feed costs* are shown in Table 8. These figures are based on the average performance of all groups of heifers used in a particular experiment and not just the groups which gained the fastest. Feed prices used throughout were as follows: grain silages, \$8/ton; orchardgrass-clover and alfalfa silages, \$6/ton; hay, \$25/ton; ground ear corn, \$1.25/bu.; and cottonseed meal, \$65/ton.

The returns ranged from a low of \$21.63 per head in 1960-61 to a high of \$49.35 in 1958-59. In 2 of the 6 years, the cattle sold for less per hundredweight than their original purchase price. However, due to the efficient and economical gains, a return above feed costs was realized.

Table 8
Financial results

Year	Purchase price/cwt.	Sale price /cwt.	Feed Costs /head (silage phase)	Feed cost/head (full-feeding phase)	Returns per head over feed costs
1956-57	\$16.40	\$18.27	\$22.13	— ¹	\$24.48
1957-58	\$19.00	\$25.11	\$22.89	— ¹	\$47.82
1958-59	\$25.12	\$26.85	\$24.80	\$17.34	\$49.85
1959-60	\$25.77	\$25.40	\$25.65	\$25.08	\$26.28
1960-61	\$22.27	\$22.05	\$27.42	\$23.80	\$21.63
1961-62	\$24.32	\$24.50	\$28.28	\$28.35	\$33.40

¹ Heifers were sold immediately after the silage feeding phase.

The heifers used in 1956-57 and 1957-58 were appraised at the end of the silage feeding phases and the returns per head over feed costs for these periods were calculated. As shown in Appendix Table 1, calves fed the small grain silage ration in 1956-57 returned \$19.52 per head over feed costs as compared to about \$24 to \$28 per head by the calves fed the other silages. Returns per head over feed costs in 1957-58 ranged from \$32.60 per head for calves fed the small grain silage ration to about \$51-\$55 per head by the other groups (see Appendix Table 2). Calves used in the remaining experiments were not appraised following the silage comparison phase; therefore returns per head of the calves fed specific silages could not be calculated.

General Comments. Based on the results in this bulletin the feeding of beef heifers during the fall, winter, and early spring months would appear to be an enterprise worthy of consideration by many Tennessee farmers. Such a feeding program involves maximum use of economical and high quality forages (silages) with just enough concentrate feeds to produce desirable slaughter cattle from the standpoint of both the packer and consumer. Furthermore the feeding program is carried out during the time of year when the demand for labor by other farm enterprises is at a minimum.

Beef heifers are especially suited for the program due to the facts that they fatten faster (although they gain slightly slower), and they are marketed at lighter weights than are steers. Thus they can be marketed sooner in the spring than could steers. Also, beef heifer calves generally cost less per hundredweight than do comparable weight and grade steer calves.

As shown by the experimental data, the preferred silage to use in such a feeding program based on animal performance was corn

followed closely by sorghum, alfalfa, and perhaps orchardgrass-clover in some instances.

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APPENDIX

Appendix Table 1

Performance of beef heifer calves fed different silages and a limited amount of concentrates

(October 16, 1956 to February 19, 1957—126 days)

	Corn silage	Sorghum silage	Oats-vetch silage	Orchardgrass- clover silage
No. of calves/lot	5	5	5	5
No. of calves/treatment	10	10	10	10
Av. wt. and gain/head, lb.				
Initial wt.	429	436	434	434
Final wt.	644	640	633	658
Total gain	215	204	199	224
Daily gain	<u>1.71</u>	<u>1.62</u>	<u>1.58</u>	<u>1.78</u>
Av. daily ration, lb.				
Silage	20.0	22.8	23.2	31.7
Cottonseed meal	1.2	1.2	1.2	1.2
Corn, cob & shuck meal	3.4	3.4	3.4	3.4
Air-dry feed/cwt. gain, lb.				
Silage	388(1170) ¹	406(1407) ¹	389(1468) ¹	381(1781) ¹
Cottonseed meal	70	74	75	67
Corn, cob & shuck meal	200	211	215	192
Total	<u>655</u>	<u>691</u>	<u>679</u>	<u>640</u>
Feed cost/pound gain ²	<u>10.3¢</u>	<u>10.8¢</u>	<u>10.4¢</u>	<u>10.7¢</u>
Av. initial type grade	H.G.	H.G.	H.G.	H.G.
Av. initial slaughter grade	G.	G.	G.	G.
Av. final slaughter grade	L.G.	L.G.	H. Std.	L.G.
Financial results				
Initial cost/cwt.	\$ 16.47	\$ 16.17	\$ 16.48	\$ 16.47
Final value/cwt.	\$ 18.75	\$ 18.55	\$ 17.65	\$ 18.15
Total cost/head				
(initial & feed)	\$ 92.66	\$ 92.46	\$ 92.20	\$ 95.37
Final value/head	\$120.75	\$118.72	\$111.72	\$119.43
Returns/head over				
feed costs	<u>\$ 28.09</u>	<u>\$ 26.26</u>	<u>\$ 19.52</u>	<u>\$ 24.06</u>

¹ Silage—wet basis.

² Costs based on following feed prices: Corn and small grain silages, \$8/ton; sorghum silage, \$7/ton; grass silage, \$6/ton; corn, cob and shuck meal, \$1.25/bu.; cottonseed meal, \$65/ton.

Appendix Table 2

Performance of beef heifer calves fed different silages and a limited amount of concentrates

(November 8, 1957 to February 28, 1958—112 days)

	Corn silage	Sorghum silage	Rye-vetch silage	Orchardgrass- clover silage
No. of calves/lot	6	6	6	6
No. of calves/treatment	12	12	12	12
Av. wt. and gain/head, lb.				
Initial wt.	479	471	482	468
Final wt.	657	658	591	659
Total gain	178	187	109	191
Daily gain	<u>1.59</u>	<u>1.67</u>	<u>0.98</u>	<u>1.71</u>
Av. daily ration, lb.				
Silage	21.4	23.2	18.6	20.0
Cottonseed meal	1.0	1.0	1.0	1.0
Corn, cob & shuck meal	4.0	4.0	4.0	4.0
Hay	2.0	2.0	2.0	2.0
Air-dry feed/cwt. gain, lb.				
Silage	377(1346) ¹	347(1389) ¹	399(1898) ¹	399(1170) ¹
Cottonseed meal	63	60	102	58
Corn, cob & shuck meal	252	240	408	234
Hay	126	120	204	117
Total	<u>818</u>	<u>767</u>	<u>1113</u>	<u>808</u>
Feed cost/lb. gain ²	<u>13.5¢</u>	<u>12.6¢</u>	<u>20.8¢</u>	<u>11.1¢</u>
Av. initial type grade	G.	G.	G.	G.
Av. initial slaughter grade	Std.	Std.	L. Std.	Std.
Av. final slaughter grade	L.G.	L.G.	H. Std.	L.G. +
Financial results				
Initial cost/cwt.	\$ 19.00	\$ 19.00	\$ 19.00	\$ 19.00
Final value	\$ 25.29	\$ 25.19	\$ 24.83	\$ 25.13
Total cost/head				
(initial & feed)	\$115.06	\$113.04	\$114.37	\$110.10
Final value/head	\$166.05	\$165.62	\$146.97	\$165.71
Returns/head over				
feed costs	<u>\$ 50.99</u>	<u>\$ 52.58</u>	<u>\$ 32.60</u>	<u>\$ 55.61</u>

¹ Silage—wet basis.

² Costs based on following feed prices: Corn and small grain silages, \$8/ton; sorghum silage, \$7/ton; grass silage, \$6/ton; corn, cob and shuck meal, \$1.25/bu.; cottonseed meal, \$65/ton; hay, \$25/ton.

Appendix Table 3

Performance of beef heifer calves fed different silages and a limited amount of concentrates

(November 10, 1958 to March 20, 1959—130 days)

	Corn silage	Sorghum silage	Rye silage	Orchardgrass- clover silage
No. of calves/lot	6	6	6	6
No. of calves/treatment	12	12	12	12
Av. wt. and gain/head, lb.				
Initial wt.	439	444	447	444
Final wt.	663	631	592	653
Total gain	224	187	145	209
Daily gain	<u>1.72</u>	<u>1.44</u>	<u>1.12</u>	<u>1.61</u>
Av. daily ration, lb.				
Silage	17.0	19.2	12.6	23.4
Cottonseed meal	1.0	1.0	1.0	1.0
Corn, cob and shuck meal	4.0	4.0	4.0	4.0
Hay	1.8	1.8	1.8	1.8
Air-dry feed/cwt. gain, lb.				
Silage	316(988) ¹	378(1333) ¹	305(1125) ¹	336(1453) ¹
Cottonseed meal	58	69	89	62
Corn, cob and shuck meal	233	278	357	248
Hay	105	125	161	112
Total	<u>712</u>	<u>851</u>	<u>912</u>	<u>758</u>
Feed cost/lb. gain ²	<u>11.3¢</u>	<u>13.5¢</u>	<u>15.8¢</u>	<u>12.2¢</u>
Av. initial type grade	G.	G.	G.	G.
Av. initial slaughter grade	L. Std. +	L. Std. +	Std. —	Std. —
Av. final slaughter grade	L.G. —	H. Std.	L. Std. +	L.G.

¹ Silage—wet basis.

² Costs based on following feed prices: Corn and rye silages, \$8/ton; sorghum silage, \$7/ton; grass silage, \$6/ton; corn, cob and shuck meal, \$1.25/bu.; cottonseed meal, \$65/ton; hay, \$25/ton.

Appendix Table 4

Performance of beef heifer calves fed different silages and a limited amount of concentrates

(November 1, 1960 to March 20, 1961—140 days)

	Orchardgrass- clover silage (chemical pres.) ¹	Orchardgrass- clover silage (molasses)	Alfalfa silage	Oat silage
No. of calves/lot	5	5	5	5
No. of calves/treatment	10	10	10	10
Av. wt. and gain/head, lb.				
Initial wt.	458	464	472	472
Final wt.	589	616	707	648
Total gain	131	152	235	176
Daily gain	<u>0.94</u>	<u>1.08</u>	<u>1.67</u>	<u>1.25</u>
Av. daily ration, lb.				
Silage	15.3	17.9	21.2	26.0
Cottonseed meal	1.0	1.0	1.0	1.0
Corn, cob and shuck meal	4.0	4.0	4.0	4.0
Hay	2.0	2.0	2.0	2.0
Air-dry feed/cwt. gain, lb.				
Silage	369(1627) ²	443(1651) ²	358(1270) ²	505(2077) ²
Cottonseed meal	106	92	60	80
Corn, cob and shuck meal	425	369	239	318
Hay	204	185	120	153
Total	<u>1104</u>	<u>1089</u>	<u>777</u>	<u>1056</u>
Feed cost/lb. gain	<u>18.0¢</u>	<u>16.4¢</u>	<u>11.2¢</u>	<u>18.2¢</u>
Av. initial type grade	G.—	G.	G.	G.
Av. initial slaughter grade	L.G. +	G. +	G. +	G.
Av. final slaughter grade	Std.	H. Std.	H. Std. +	H. Std.

¹ Results on treatment 1 based on 7 calves only. Two calves on this treatment died due to botulism and one with calf was removed.

² Silage—wet basis.

³ Costs based on following prices: Oat silage, \$8/ton; alfalfa and grass silages, \$6/ton; corn, cob and shuck meal, \$1.25/bu.; cottonseed meal, \$65/ton; hay, \$25/ton.

Appendix Table 5

Performance of beef heifer calves fed different silages and a limited amount of concentrates

(October 17, 1961 to February 21, 1962—140 days)

	Orchardgrass- Ladino silage (chemical pres.)	Orchardgrass- Ladino silage (molasses)	Alfalfa silage	Oat silage
No. of calves/lot	5	5	5	5
No. of calves/treatment	10	10	10	10
Av. wt. and gain/head, lb.				
Initial wt.	466	464	466	471
Final wt.	645	644	656	624
Total gain	179	180	190	153
Daily gain	<u>1.29</u>	<u>1.29</u>	<u>1.36</u>	<u>1.09</u>
Av. daily ration, lb.				
Silage	24.4	24.2	24.5	19.1
Corn, cob and shuck meal	4.0	4.0	4.0	4.0
Cottonseed meal	1.0	1.0	1.0	1.0
Hay	2.0	2.0	2.0	2.0
Air-dry feed/cwt. gain, lb.				
Silage	461(1891) ²	435(1876) ²	485(1801) ²	387(1752) ²
Corn, cob and shuck meal	310	310	295	366
Cottonseed meal	78	78	74	92
Hay	155	155	147	183
Total	<u>1004</u>	<u>978</u>	<u>1001</u>	<u>1028</u>
Feed cost /lb. gain	<u>15.2¢</u>	<u>15.2¢</u>	<u>14.5¢</u>	<u>18.3¢</u>
Av. initial type grade	H.G.	H.G.	H.G.	H.G.
Av. initial slaughter grade	L.G.—	L.G.	L.G.	L.G.—
Av. final slaughter grade	H. Std.	H. Std.	L.G.—	H. Std.—

¹ Costs based on following prices: Oat silage, \$8/ton; alfalfa and grass silage, \$6/ton; corn, cob and shuck meal, \$1.25/bu.; cottonseed meal, \$65/ton; hay, \$25/ton.

² Silage—wet basis.

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