

ALFALFA HAY AND DEHYDRATED ALFALFA MEAL
IN FATTENING RATIONS FOR STEER CALVES

By

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INTRODUCTION

During the past few years, research has shown that the growth response in cattle is greatly affected by the balance of energy, protein, vitamins, minerals and possibly other unknown factors in the ration. Cattle possess the ability to synthesize many of the nutrients required for life by means of the rumen bacteria. The billions of bacteria which inhabit the rumen, if properly nourished, are capable of breaking down otherwise indigestible feedstuffs into a usable form. Therefore, in order to properly feed ruminants, a supplement must contain adequate nutrients to nourish the microorganisms as well as meet the nutritional requirements of the host animal.

In many sections of the country, alfalfa hay and dehydrated alfalfa meal have been used with success in wintering cattle and also in dry-lot feeding. In recent years, several feeding trials with beef cattle have been conducted to study the value of dehydrated alfalfa meal and alfalfa hay in replacing part or all of the commonly used protein supplements. In certain of these tests, an advantage in daily gain and feed efficiency has been obtained which was greater than could be explained on the basis of the protein or carotene supplied by the alfalfa products. This suggests that there may be certain unidentified factors in alfalfa that contribute to the well-being of the ruminant, rumen microorganisms, or possibly both.

Alfalfa hay can be grown in abundant quantities in most sections of Oklahoma as well as the entire Southwest. Being an economical home-grown feed, relatively high in protein, its use in rations for fattening beef cattle may provide a profitable market for the crop -- as well as reduce the amount of supplemental feed which must otherwise be purchased. Most feeders prefer to feed dehydrated alfalfa meal because of its richness in carotene and ease in mixing with the ration. However, alfalfa hay is a more economical feed and, with the exception of the dehydrated product being higher in carotene, there appears to be very little difference in composition between the two feeds. If cattle feeders can obtain an increase in gain and feed efficiency by replacing the commonly used protein supplements with alfalfa, as recent research has indicated, it may mean the difference in profit or loss from the cattle feeding operation. Also, if the alfalfa products can be profitably fed in rations with grain sorghums, more cattle can be fattened in the Southwest rather than shipped to cornbelt areas.

REVIEW OF LITERATURE

Numerous experiments have been conducted to study the value of alfalfa hay as compared to commonly used protein supplements. Morrison (1951) states that good-quality alfalfa hay, when fed to fattening cattle in liberal amounts along with corn or other grain, will supply sufficient protein, calcium and vitamin A and D to produce good gains. Whether or not it will pay to add any additional protein supplement to rations containing liberal amounts of alfalfa hay will depend on amount of hay being fed, relative price of the supplement and hay, and age of the cattle fed. In a single fattening trial with steer calves, Long et al., (1952) at the Oklahoma station, reported that alfalfa hay would not satisfactorily replace cottonseed meal as the sole source of supplemental protein.

Alfalfa Hay for Beef Cattle

Somewhat conflicting results have been reported from the early work where alfalfa hay was fed in fattening rations as the sole roughage, and in some cases the only feedstuff. The early work of Foster and Simpson (1916), at the New Mexico station, showed that alfalfa hay when fed alone for a period of ninety days produced more profit from two-year-old steers than when a limited amount of grain was fed. Results from the work of Thalman (1944), Potter and Whithycomb (1922), and Williams (1920), indicate that feeding silage and/or limited amounts of grain in addition to alfalfa hay would

increase daily gains and feed efficiency over feeding alfalfa hay alone. Williams (1920) also showed that daily gains could be increased somewhat by adding alfalfa hay to a ration composed of milo, silage and cottonseed meal. According to Snapp (1952), alfalfa hay is occasionally criticized because of its somewhat laxative effect when fed in large quantities. Also its use is somewhat limited by frequent occurrence of bloat. Both of these effects are more pronounced in calves than in older cattle.

In more recent studies, Vinke and Pearson (1931), and Knox and Neal (1943) found that more profit can be obtained from full-feeding as compared to a limited feeding of grain when alfalfa hay is fed free-choice. The steers fed the larger amounts of alfalfa hay made more economical gains, however they lacked finish at the close of the feeding trial.

In studying various ratios of concentrate-to-roughage for fattening steers, the Idaho workers (1950, 1952) reported that higher levels of alfalfa hay (1:3 ratio) produced more economical gains with a slower rate of gain. They concluded that the most economical return appears to be between the 1:2 and 2:1 ratios.

From the results of several early trials, Arnett et al. (1926, 1927) concluded that alfalfa hay had approximately one-fourth the value of cottonseed meal for wintering beef cows, when fed in combination with corn silage and straw. From studies covering a nine-year period, Nelson et al. (1954) concluded that approximately eight lbs. of alfalfa hay satisfactorily replaced two and one-half lbs.

of cottonseed cake as the protein supplement for wintering commercial cows on native grass pasture.

The above work has shown that good-quality alfalfa hay, because of its richness in protein, calcium, and vitamins A and D, has from one-third to one-fourth the feeding value of cottonseed meal for wintering beef cows. In the case of fattening cattle, much better results are usually obtained when the ration includes at least some alfalfa hay. However, for the most economical returns in fattening cattle, alfalfa hay should not be fed in excessively large quantities.

Dehydrated Alfalfa Meal for Beef Cattle

Baker et al. (1947, 1953) at Nebraska, conducted a series of fattening trials with steer calves designed to study the value of dehydrated alfalfa meal as a substitute for soybean oil meal. The results showed an increase in gain and feed efficiency when soybean oil meal was replaced by dehydrated alfalfa meal. The supplements were added on a protein equal basis to a basal ration consisting of an average of 11.50 lbs. of corn silage and 17.50 lbs. of ground ear corn per steer daily. The protein supplements fed were either all soybean oil meal, all alfalfa meal, or alfalfa meal fed in amounts to replace one-half or three-fourths of the soybean oil meal. Generally, as the proportion of alfalfa meal increased, the average daily gain increased, less feed was required per unit gain and under prevailing prices a more economical gain was produced. The response obtained was greater than could be explained by protein or vitamin A content alone. In similar studies Dowe and Arthaud

(1949) found very little difference in rate of gain when dehydrated alfalfa meal was substituted for linseed meal. However, there was an increase in feed efficiency when the alfalfa meal was fed. The supplements were added on a protein-equivalent basis, to a basal ration consisting of a full-feed of ground shelled corn and prairie hay.

Klosterman et al. (1953), from a summary of three trials, reported a significant increase in daily gains could be obtained when dehydrated alfalfa meal was used to replace part or all of the soybean oil meal in a 245-day fattening trial with steer calves. The soybean oil meal was replaced by dehydrated alfalfa at levels of one-third, one-half, two-thirds and as all of the protein supplement. The supplements were fed on a protein-equivalent basis in a basal ration consisting of ground ear corn and timothy hay. They also found that the addition of alfalfa ash, equivalent to 1.75 lbs. of alfalfa meal, or cobalt would improve the utilization of the same fattening ration.

From a series of growth trials with calves and yearling steers, Beeson et al. (1952) reported an increase in daily gains when dehydrated alfalfa meal was added to the "Supplement A" formula, and a significant difference in daily gains when two lbs. of alfalfa meal was used to replace two lbs. of corn cobs. In these trials, a high-roughage ration consisting of corn cobs, oat straw, corn silage or grass silage was fed for a period of 150 to 200 days. In somewhat similar feeding trials at the Oklahoma station, Nelson et al. (1954, 1955) reported an increase in daily gain when 0.5 lb.

of alfalfa meal was used to replace part of the cottonseed meal as a protein supplement, fed in combination with small amounts of grain, for wintering weanling calves on weathered range grass hay.

Richardson and associates (1953) reported an increase in daily gains and feed efficiency when 1.0 lb. of dehydrated alfalfa meal was fed as part of the protein supplement in a basal ration composed of wheat straw, a small amount of milo and enough soybean oil meal to supply adequate protein. A smaller increase was reported when 50,000 units of vitamin A were added to the same basal ration.

Stephens et al. (1948) found that two-year-old steers wintered on native grass would make better winter gains when 1.0 lb. of dehydrated alfalfa meal was fed as part of the protein supplement.

In most of the feeding trials, the addition of dehydrated alfalfa meal to rations for fattening or wintering beef cattle has resulted in increased weight gains, improved feed efficiency and profit per steer. While the protein and carotene content of alfalfa meal are considered the most important factors, it seems from certain tests that the beneficial results obtained cannot be explained on the basis of these two components alone and that other factors, such as certain minerals contained in alfalfa, may be equally as important -- depending on the roughage used in the basal ration.

The Effect of Alfalfa Ash and Other Fractions
of Alfalfa on the Digestibility of Various Roughages

The work of Burroughs et al. (1950), at the Ohio station, showed that the addition of alfalfa ash, as well as other alfalfa extracts, improved the digestibility of cellulose in the artificial rumen. Working with cattle, Burroughs and associates (1948, 1950) showed that the digestibility of corn cobs could be improved by the addition of alfalfa ash, or a water extract from alfalfa meal. Swift et al. (1951) reported similar results from the addition of alfalfa meal to a basal ration containing corn cobs for sheep. Chappel et al. (1950) showed an increase in digestibility of a corn cob basal ration for lambs by adding a synthetic alfalfa ash composed of inorganic salts in amounts similar to their composition in natural alfalfa ash.

Using a series of three-day collection periods, Tillman et al. (1954), working with sheep, failed to get an increase in digestibility of prairie hay when alfalfa ash was added to the ration. However, in similar work using cottonseed hulls as the roughage, Tillman and associates (1954) reported an increase in digestibility when alfalfa ash was added to the basal ration.

Thus, it would appear from the research to date that alfalfa hay and dehydrated alfalfa meal may increase the weight gains and feed efficiency when fed to beef cattle. The cause for this increase from feeding alfalfa has not been established at the present time.

However, there are indications it may be associated with the mineral content, and its effect on the rumen microorganisms. If this is true, the kind and quality of roughage used in the basal ration may be an important factor. Further research is needed to study the value and effects of alfalfa hay and dehydrated alfalfa meal in a wide range of rations for beef cattle.

OBJECTIVES

Three fattening trials with steer calves were conducted during the period 1952-1955 with the following objectives in mind:

1. To study the value of dehydrated alfalfa meal in fattening rations for steer calves containing milo, cottonseed meal and sorghum silage. In these tests, the dehydrated alfalfa replaced one-fourth, one-half and all of the cottonseed meal on a protein-equivalent basis.
2. To compare the value of alfalfa hay and dehydrated alfalfa meal at the one-fourth and one-half replacement levels as measured by rate of gain, feed efficiency, carcass grade, yield and profit per steer.

PROCEDURE

A total of 210 good to choice, weanling, Hereford steer calves were used in the feeding trials reported herein. In the 1952-53 trial, nine calves in each lot were from a uniform group purchased from the E. C. Mullendore ranch at Pawhuska, Oklahoma, and one calf was from the experimental herd at Lake Carl Blackwell. In the 1953-54 trial, six calves in each lot were from a group of feeder calves purchased at the Ardmore Feeder Calf sale, and four calves were from the Ft. Reno experimental herd. In the 1954-55 trial, four calves in each lot were selected from a group purchased from E. C. Mullendore ranch at Pawhuska, Oklahoma; the remainder of the calves, six head in each lot, came from the Ft. Reno experimental herd. In the group from the experimental herd used in the 1953-54 and 1954-55 trials, most of the calves were sired by four pure-bred bulls. When these calves were placed on experiment they were allotted so as to equalize sire effect as much as possible.

On arrival at the experimental steer shed at Stillwater, the calves were given approximately twenty days to become accustomed to the change in environment and feed, and also to recover from weaning before being placed on experiment. In all trials, the calves were allotted into uniform groups of ten head each on the basis of source (and sire where possible), shrunk weight and feeder grade. The experimental rations to be fed were then assigned to the groups at random.

The steers of each lot were confined to concrete paved pens, approximately 30 by 50 feet in size, with access to an open shed. The feed bunks in each lot were placed under the open shed. The steers in all lots were hand-fed twice daily a ration composed of rolled milo, a limited amount of sorghum silage and varying amounts of cottonseed meal and alfalfa hay or dehydrated alfalfa meal. The calves received 2.5 lbs. of milo at the start of the trials, and this amount was gradually increased to a full-feed. They were then fed all they would clean up by the time of the next feeding. The amount of silage fed was gradually reduced to assure a maximum intake of milo. The concentrates and silage were fed twice daily in open bunks. The alfalfa hay was fed only at the morning feeding, with the exception of feeding it twice daily to the steers receiving over two lbs. per day. Refused feed was weighed back, although the daily allowance was adjusted so that the steers would consume almost all the feed offered. In all trials, the steers had free access to a mineral mixture composed of two parts salt and one part steamed bonemeal. One ounce of calcium carbonate was added to the ration of steers receiving less than two lbs. of alfalfa hay, i.e. steers receiving the basal ration and those fed alfalfa at the one-fourth replacement level.

Varying amounts of cottonseed meal, alfalfa hay and dehydrated alfalfa meal were fed as protein supplements to a full-feed of milo, and limited amounts of sorghum silage. In the 1952-53 trial the protein supplements fed were as follows: Lot 1 (basal), 1.8 lbs. of cottonseed meal; Lot 2, 1.5 lbs. of cottonseed meal and 1 lb. of

alfalfa hay; Lot 3, 0.75 lbs. of cottonseed meal plus 3.0 lbs. alfalfa hay, and Lot 4, 0.75 lb. of cottonseed meal with 2.6 lbs. of dehydrated alfalfa pellets. In the 1953-54 and 1954-55 trials, six of essentially the same treatments were used which consisted of: Lot 1, (basal), 1.8 lbs. of cottonseed meal; Lot 2, 1.35 lbs. of cottonseed meal plus 1.2 lbs. of alfalfa hay (1/4 replacement); Lot 3, 1.3 lbs. of cottonseed meal and 0.9 lb. of dehydrated alfalfa pellets (1/4 replacement); Lot 4, 0.9 lb. of cottonseed meal plus 2.3 lbs. of alfalfa hay (1/2 replacement); Lot 5, 0.9 lb. cottonseed meal plus 1.7 lbs. dehydrated alfalfa meal (1/2 replacement), and Lot 6, 3.3 lbs. of dehydrated alfalfa meal pellets. In the 1954-55 trial, the dehydrated alfalfa meal, fed Lots 3 and 5, were mixed in proper proportion to the cottonseed meal and pelleted shortly after the dehydrated product was obtained in June in an attempt to reduce carotene losses while in storage.

In addition to the six treatments mentioned above, in the 1954-55 test two additional lots were added. The steers in one of these lots received the basal (no alfalfa) plus a crude carotene concentrate. The steers in the other lot received the basal plus crude carotene and alfalfa ash. The levels of carotene and alfalfa ash were added to approximate the amount contained in about 1.0 lb. of alfalfa hay.

In the 1952-53 trial, the initial and final weights were an average of three consecutive daily weights taken in the afternoon. In the other two trials the initial and final weights were obtained after a 16-hour shrink in dry lot. In all three trials, the steers were weighed at 21-day intervals during the feeding period.

The cattle were sold on the Oklahoma City market shortly after the completion of the trial and shrink to market, selling price, dressing percent and carcass grades were obtained. Also, a live market value was calculated using yield, grade and carcass value - computed back to a live weight basis.

The weight gains of the steers were subjected to an analysis of variance (Snedecor, 1946).

RESULTS AND DISCUSSION

The average results of each fattening trial with steer calves are given in Tables I through VI. The chemical composition of the feeds used in each trial, feed prices, and carcass values used to calculate the average market value of the steers are shown in Appendix Tables VII, VIII and IX, respectively.

Trial I - 1952-53

The steers of Lot 2, receiving 1.0 lb. of alfalfa hay per head daily as a replacement for one-fourth the cottonseed meal, showed an increase in daily gain of 0.23 lb. over those fed the basal ration (Lot 1), as shown in Table I. Steers of Lot 3 receiving 3.0 lbs. of alfalfa hay per head daily (one-half replacement of cottonseed meal) gained 0.17 lb. more per head daily than steers of Lot 1, although the higher level of alfalfa hay produced no greater daily gains than the 1.0 lb. fed steers of Lot 2. Lot 4 steers fed 2.45 lbs. per head daily of dehydrated alfalfa meal pellets (one-half replacement of cottonseed meal) showed an increase in average daily gains of 0.23 lbs. over the basal group. However, when the average daily gains were subjected to statistical analysis there was no significant difference at the five percent level of probability. This appears to have been due to the lack of uniform growth response within lots.

Toward the end of the feeding trial, the steers receiving the basal ration with no alfalfa (Lot 1), began to show definite symptoms of a vitamin A deficiency. One steer became completely blind and several bad cases of anasarca and convulsions were observed with other steers. Feed consumption for the entire lot declined. There were no symptoms in other lots fed 1.0 lb. or more of alfalfa hay or dehydrated alfalfa meal.

The average cost per 100 lbs. gain was \$25.38, \$24.20, \$23.80 and \$24.38 for Lots 1, 2, 3 and 4 respectively. In the same order, the amount of rolled Redland kafir required per 100 lbs. gain was 554, 554, 558 and 513 lbs., with the least amount required for steers receiving 2.45 lbs. dehydrated alfalfa meal and 0.80 lbs. cottonseed meal as their protein supplement. Furthermore, the average live weight value, a figure calculated from yield, grade and carcass value, was \$21.58, \$22.14, \$22.03 and \$21.79. The steers receiving the two levels of alfalfa hay were slightly fatter at the completion of the trial, as indicated by their carcass grade, yield and live weight value.

Due to the high cost of feed and the severe break in the fat cattle market during the winter, all lots in this trial lost money. It is of interest to note, however, that financial losses were less with steers that produced the most rapid gains and were the most efficient in converting feed to gain.

The results of this trial are somewhat in agreement with those reported by Baker et al. (1947, 1953) and Beeson et al. (1952) who obtained an increase in daily gain and lowered feed

Table I. Average results with dehydrated alfalfa meal and alfalfa hay as partial replacements for cottonseed meal in rations for fattening steer calves. (Trial 1, 1952-53, 163 days)

Lot and supplement	1	2	3	4
	CS meal	CS meal 1 lb. alf. hay	CS meal 3 lb. alf. hay	CS meal 2.6 lb. dehyd. alf.
No steers/lot	10	10	10	10
Average weight (lbs)				
Initial 10/26/52	474	473	474	472
Final 4/7/53	805	841	833	841
Total gain	331	368	359	369
Av. daily gain	2.03	2.26	2.20	2.26
Average daily ration (lbs)				
Rolled redland kafir	11.25	12.51	12.30	11.62
Cottonseed meal	1.91	1.50	.80	.80
Dehyd. alf. pellets				2.45
Alfalfa hay		1.00	3.00	
Sorghum silage	8.58	7.92	6.31	7.68
Mineral mix ¹	.04	.04	.04	.04
Total feed required/100 cwt. gain				
Rolled redland kafir	554	554	558	513
Cottonseed meal	94	66	36	35
Dehyd. alf. pellets				108
Alfalfa hay		44	136	
Sorghum silage	423	351	287	339
Feed cost/cwt. gain (\$)	25.38	24.20	23.80	24.38
Financial results (\$)				
Actual value/steer ²	21.58	22.14	22.03	21.79
Total value/steer	173.72	186.20	183.51	183.25
Initial cost @ \$28.00/cwt.	132.72	132.44	132.32	132.16
Total feed cost/steer	86.37	91.49	87.92	97.38
Total cost per steer ³	219.09	223.93	220.64	224.54
Net return per steer	-45.37	-37.73	-37.13	-41.29
Carcass data				
Yield %	60.9	61.6	60.4	61.1
Shrink to market %	3.4	5.5	4.0	4.0
Carcass grade				
Prime		2	2	1
Choice	10	8	8	9
Good				

¹ Two parts salt and one part bonemeal, free choice.

² A live market value was calculated/cwt./steer using live weight, dressing percent, carcass grade and current value of the carcass.

³ Includes cost of spraying for grubs and lice plus marketing, excluding trucking (\$2.31 per head).

cost per 100 lbs. gain when dehydrated alfalfa meal was fed as part of the protein supplement.

Trial II - 1953-54

The second fattening trial consisted of six lots of ten steer calves each. The steers were fed protein supplements consisting of cottonseed meal, alfalfa hay and dehydrated alfalfa meal in addition to a full-feed of rolled milo and a limited amount of silage. The average results are shown in Table II.

Steers of Lot 1 (basal) fed rolled milo, cottonseed meal and sorghum silage gained 1.89 lbs. per head daily, while those in Lots 2 and 3 in which one-fourth of the cottonseed meal was replaced by protein-equivalent amounts of either alfalfa hay or dehydrated alfalfa meal gained 1.95 and 2.05 lbs., respectively. When the levels of alfalfa hay and dehydrated alfalfa meal were increased to replace one-half of the cottonseed meal, daily gains were increased to 2.10 and 2.13 lbs., respectively. The steers in Lot 6, in which dehydrated alfalfa meal pellets completely replaced cottonseed meal as the protein supplement, gained 2.12 lbs. per head daily. When the weight gains were subjected to analysis of variance (Table III) there was a significant difference at the one percent level. The orthogonal comparisons revealed that most of this difference was accounted for in the comparison of the basal group (Lot 1) with all other lots receiving alfalfa.

Table II. Average results with alfalfa hay and dehydrated alfalfa meal pellets as partial replacements for cottonseed meal for fattening steer calves (Trial II, 1953-54, 166 days on test).

Lot and Protein Composition of Supplements	1	2	3	4	5	6
	CS meal	3/4 CS meal 1/4 alf. hay	3/4 CS meal 1/4 dehyd.alf.	1/2 CS meal 1/2 alf.hay	1/2 CS meal 1/2 dehyd.alf.	Dehyd. alf.
No of steers	10	10	9 ¹	10	10	10
Average weight (lbs.)						
Initial 10/23/53	514	514	510	515	516	513
Final 4/2/54	827	837	851	864	869	865
Total gain	313	323	341	349	353	352
Average daily gain	1.89	1.95	2.05	2.10	2.13	2.12
Average daily ration (lbs.) ²						
Rolled milo	11.89	12.83	13.12	13.31	13.11	13.24
Cottonseed meal	1.80	1.35	1.35	.90	.90	
Chopped alfalfa hay		1.15		2.31		
Dehydrated alfalfa meal pellets			.90		1.67	3.32
Sorghum silage	8.61	8.49	8.58	6.81	8.57	8.51
2:1 mineral mix	.03	.03	.03	.03	.03	.03
Feed required/cwt. gain						
Rolled milo	631	659	639	633	617	624
Cottonseed meal	95	69	66			
Chopped alfalfa hay		59		110		
Dehyd. alfalfa meal pellets			44		79	157
Sorghum silage	457	436	418	324	403	401

¹Two steers foundered in this lot; one was removed from the experiment while the other continued to make average gains and was left in the lot.

²One ounce of ground limestone was added to all lots except 4, 5 and 6 to assure ample calcium intake.

Table II. (continued) Average results with alfalfa hay and dehydrated alfalfa meal pellets as partial replacements for cottonseed meal for fattening steer calves (Trial II, 1953-54, 166 days on test).

Lot and Protein composition of Supplements	1	2	3	4	5	6
	CS meal	3/4 CS meal 1/4 alf. hay	3/4 CS meal 1/4 dehyd.alf.	1/2 CS meal 1/2 alf.hay	1/2 CS meal 1/2 dehyd.alf.	Dehyd. alf.
Feed cost per cwt. gain	21.24	21.92	21.44	20.65	20.93	21.75
Financial results (\$)						
Actual value of steers/cwt. ³	22.32	22.67	23.01	23.09	22.71	22.83
Total value/steer	184.59	189.75	195.82	199.50	197.34	197.48
Initial cost @ 18.90/cwt.	97.15	97.15	96.39	97.34	97.52	96.96
Total feed cost/steer	66.48	70.81	73.12	72.06	73.88	76.56
Total cost/steer ⁴	166.13	170.11	172.01	171.90	173.90	176.02
Net return/steer	18.46	19.64	23.81	27.60	23.44	21.41
Carcass data						
Yield % ⁵	60.93	61.22	61.58	61.38	61.17	61.01
Shrink to market % ⁵	+1.3	+ .4	+ .6	+ .8	+ .8	- .2
Carcass grade						
Prime			2	3	1	1
Choice	10	9	6	6	9	9
Good		1	1	1		

³ A live market value figure was calculated as described in footnotes of Table I.

⁴ Includes cost of spraying for grubs and lice plus marketing, excluding trucking (\$2.50 per head).

⁵ The shrink to market was obtained from weight of steers about two weeks before the end of the feeding trial.

Table III. Analysis of variance and orthogonal comparison of weight gains of steers fed various protein supplements. (Average of the 1953-54 test, 166 days on test.)

Analysis of Variance		
Source	d.f.	m.s.
Total	58	
Treatment	5	* 6,552
Lot 1 vs. 2, 3, 4, 5 and 6	1	*12,008
Lot 2 and 4 vs. 3 and 5	1	3,062
Error	53	1,318

*Significant at the 1% level.

The rate of gain of the basal group appears to have been adversely affected by lack of vitamin A in their ration. These steers received only the carotene supplied by the small amount of silage fed (estimated at 14 mg. per head daily). During the last fifty days on test, the steers of this lot had a lowered feed consumption as compared to steers of the other lots due to a pronounced lack of appetite. Later, symptoms such as lowered plasma vitamin A levels, thin and watery diarrhea, some evidence of night blindness, swelling about the hocks and stiffness of gait were noticeable.

Steers in Lots 4 and 5 fed alfalfa hay or dehydrated alfalfa meal as one-half their protein supplement, because of their increase in rate of gain, lowered feed cost per 100 lbs. gain and higher carcass grade, had a greater financial return than

any of the other steers. The steers in Lot 1 were valued at from \$0.35 to \$0.75 per cwt. less than the other lots in this test, and therefore were the least profitable group.

In this test, alfalfa hay was slightly less valuable than dehydrated alfalfa meal when each replaced one-fourth or one-half of the cottonseed meal protein. The alfalfa hay fed in this trial was rather stemmy and bleached. It was graded as No. 2 hay, and was low in carotene as indicated by the analysis shown in Appendix Table VII. Likewise, the dehydrated alfalfa meal which was purchased in June of the previous summer was high in protein, but quite low in carotene when fed. Thus, it seems possible that the steers of Lots 2 and 3 may not have received a carotene intake sufficient for maximum gains. It appears that considerable carotene was lost from the dehydrated alfalfa meal pellets while in storage.

Trial III - 1954-55

The average results obtained in the third fattening trial with eight lots of steer calves are shown in Tables IV and V. Essentially the same treatments were used in the first six lots as described for the second trial.

During the early part of the test, a respiratory infection broke out in Lot 5 and spread to all lots except Lot 1. Eventually all calves were treated with injections of penicillin and streptomycin. It was necessary to remove one steer from Lot 2 during the fifth week on experiment. It is impossible

Table IV. Average results with alfalfa hay and dehydrated alfalfa meal pellets as partial replacements for cottonseed meal in fattening rations for steer calves.
(Trial III, 1954-55, 163 days)

Lot and Protein Composition of Supplements	1	2	3	4	5	6
	CS meal	3/4 CS meal 1/4 alf. hay	3/4 CS meal 1/4 dehyd. alf.	1/2 CS meal 1/2 alf. hay	1/2 CS meal 1/2 Dehyd. alf.	Dehyd. alf.
No steers/lot	10	10 ¹	10	10 ¹	10	10
Average weight (lbs.)						
Initial 10/23/54	466	477	466	467	469	467
Final 4/5/55	839	860	847	833	838	834
Total gain	373	383	381	366	369	367
Av. daily gain	2.29	2.35	2.34	2.25	2.26	2.25
Average daily ration (lbs.) ²						
Rolled milo	13.5	14.0	13.6	13.3	13.1	13.4
Cottonseed meal pellets	1.6	1.2		.8		
Cottonseed meal-Dehyd. alf. pellets			2.2		2.5	
Dehyd. alf. meal pellets						3.4
Alfalfa hay		.9				
Sorghum silage	10.4	9.2	8.7	8.6	8.6	8.4
2:1 mineral mix	.06	.06	.06	.06	.06	.06
Feed required/cwt. gain (lbs.)						
Milo	592	598	582	592	580	585
Cottonseed meal pellets	70	52		35		
Cottonseed meal-Dehyd. alf. pellets			96		109	
Dehyd. alf. meal pellets						157
Alfalfa hay		40		80		
Sorghum silage	453	389	373	383	380	374

¹One steer was removed from Lot 2 early in the trial due to respiration infection and one steer from Lot 4 at the close of the trial because of disposition. Data is not included on these two steers.

²One ounce of ground limestone was added to daily ration of Lots 1, 2, and 3 to assure ample calcium intake.

Table IV. (continued). Average results with alfalfa hay and dehydrated alfalfa meal pellets as partial replacements for cottonseed meal in fattening rations for steer calves. (Trial III, 1954-55, 163 days)

Lot and Protein Composition of Supplements	1	2	3	4	5	6
	CS meal	3/4 CS meal 1/4 alf. hay	3/4 CS meal 1/4 dehyd. alf.	1/2 CS meal 1/2 alf. hay	1/2 CS meal 1/2 dehyd. alf.	Dehyd. alf.
Feed cost/cwt. gain (\$)	19.34	19.10	19.25	19.89	19.26	20.22
Financial results (\$)						
Actual value of steers/cwt. ³	22.44	23.52	22.61	22.10	22.83	22.34
Total value/steer	188.27	202.27	191.51	184.93	189.32	186.32
Initial cost @ \$21.00/cwt.	97.86	100.17	97.86	98.07	98.49	98.07
Total feed cost/steer	72.14	73.15	73.35	69.06	71.07	74.22
Total cost/steer ⁴	170.00	173.32	171.21	167.13	169.56	172.29
Net return/steer	18.77	28.95	20.30	17.80	19.76	14.03
Carcass data						
Yield %	61.73	61.32	61.70	62.85	62.12	60.39
Shrink to market %	3.2	2.3	2.4	3.2	2.1	1.1
Carcass grade						
Prime						
Choice	8	9	9	7	10	9
Good	2		1	2		1

³A live market value was calculated as described in footnotes of Table I.

⁴Includes cost of treating for grubs and lice, \$0.30/head.

to state definitely if any calves were permanently affected. However, since most of the calves appeared to recover rapidly upon treatment and went ahead to make excellent gains, it appeared that the disease did not materially affect the results of the trial.

The addition of alfalfa hay or dehydrated alfalfa meal had only slight effect on daily gains. The steers of Lot 1 (basal) fed only cottonseed meal as their protein supplement gained 2.29 lbs. per head daily. The greatest daily gains, 2.35 and 2.34 lbs., were made by steers in Lots 2 and 3, in which one-fourth of the cottonseed meal was replaced by alfalfa hay or dehydrated alfalfa meal. Steers in Lots 4 and 5, fed alfalfa hay or dehydrated alfalfa meal as one-half their protein supplement, gained 2.25 and 2.26 lbs. per head daily, while the steers fed dehydrated alfalfa meal as the only protein supplement (Lot 6) produced a daily gain of 2.25. When the weight gains were subjected to an analysis of variance, there was no significant difference in performance among the lots.

There was no appreciable difference in feed required per cwt. gain, or cost of 100 lbs. gain among the different lots. The steers of Lot 2, fed alfalfa hay at the one-fourth replacement level, produced the greatest financial return of \$28.95 per steer. This was \$14.91 per head more profit than was realized from the least economical steers (Lot 6). It appears from the three trials reported in this study that dehydrated alfalfa meal when used as the only protein supplement was one of the least

economical supplements. Although the rate of gain was essentially as high as when alfalfa hay and dehydrated alfalfa meal was fed at lower levels, the difference in financial return was due to the higher cost of dehydrated alfalfa meal on a protein-equal basis as compared to cottonseed meal. In similar studies, Klosterman et al. (1953) also reported an increase in cost per 100 lbs. gain when dehydrated alfalfa meal was used as the only protein supplement. From the results of this experiment, in terms of daily gain and profit, there appears to be no advantage in replacing more than one-half of the cottonseed meal with dehydrated alfalfa meal pellets.

The work of Baker et al. (1947, 1953), as well as the first two trials of this experiment, showed that additions of 1.0 lb. or more of dehydrated alfalfa meal increased efficiency of gain and markedly improved performance over the basal ration. However, the results of the third trial reported failed to show any such advantage.

In the first two trials, symptoms of vitamin A deficiency were noted in the basal lot which received no alfalfa. In the third trial, no symptoms of vitamin A deficiency were noted while the steers were on test. However, while the steers were on the Oklahoma City yards waiting to be sold, it was noted that one steer in the basal lot had a bad swelling of the right front leg, and that two other steers of the same lot were watering badly at the eyes. When the steers were slaughtered, it was necessary

to trim five out of the ten carcasses of steers from the basal lot due to swelling of the shank and brisket.

Because of the increase in daily gains in the first two trials, when alfalfa hay or dehydrated alfalfa meal was fed, two additional lots were included in the third trial in an attempt to determine the reason for this growth response. As shown in Table V, the addition of 15 mg. of crude carotene concentrate per head daily to Lot 7, or the addition of the same amount of carotene plus alfalfa ash (equivalent to that contained in about 1.0 lb. of alfalfa hay) for Lot 8, failed to improve performance of these steers over the basal ration. These results are not in complete agreement with the findings of Klosterman et al. (1953) in which the ash of 1.75 lbs. of alfalfa produced equally as good results as feeding equivalent amount of dehydrated alfalfa meal when both were added to a fattening ration containing low quality timothy hay. Both the meal and the ash produced greater gain than did soybean oil meal alone.

Chemical analysis of the sorghum silage fed in this trial revealed a relatively high amount of carotene, as shown in Appendix Table VII, despite a severe drought during the growing season. From the sorghum silage, it is estimated that the calves of Lot 1 obtained nearly 28 mg. of carotene in their daily ration. According to Morrison (1952), 600 to 800 pound steers would need 30 to 40 mg. of carotene per day for normal growth. The carotene in the silage along with their liver storages apparently met the vitamin A requirement for calves of the basal lot over the

Table V. Average results obtained from the addition of carotene or carotene plus alfalfa ash to fattening rations for steer calves. (Trial III, 1954-55, 163 days)

Lot number and Supplements	1	7	8
	CS meal	CS Meal + Carotene	CS meal + Carotene + Alf Ash
No steers/lot	10	10 ¹	10
Average Weight (lbs)			
Initial 10-23-54	466	462	467
Final 4/5/55	839	824	838
Total gain	373	362	371
Av. daily gain	2.29	2.22	2.28
Average daily ration (lbs) ²			
Rolled milo	13.5	13.9	13.6
Cottonseed meal pellets	1.6	1.6	1.6
Carotene content (mg)		15	15
Alfalfa ash			108
Sorghum silage	10.4	10.4	10.4
2:1 Mineral Mix.	.06	.06	.06
Feed required/cwt. gain (lbs)			
Rolled milo	592	612	588
Cottonseed meal	70	72	70
Sorghum silage	453	466	458
Feed cost/cwt. gain (\$) ³	19.34	21.46	21.34
Financial results (\$)			
Market value of steer/cwt.	22.44	22.77	22.39
Total value/steer	188.27	187.62	187.69
Initial cost/steer @ \$21/cwt.	97.86	97.02	98.07
Total feed cost per steer	72.14	77.69	96.15
Total cost per steer ⁴	170.00	172.71	177.53
Net return per steer	18.27	14.91	10.16
Carcass data			
Yield %	61.73	62.83	62.44
Shrink to market %	3.2	3.0	2.1
Carcass grade			
Prime			
Choice	8	7	5
Good	2	2	5

¹One steer removed from Lot 7 due to urinary calculi and not included in these data.

²One ounce of ground limestone was added to the daily ration of all steers.

³Includes cost of carotene (\$0.03 per day) and mineral. Alfalfa ash calculated to hay equivalent in computing cost.

⁴Includes cost of \$0.30 for treating for grubs and lice.

163-day feeding period. There was no analysis for carotene content of the sorghum silage in the first trial, but in the second trial in which there was a vitamin A deficiency, the calves obtained only 12.05 mg. per head daily from the silage as compared to 28 mg. during the third trial.

From the results of this experiment, it appears that the response from alfalfa may be due mainly to its carotene content. These results are not in complete agreement with those reported by Baker et al. (1947, 1953) and Beeson et al. (1952) in which greater response was obtained than could be explained by the protein or carotene content of the dehydrated alfalfa.

The work reported herein has indicated that the carotene content of the alfalfa may be one of the most important beneficial factors from the feeding of alfalfa. Therefore, preservation of large amounts of carotene in the alfalfa appears to be a serious consideration. In recent research, Mitchell and Silker (1950) and Brunius and Kellestrom (1946) have shown that dehydrated alfalfa meal, in mixtures with cottonseed meal, will maintain a higher percentage of its carotene content during storage than straight dehydrated alfalfa meal. With this in mind, the dehydrated alfalfa meal fed Lots 3 and 5 in Trial III were mixed in proper proportions with cottonseed meal and pelleted shortly after obtaining it in June. The dehydrated alfalfa fed Lot 6 was also pelleted, and a representative sample of meal was unpelleted as a check on carotene loss in storage. The results are shown in

Table VI. There was a high loss of carotene (approximately 50 percent) from the pelleting process alone. Even after this severe loss, the pelleted meals continued to lose approximately the same amount of carotene as the loose meal. The loss in carotene from the alfalfa hay was gradual throughout the feeding period. As shown in Table VI, apparently there was no advantage in mixing the alfalfa with cottonseed meal and pelleting in terms of maintenance of carotene stores.

In the second trial, grade No. 2 alfalfa hay was slightly less valuable than dehydrated alfalfa meal when each replaced one-fourth or one-half of the cottonseed meal protein. However, in the third trial there was very little difference in value of No. 1 extra leafy alfalfa hay and dehydrated alfalfa meal. Considering all trials, dehydrated alfalfa meal was worth only 73 percent of cottonseed meal and alfalfa hay 49.32 percent at the one-half replacement level as a protein supplement for fattening steer calves. At the same time, dehydrated alfalfa meal was worth only 49 percent of cottonseed meal when fed as the only protein supplement.

Table VI. Carotene loss by periods for dehydrated alfalfa meal and alfalfa hay in Trial III.

Date analyzed	Dehydrated alfalfa meal		Dehydrated alfalfa meal pellets		¹ Lot 3 Pellets		¹ Lot 5 Pellets		Alfalfa hay	
	Carotene mg/lb	% loss	Carotene mg/lb	% loss	Carotene mg/lb	% loss	Carotene mg/lb	% loss	Carotene mg/lb	% loss
July 1954 ²	99.40	---	80.16	---	34.58	---	42.72	---	56.31	---
Sept. 1954	73.40	26.16	34.00	57.58	20.10	41.88	20.30	52.48	36.50	35.19
Nov. 1954	71.70	27.87	38.80	51.60	21.00	39.28	18.90	55.76	29.70	42.26
Dec. 1954	48.60	51.11	28.00	65.07	14.00	59.52	21.40	50.00	24.90	55.79
Feb. 1955	51.46	48.22	25.17	68.50	11.62	66.40	17.33	59.63	---	---
April 1955	---	---	30.1	62.45	11.29	67.36	20.77	51.38	22.1	60.76

¹ Lot 3 pellets contained 59% cottonseed meal and 41% dehydrated alfalfa meal. Lot 5 pellets contained 33% cottonseed meal and 67% dehydrated alfalfa meal.

² Difference in carotene content between the dehydrated alfalfa meal and dehydrated alfalfa meal pellets reflects loss in the pelleting process.

SUMMARY

Three fattening trials involving 210 steer calves were conducted to study the value of alfalfa hay or dehydrated alfalfa meal as replacements for cottonseed meal on a protein-equal basis. Alfalfa hay replaced cottonseed meal at levels of one-fourth and one-half of the protein supplement, while dehydrated alfalfa meal was substituted at the one-fourth, one-half and full replacement levels. The steers were fed a basic ration of rolled grain sorghums (full-fed), protein supplement and a limited amount of sorghum silage for a period of approximately 165 days.

In the first two trials, an increase in rate of gain and a decrease in feed cost per 100 lbs. gain, above that obtained with the basal ration, resulted when at least 1.0 lb. (one-fourth replacement level) of alfalfa hay or dehydrated alfalfa meal was fed. However, only in the second trial was the difference in weight gains statistically significant. In the second trial, the feeding of alfalfa hay or dehydrated alfalfa meal at the one-half replacement level (2.0 lbs. per steer daily) produced greater gain than when fed at the one-fourth replacement level (1.0 lb. per head daily).

In the third trial there was no consistent advantage from feeding alfalfa hay or dehydrated alfalfa meal as part of the

protein supplement. In all trials, there appeared to be no advantage from feeding dehydrated alfalfa meal to replace more than one-half of the cottonseed meal.

In the first two trials, there were indications of vitamin A deficiency symptoms among the steers of the basal lot receiving no alfalfa. However, in the third trial there were no symptoms of a deficiency during the feeding test, apparently due to the relatively high carotene content of the sorghum silage. Also, in the third trial the addition of a crude carotene concentrate, or carotene plus alfalfa ash, failed to show any improvement over the basal ration. The results indicate that the response obtained from feeding alfalfa in the first two trials may have been due principally to its carotene content. When the requirement for carotene was met by other ingredients in the type of ration used in these trials, there was no advantage from feeding alfalfa hay or dehydrated alfalfa meal. The alfalfa products proved to be the less economical sources of protein. It appeared that the mineral content of the alfalfa did not improve performance of steers fed this type of basic ration.

In this study there was very little difference in value of alfalfa hay compared to dehydrated alfalfa meal. Based on the feed prices used in these trials, dehydrated alfalfa meal was worth 73 percent of cottonseed meal, and alfalfa hay worth 49.3 percent, when fed at the one-half replacement level. Dehydrated alfalfa meal was worth only 49 percent of cottonseed meal when fed as the only protein supplement.

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APPENDIX

Appendix Table VII. Chemical composition of feeds used in fattening trials with steer calves.

	Percent dry matter	Percentage composition of dry matter							Carotene mg/lb ¹
		Ash	Protein	Fat	Crude fiber	N.F.E.	Ca.	P.	
1952-53 Trial									
Corn	86.60	1.65	9.17	4.67	1.92	82.65	.07	.11	
Cottonseed meal	94.01	6.49	41.99	5.37	10.18	35.96	.19	.76	
Alfalfa hay	91.06	9.21	17.54	1.26	33.69	37.39	1.00	.16	
Sorghum silage	32.94	5.87	4.31	3.55	26.56	47.75	.33	.01	
Dehydrated alf. meal pellets	—	—	—	—	—	—	—	—	
1953-54 Trial									
Milo	84.78	1.16	10.77	2.25	1.57	69.05	.65	.70	—
Cottonseed meal	92.52	6.17	38.38	7.67	9.22	30.49	—	—	—
Alfalfa hay	91.38	9.64	21.67	4.24	17.37	38.05	—	—	40.9
Dehyd. alf.meal pellets	90.76	9.54	16.23	3.42	26.11	34.07	—	—	25.3
Sorghum silage	31.66	2.12	1.75	1.45	6.88	19.06	.13	.04	1.4
1954-55 Trial									
Milo	89.81	1.81	10.13	2.84	1.70	73.33	.06	.29	—
Cottonseed meal	92.32	5.89	43.28	3.54	10.51	29.10	.18	.835	—
Lot 3 pellets ²	94.64	10.06	31.47	4.71	15.19	33.21	.68	.287	7.5
Lot 5 pellets	95.21	12.20	27.77	4.45	15.19	34.88	.77	.259	8.83
Dehyd. alf.meal pellets	95.55	16.58	19.19	3.45	18.41	38.02	1.21	—	12.72
Alfalfa hay	91.54	9.33	18.83	2.83	23.88	36.67	1.25	—	16.73
Sorghum silage	30.00	2.33	1.95	1.05	4.61	20.04	.135	.052	2.8

¹Represents an average of four analyses made at intervals during the trial for carotene in Lots 3, 5 and dehydrated alfalfa meal pellets. Carotene value of silage represents an average of two analyses.

²For percent composition of Lot 3 and 5 pellets, see footnotes to Table VI.

Appendix Table VIII. Feed prices per ton used in fattening trials with steer calves (Dollars).

Trial	I 1952-53	II 1953-54	III 1954-55
Milo	66.00	51.40	49.60
Cottonseed meal	106.00	66.00	80.00
Alfalfa hay	30.00	30.00	30.00
Dehydrated alfalfa meal	72.00	48.00*	50.00
Lot 5 pellets	-----	-----	68.20
Lot 3 pellets	-----	-----	66.40
Sorghum silage	10.00	8.00	8.00
Mineral mixture	48.33	38.60	43.33

*Includes \$2.00 per ton for cost of pelleting.

Appendix Table IX. Carcass prices used in calculating live market value/steer.

Trial	I 1952-53	II 1953-54	III 1954-55
Prime	38.50	40.00	41.00
Prime-	37.50	39.00	40.00
Choice +	36.00	38.00	37.50
Choice	35.50	37.00	37.00
Choice-	35.00	36.00	36.50
Good +	33.00	35.00	34.50
Good	32.50	34.00	34.00
Good-	32.00	33.00	32.00
Comm. +	31.00	32.00	31.00
Comm.	30.00	31.00	30.00

¹Chicago prices obtained from the National Provisioner minus 1.00/cwt. for freight differential. These prices were calculated from an average of four weekly prices nearest the time the calves were sold.

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Thesis: ALFALFA HAY AND DEHYDRATED ALFALFA MEAL IN FATTENING
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