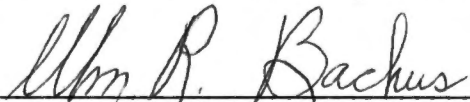
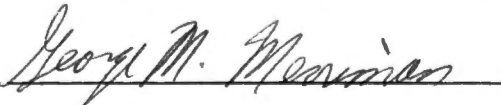


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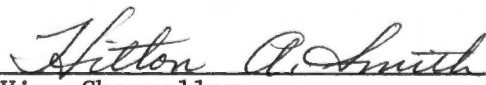
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EFFECT OF DIFFERENT SOURCES AND LEVELS OF PROTEIN
ON THE PERFORMANCE OF FEEDER HEIFERS

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee

Dwight Allan Kaufman

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ABSTRACT

The purpose of this experiment was to determine the effects on feedlot performance and carcass characteristics of slaughtered heifers when grown and fattened on a urea-limestone treated corn silage ration in which the average daily crude protein intake per head was 0.8, 0.9, and 1.0 kg. (1.7-1.8, 1.9-2.0, and 2.1-2.2 lbs.) and to test for any difference between cottonseed meal and urea as an additional supplemental protein source.

In addition to corn silage ad libitum, each animal received 2.7 kg. (6.0 lbs.) of concentrate per day during a 140 and 110 day roughage phase for Trial I and II, respectively, to provide three different levels of protein. The concentrate portion of ration 1 consisted of corn only and provided 0.8 kg. (1.7-1.8 lbs.) of crude protein per head per day. Concentrate in rations 2 and 4 consisted of corn plus cottonseed meal and provided 0.9 kg. and 1.0 kg. (1.9-2.0 and 2.1-2.2 lbs.) of crude protein per head per day, respectively. Rations 3 and 5 consisted of corn plus urea and provided 0.9 kg. and 1.0 kg. (1.9-2.0 and 2.1-2.2 lbs.) of crude protein per head per day, respectively. The heifers were full fed a concentrate ration of eight parts cracked shelled corn to one part cottonseed meal following the roughage phase.

Animals were finished to a predetermined, ultrasonically measured fat thickness.

There were a few significant ($P < .05$) differences in feedlot performance and carcass characteristics between treatments. However,

the significances were not found in traits of economic importance in either trial.

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CHAPTER I

INTRODUCTION

Increased utilization of forages, such as corn silages, in growing and finishing beef cattle could result in increased efficiency of production and income to the beef industry in the southeast.

Forages have long been utilized to produce beef in the southeast (Glenn, 1866). Pastures and hays were the principal feeds used to produce three- to four-year-old slaughter steers.

However, the increased consumer demand for meat with less fat, more lean and tenderness has resulted in increased nutritional requirements for growth, especially protein. Some forage, such as corn silage, are low in crude protein. Research at The University of Tennessee has demonstrated that urea-limestone treated corn silage supplemented with ground shelled corn is an economical growing finishing ration.

Non-protein nitrogen (NPN), especially urea, has been used to replace part of the natural protein supplements, depending on age and desired growth of the cattle, in growing and finishing rations. However, neither the level of urea nor the percentage of natural protein that can be replaced by NPN sources in the rations of young growing-finishing cattle has been definitely determined. Addition of a higher percentage of NPN source to a ration could be profitable because of its lower cost compared to natural protein sources.

Requirements published by the National Research Council (1970) and results from previous feeding trials by The University of Tennessee have indicated that .8 kg. (1.7 to 1.8 lb.) of crude protein per head per day produced satisfactory gains in growing and finishing slaughter heifers.

The objectives of this experiment were the following:

1. To study the effects of three levels of crude protein for growing and finishing feeder heifers.
2. To evaluate two sources of crude protein (urea vs. cottonseed meal) for growing and finishing feeder heifers.

CHAPTER II

REVIEW OF LITERATURE

I. PROTEIN LEVELS

The protein level for finishing 600 lb. calves as short yearlings has been established as 1.8 lbs. crude protein per day, 1.3 lbs. digestible protein per day, or 11 percent crude protein in the ration. These levels were recommended by Morrison (1961) and the National Research Council (1963). In recent years these levels have been converted to the metric system. Thus, the protein levels, according to the National Research Council (1970), for finishing 300 kilogram (661 lb.) heifer calves is either 0.89 kilograms (1.95 lbs.) crude protein per day or 0.59 kilograms (1.3 lbs.) digestible protein per day.

II. DETERMINING THE REQUIREMENTS

According to Armsby (1971), the German scientist Gorien, in 1858, was the first to specifically determine the protein requirements of farm animals in crude terms. Later Wolff, in 1864, expressed the protein requirements as digestible nutrients. Kellner, in 1905, prepared a system using starch values and used only total protein for his standards. Henry and Morrison reviewed past work and proposed using "Digestible protein per thousand pound" with varying age groups as a statement of protein requirements. These levels were the basis of the nitrogen balance trials conducted by the National Research Council (1921) to determine the correct protein requirements. The National

Research Council (1921) indicated that 2.40 lbs. of digestible protein per thousand pounds for a six-month-old calf was adequate for normal growth. The National Research Council (1921) derived these figures from the equation

$$G = \frac{135}{A + 20}$$

where G is the increase of protein per day per 100 lbs. body weight and A is the age of the animal in days. The National Research Council (1929) set the daily maintenance requirements of a 600 lb. calf at 0.59 lbs. of digestible protein for the normal growth. The National Research Council (1929) then determined the protein requirements for fattening animals by the factorial method. The National Research Council (1970) used these aforementioned standards plus results from feeding trials as the basis of the feeding standards used today by most authorities. If the factorial method is used as the only source to establish the protein requirements, the level needed will be slightly lower as was shown by the Agriculture Research Council (1965).

III. TESTING REQUIREMENTS

To insure that the protein requirements are still accurate, feeding trials periodically are run by different institutions. Testing protein requirements may be the primary reason for conducting a feeding trial or a useful addition to feeding experiments.

Gerlaugh (1930) and Gerlaugh and Rodgers (1938) were some of the early researchers to test National Research Council (1929) protein requirements for fattening yearling steers weighing 600 lbs. In both

studies linseed meal, whole soybeans, cottonseed meal, and equal mixtures of each were fed to 600 lb. yearling steers at the rate of 1.8 lbs. of crude protein per day. These rations produced adequate average daily gains of approximately 2.20 lbs.

Gerlaugh (1936) conducted an experiment involving fattening 400 lb. steer calves fed to 900 lbs. He fed five different groups a 45 percent crude protein supplement, varying the levels of supplement every twelve weeks for forty-eight weeks. The daily crude protein levels were as follows: Group 1 was fed 0.8 lbs. crude protein throughout the 48-week period; Group 2 was fed 0.8, 1.6, 2.4, and 3.2 lbs.; Group 3 was fed 2.4 lbs. of crude protein throughout the 48-week period; Group 4 was fed 2.4, 1.6, 0.8, and 0.0 lbs. of crude protein and Group 5 was fed 1.6 lbs. of crude protein. There was a significant difference between the first group and the other four groups in average daily gain indicating that 0.8 lbs. crude protein was inadequate for fattening steer calves.

Keith et al. (1967) fed 420 lb. steers and heifers to a weight of 900 lbs. adjusting the crude protein levels to 12, 14, 16, and 19 percent in each respective ration. The cattle fed the 12 percent protein ration gained significantly slower than the other three groups. Haskings et al. (1967), found that cattle receiving a 14 percent ration gained significantly faster than cattle receiving an 11 percent ration.

Kay et al. conducted a similar experiment with growing steers fed 11, 14, and 17 percent crude protein on a dry matter basis. Results indicated that dry matter intake and average daily gain were significantly less in the 11 percent level group than among the other two

levels until the cattle reached 250 kg. live weight. Above 250 kg., weight gains were similar in all three groups. The dry matter and apparent nitrogen digestion were lowest with the 11 percent level throughout the test.

Not all investigators obtained this desirable increase in performance when the protein level was increased. Goodrich et al. (1961) fed crude protein levels of 9.5, 10.6, 12.0, and 12.7 percent. Gain and feed efficiency were 2.42, 925; 2.55, 878; 2.46, 885; and 2.39, 903 lbs., respectively. Results indicated that the 10.6 percent crude protein level was significantly superior to the other protein levels. Harris et al. (1954) obtained similar results when he fed crude protein levels of 1.49, 1.66, 1.80, 1.95, and 2.08 lbs. per head per day to 750 lb. steers during a two-year study. Average daily gains were 2.02, 2.15, 2.25, 2.08, 1.97, and 1.78 lb. for each level, respectively. Harris concluded that 1.8 lb. of crude protein per head per day was superior to either higher or lower levels.

When the amount of protein is lowered from the established standard level, a decrease is noticed in the performance of the animals. Klosterman et al. (1959) lowered the digestible protein level fed to 480 lb. calves. In one study, he lowered the protein level from 1.22 lbs. per head per day to 1.00 lb. which resulted in a significant decrease in average daily gain from 2.14 to 2.01 lbs. per day.

Bond et al. (1962) found that when the protein level was considerably decreased from the required level the average daily gain and feed efficiency significantly decreased. Daily crude protein intake levels of 0.54, 0.44, 2.10, 2.19, and 1.80 lbs. resulted in average

daily gains of 0.02, 0.02, 1.73, 2.10, and 2.26 lbs. for each level, respectively. Cattle fed the recommended level of 1.8 lb. of crude protein per day made significantly greater average daily gains and had greater feed efficiency than the other groups.

Bedrak et al. (1964) and Winchester et al. (1957) also found that when the protein levels were markedly reduced from the recommended level the feedlot performance of the animal was also decreased. The decreased protein level caused the animals to decrease in dry matter and energy consumption resulting in lowered performance.

IV. COTTONSEED MEAL AS A NITROGEN SOURCE

Cottonseed meal is the product which results from finely grinding the cake which remains following removal of most of the oil from cottonseeds. The value of this meal as a livestock feed has been demonstrated by both experiment stations and practical livestock feeders.

According to Curtis (1938) cotton-gin by-products were the first source of cottonseed products available for livestock feeding. Kilgore (1896) stated that cottonseed meal was fed in the United States prior to 1860 and in England prior to 1864. However, in most instances, the entire hull of the cottonseed was fed rather than the meal. According to Butler (1928) the use of the meal became more popular due to increased economic importance of the cottonseed oil for human consumption. Kilgore (1896) stated that increased use of cottonseed meal in livestock corresponded to increases in oil production. The use of cottonseed meal expanded to other regions outside the South. It was used

V. UREA AS A NITROGEN SOURCE

Protein is often the major limiting nutrient for ruminants. Protein-rich legumes are not widely grown in many areas grazed by ruminants, and vegetable protein supplements are usually expensive or not available. In many countries the manufacture of urea and ammonia for use as fertilizer has expanded but these compounds could be used more extensively in feeds for ruminants. The ability of the rumen micro-organism of cattle and sheep to utilize these non-protein-nitrogen sources to form protein that can be converted to meal by the animals represent an important contribution to man's food supply.

Loosli and McDonald (1968) stated that urea was discovered by Roxelle in 1773 and its composition established by Pratt in 1818. Morgan in 1925, supplementing past investigations with his own works found that urea could replace 30-50 percent of the protein in rations of cattle and sheep. Scarcity of vegetable protein for feeds during the first World War stimulated research in urea synthesis and on its use in ruminant feeds. Not all studies yielded favorable results. It was discovered that the unfavorable results resulted from feeding excessive levels of urea or lack of trace minerals in the rations.

Toxicity

Parham et al. (1955) found that toxic effects occurred when urea made up 30 percent of the total crude protein in the ration. Dinning et al. (1949) reported that urea should not exceed 2 percent of the total ration (dry matter basis).

Gallup et al. (1953) and Whitehair et al. (1955) reported that death occurred when 30 grams per 50 kg. of body weight of urea was fed to lambs.

Palatability

Culbertson et al. (1949) found that 0.31 lb. of urea per day did not adversely affect ration palatability. Bartly (1969) in a review of urea research, stated that reduced palatability occurred when urea was fed at the rate of 0.6 to 0.8 lb. per head per day.

Feeding Investigation

Connell et al. (1944) concluded that feeding 0.18 lb. per head per day of urea had no effect on the subsequent value of the carcass but produced a lower average daily gain than the feeding of a conventional ground hay ration. Baker et al. (1949) indicated no significant difference in average daily gain when urea was used as the sole source of supplemental protein compared to soybean oil meal with a corn silage based ration. Culbertson et al. (1949) reported no significant difference in performance of cattle fed either 0.2 lb. of urea per head daily or vegetable protein with corn silage. Van Arsdell et al. (1953) reported that supplements composed of urea and corn produced significantly better performance than corn and soybean meal as top dressings for corn silage. Bell et al. (1954) found no significant difference in average daily gain when cottonseed meal was replaced by urea and corn as a crude protein source in a grass hay ration.

VI. UREA VERSUS COTTONSEED MEAL AS A NITROGEN SOURCE

Clark et al. (1967) found no difference in rate or economy of gain by feeder heifer calves when comparing a complex protein supplement containing 63.5 percent cottonseed meal with one containing 15.0 percent dehydrated alfalfa meal and 5.0 percent urea. However, Essig and Smithson (1969) reported that calves on a high sorghum silage ration gained more rapidly when fed cottonseed meal as a source of crude protein than animals fed urea. Bell et al. (1957) reported that cattle fed a fattening ration supplemented with cottonseed meal gained 0.29 lb. more per day than cattle fed an identical ration but supplemented with urea.

Barth et al. (1968), in comparing urea with cottonseed meal in digestion and metabolism experiments, found that the total digestible nutrient values were higher in the urea ration, but that nitrogen utilization was approximately the same when a high-concentrate ration was fed. When a high-silage ration was fed, the steers fed high-urea rations retained less of the absorbed nitrogen than those fed cottonseed-meal rations.

In summary, research reviewed has indicated that urea or cottonseed meal plus a cereal grain and roughage produces satisfactory growing-finishing rations for beef cattle. Satisfactory daily gains by growing and finishing 600 lb. cattle may be produced by feeding 1.8 lb. of crude protein per day. However, a deviation from the 1.8 lbs. level of daily crude protein intake seems to produce conflicting results.

CHAPTER III

EXPERIMENTAL PROCEDURE

Data for this study were collected over a two-year period from experiments conducted at The University of Tennessee's Blount Farm, Knoxville, Tennessee. The first experiment was conducted during the fall and winter of 1969-1970 (Trial I) and the second experiment was conducted during the fall and winter of 1970-1971 (Trial II). The purpose of these experiments was to determine the effects of various crude protein levels and sources on the feedlot performance and carcass characteristics of feeder heifers.

I. SOURCE AND DESCRIPTION OF DATA

Data for this study were collected from 234 Angus, Hereford, and crossbred heifers with an initial weight range of 204-249 kg. (450-550 lbs.). Fifty-four and 180 heifers were utilized in the 1969-1970 and 1970-1971 studies, respectively. The heifers were purchased at Tennessee graded feeder-calf sales each year of the experiment. Upon arrival at the experimental facilities the heifers were weighed, identified, and placed on a three-week adjustment period to recover from the stress of weaning and sale.

II. CLASSIFICATION OF DATA

Following the three-week adjustment period, the heifers were weighed, sonorayed for fat thickness, implanted with 24 mg. of diethylstilbestrol

and graded for type and condition by members of the Animal Husbandry-Veterinary Science Department. On the basis of weight, type and condition grades the heifers were randomly allotted into uniform lots of six heifers each and were assigned to one of the following treatments with three lots per treatment in 1969-1970 and six lots per treatment in 1970-1971.

Treatment I: This treatment consisted of 140 day (1969-1970) and 110 day (1970-1971) roughage periods in which the heifers were fed corn silage ad libitum twice daily with increases or decreases in daily feed levels based on the amount remaining in the feed trough from the previous day. Refused silage was removed and weighed on Monday, Wednesday, and Friday of each week. Water and minerals were available free choice. In addition, each heifer received approximately 2.7 kg. (6.0 lb.) of cracked corn daily. The silage had been treated with 0.5 percent feed grade urea and 0.5 percent limestone at time of ensiling. Daily crude protein intake was calculated to be 0.77 to 0.82 kg. (1.7-1.8 lbs.) per head.

Treatment II: Treatment II was identical to Treatment I with the exception that the daily 2.7 kg. (6.0 lb.) concentrate intake was composed of 5.4 parts cracked corn and 0.6 parts cottonseed meal. Daily crude protein intake was calculated to be 0.86 kg. (1.9 lb.) to 0.91 kg. (2.0 lb.).

Treatment III: Treatment III was identical to Treatment I also, with the exception that the daily 2.7 kg. (6.0 lb.) concentrate intake was composed of 5.9 parts cracked corn and 0.1 parts feed grade urea.

Daily crude protein intake was calculated to be 0.86 kg. (1.9 lbs.) to 0.91 kg. (2.0 lb.).

Treatment IV: Treatment IV was identical to Treatment I with the exception that the daily 2.7 kg. (6.0 lb.) concentrate intake was composed of 4.75 parts cracked corn and 1.25 parts cottonseed meal. Daily crude protein intake was calculated to be 0.95 kg. (2.1 lbs.) to 1.0 kg. (2.2 lbs.).

Treatment V: Treatment V was identical to Treatment I with the exception that the daily 2.7 kg. (6.0 lb.) concentrate intake was composed of 5.8 parts cracked corn and 0.2 parts feed grade urea. Daily crude protein intake was calculated to be 0.95 kg. (2.1 lbs.) to 1.0 kg. (2.2 lbs.).

It may be noted that Treatments II and III provided equal amounts of crude protein and Treatments IV and V were equal in crude protein levels. Treatment I, on the other hand, delivered a lower amount of crude protein than the other four. The composition of the respective concentrate supplements were the only differences.

Following the roughage phase, all cattle were placed on a fullfeed phase in which the heifers were given a full feed of concentrate of corn-cottonseed meal in an 8-1 ratio plus 1.8 kg. of mixed hay per head per day. This phase was terminated after the cattle reached a predetermined fat thickness.

III. COLLECTION OF DATA

Cattle were weighed and sonorayed for fat thickness at the initiation and conclusion of each experimental phase. In addition,

weights were recorded at 14-day intervals and sonoray measurements were taken at 28-day intervals throughout the experiments. Initial and final weights were taken at 7:00 a.m. with animals being removed from feed and water the previous night. When an animal was found ultrasonically to meet or exceed its designated fat thickness it was sent to slaughter. Cattle were also evaluated for condition grade by members of the Animal Husbandry-Veterinary Science Department at the beginning of each experiment, at the end of each roughage phase and prior to slaughter.

When ready for slaughter, the cattle were weighed, condition graded, and trucked to a local packing plant where they were again weighed, slaughtered and hot carcass weights obtained. Carcasses were chilled 48 hours. A U.S.D.A. grader then estimated, for each carcass, the quality grade, conformation, maturity, marbling, and percent kidney fat. Fat thickness and loin-eye area were measured according to procedures outlined by the American Meat Science Association (Schoonover et al., 1967). In addition, percent separable lean (Cole et al., 1962), percent retail cuts and yield grades (Murfhey et al., 1960) were calculated.

IV. CHEMICAL ANALYSIS OF FEED

Proximate analysis of samples of feeds were made according to A.O.A.C. (1965) recommendations. Samples were taken from each treatment periodically and analyzed. From these analyses the rations were rebalanced, if required, to maintain the daily crude protein levels as constant as possible.

V. STATISTICAL ANALYSIS

Statistical analyses were made and included the following dependent variables. (A two-way analysis of variance was used.)

1. Weight (initial, roughage, final)
2. Average daily gain (roughage, fullfeed, overall)
3. Feed cost per 45.5 kg. gain (roughage, fullfeed, overall)
4. Dry matter per 45.5 kg. gain (roughage, fullfeed, overall)
5. Condition grade (roughage, fullfeed, overall)
6. Dry matter consumed per day (roughage, fullfeed, overall)
7. Average feed cost per head
8. Average return per head
9. Carcass characteristics which included U.S.D.A. grade, dressing percentage, marbling score, ribeye area (sq. cm.) fat thickness (mm.), percent kidney fat, yield grade, percent retail cuts, and kgs. of separable lean.

All statistical analyses were made at the 5 percent level of probability of chance occurrence ($P < .05$). When the analysis of variance showed significance, a range test was made using Duncan's Multiple Range Test as outlined by Steele and Torrie (1960).

CHAPTER IV

RESULTS AND DISCUSSION

I. PERFORMANCE

Average Daily Gain

The average daily gain during the roughage phase was significantly ($P < .05$) higher in treatments supplemented with cottonseed meal (Treatment II and IV) in 1970-1971 (Table I). The opposite was observed for the fullfeed phase causing the difference in overall gain to be non-significant between the sources of supplemental protein. Animals which gained the most during the roughage phase gained least during the fullfeed phase. There was no significant difference in overall average daily gain between treatments in both years (Table I and Table II).

Dry Matter Consumption

Daily dry matter consumption was significantly lower in the heifers fed urea in the concentrate in 1970-1971 (Table III) during the roughage phase. However, in the 1969-1970 trial the addition of urea to the ration resulted in no apparent difference in the dry matter intake (Table IV). There was no significant difference in dry matter consumption in either the fullfeed phase or the overall average in both trials. The amount of crude protein fed per day during the roughage phase did not exhibit any observed influence on dry matter consumption.

TABLE I
PERFORMANCE OF FEEDER HEIFER CALVES FED DIFFERENT LEVELS AND SOURCES OF CRUDE
PROTEIN WITH UREA-LIMESTONE TREATED CORN SILAGE, 1970-1971

Treatment	Kilograms of Crude Protein Consumed Per Head Per Day				
	$\frac{.8}{I}$	$\frac{.9}{II}$	$\frac{.9}{III}$	$\frac{1.0}{IV}$	$\frac{1.0}{V}$
Source of Supplemental Protein	CSM	Urea	CSM	Urea	Urea
No. Animals	36.0	36.0	36.0	36.0	36.0
Average total days on feed	162.6	157.9	165.3	158.3	165.3
Average initial weight (kg.)	221.0	221.0	218.0	222.0	222.0
Average wt., end roughage phase (kg.)	314.0	324.0	314.0	323.0	315.0
Average wt., end fullfeed phase (kg.)	363.0	364.0	366.0	357.0	364.0
Average daily gain, roughage phase (kg.)	^b 0.85	^a 0.93	^b 0.87	^a 0.92	^b 0.85
Average daily gain, fullfeed phase (kg.)	^a 0.94	^b 0.83	^a 0.93	^b 0.71	^a 0.88
Average daily gain, overall (kg.)	0.88	0.90	0.89	0.86	0.86
Average total gain, roughage (kg.)	^b 93.0	^a 103.0	^b 96.0	^a 101.0	^b 93.0
Average total gain, fullfeed (kg.)	^a 49.0	^b 40.0	^a 52.0	^b 35.0	^a 49.0
Average total gain, overall (kg.)	138.0	142.0	157.0	135.0	142.0

^{a,b,c}Means with the same superscript do not differ significantly ($P < .05$).

TABLE II

PERFORMANCE OF FEEDER HEIFER CALVES FED DIFFERENT LEVELS AND SOURCES OF CRUDE PROTEIN WITH UREA-LIMESTONE TREATED CORN SILAGE, 1969-1970

Treatment ^a	Kilograms of Crude Protein Consumed Per Head Per Day				
	.8 1	1.0 4	1.0 5	1.0 5	Urea
Source of Supplemental Protein	---	CSM	---	---	---
No. animals	18.0	18.0	18.0	18.0	18.0
Average total days on feed	162.3	170.3	164.0	164.0	164.0
Average initial weight (kg.)	238.0	234.0	235.0	235.0	235.0
Average wt., end roughage phase (kg.)	352.0	355.0	352.0	352.0	352.0
Average wt., end fullfeed phase (kg.)	370.0	376.0	369.0	369.0	369.0
Average daily gain, roughage phase (kg.)	0.82	0.86	0.84	0.84	0.84
Average daily gain, fullfeed phase (kg.)	0.78	0.70	0.71	0.71	0.71
Average daily gain, overall (kg.)	0.83	0.83	0.82	0.82	0.82
Average total gain-roughage (kg.)	115.0	120.0	117.0	117.0	117.0
Average total gain-fullfeed (kg.)	18.0	23.0	17.0	17.0	17.0
Average total gain-overall (kg.)	132.0	142.0	135.0	135.0	135.0

^aThere were no significant ($P > .05$) differences between treatment means.

TABLE III

AVERAGE DAILY FEED INTAKE AND DRY MATTER INTAKE FOR FEEDER HEIFER CALVES FED DIFFERENT LEVELS
AND SOURCES OF CRUDE PROTEIN WITH UREA-LIMESTONE TREATED CORN SILAGE, 1970-1971

Treatments	Kilograms of Crude Protein Consumed Per Head Per Day				
	$\frac{.8}{I}$	$\frac{.9}{II}$	$\frac{.9}{III}$	$\frac{1.0}{IV}$	$\frac{1.0}{V}$
Source of Supplemental Protein	---	CSM	Urea	CSM	Urea
No. animals	36.0	36.0	36.0	36.0	36.0
Average daily intake, kg.					
Roughage Phase					
Corn silage	12.7	13.1	12.1	13.2	12.2
Corn	2.5	2.3	2.4	2.0	2.4
Cottonseed meal	--	0.3	--	0.5	--
Urea	--	--	.05	--	.09
Fullfeed Phase					
Hay	1.4	1.4	1.4	1.4	1.4
Corn	5.5	5.4	5.3	5.4	5.4
Cottonseed meal	0.7	0.7	0.7	0.7	0.7
Average daily dry matter intake, kg.					
Roughage phase	6.2 ^a	6.5 ^b	6.2 ^a	6.6 ^b	6.2 ^a
Fullfeed phase	6.8	6.7	6.6	6.7	6.8
Overall phase	6.4	6.6	6.4	6.6	6.4

^{a,b}Means with the same superscript do not differ significantly ($P < .05$).

TABLE IV
AVERAGE DAILY FEED INTAKE AND DRY MATTER INTAKE FOR FEEDER HEIFER CALVES FED DIFFERENT LEVELS
AND SOURCES OF CRUDE PROTEIN WITH UREA-LIMESTONE TREATED CORN SILAGE, 1969-1970

Treatment ^a	Kilograms of Crude Protein Consumed Per Head Per Day			
	$\frac{.8}{1}$	$\frac{1.0}{4}$	CSM	Urea
No. animals	18.0	18.0		18.0
Average daily intake, kg.				
Roughage phase	11.7	12.1		12.3
Corn silage	2.5	2.0		2.4
Corn	--	0.5		--
Cottonseed meal	--	--		.09
Urea				
Fullfeed phase	1.7	1.6		1.6
Hay	5.3	5.6		5.2
Corn	0.7	0.7		0.6
Cottonseed meal				
Average daily dry matter intake, kg.				
Roughage phase	6.8	7.0		7.0
Fullfeed phase	7.1	7.4		6.9
Overall phase	6.9	7.1		7.0

^aThere were no significant ($P < .05$) differences between treatment means.

Condition Grade

At the end of the roughage phase in the 1970-1971 study (Table V), the cattle fed the urea in the concentrate had a significantly ($P < .05$) lower condition grade than heifers allotted to the other three treatments. It may be observed in Tables I and V that condition grades and weight gains closely corresponded. There was no significant difference among the final condition grades in the 1970-1971 study. The 1969-1970 study (Table VI) showed no significant difference among condition grades at the end of either the roughage or fullfeed phase. The difference in the amount of crude protein fed per day during the roughage phase had no significant influence on either end of roughage or final condition grade (Table V and Table VI).

II. CARCASS CHARACTERISTICS

The following dependent variables were analyzed for significant difference between treatments: U.S.D.A. grade, dressing percentage, marbling, ribeye, fat thickness, percent kidney fat, yield grade, percent retail cut, and kg. of separable lean. There were no significant differences between treatments with any of the variables for either trial (Table V and Table VI). However, in data for both years heifers fed the high cottonseed meal supplement in the concentrate (Treatment IV) during the roughage phase had a higher U.S.D.A. grade and marbling score than heifers fed on the other treatments. It may be concluded that crude protein level fed or source of protein supplement during the roughage phase had no significant effect on the subsequent carcass quality or quantity.

TABLE V
GRADE AND CARCASS CHARACTERISTICS OF FEEDER HEIFER CALVES FED DIFFERENT LEVELS AND SOURCES OF CRUDE PROTEIN WITH UREA-LIMESTONE TREATED CORN SILAGE, 1970-1971

Treatment	Kilograms of Crude Protein Consumed Per Head Per Day				
	$\frac{.8}{I}$	$\frac{.9}{II}$	$\frac{.9}{III}$	$\frac{1.0}{IV}$	$\frac{1.0}{V}$
Source of Supplemental Protein	---	CSM	Urea	CSM	Urea
No. animals	36.0	36.0	36.0	36.0	36.0
Average initial fat thickness (mm.)	3.4	3.4	3.3	3.4	3.4
Live grades [*]					
Average initial condition	8.4 ^a	8.5	8.7 ^b	8.6 ^a	8.3 ^b
Average condition, end roughage phase	9.5 ^a	9.7 ^a	9.0 ^b	9.6 ^a	9.1 ^b
Average final condition	11.0	11.3	11.4	11.4	11.2
Carcass characteristics					
U.S.D.A. grade	11.2	11.4	11.1	11.7	11.1
Dressing percent	59.8	59.9	59.1	59.4	59.9
Marbling**	4.8	4.9	4.8	5.3	4.8
Ribeye area (sq. cm.)	65.2	65.8	66.5	63.2	64.5
Fat thickness (mm.)	10.5	11.0	10.0	11.1	10.8
Kidney fat percent	3.4	3.4	3.4	3.4	3.4
Yield grade	2.9	2.8	2.7	2.9	2.9
Percent retail cwt.	50.1	50.6	50.7	50.2	50.2
Separable lean (kg.)	120.0	119.5	119.8	118.2	119.4

a,b Means with the same superscript do not differ significantly ($P < .05$).

*Medium 6-8, Good 9-11, Choice 12-14.

**Slight-4, Small-5, Modest-6.

TABLE VI
GRADE AND CARCASS CHARACTERISTICS OF FEEDER HEIFER CALVES FED DIFFERENT LEVELS AND SOURCES OF CRUDE PROTEIN WITH UREA-LIMESTONE TREATED CORN SILAGE, 1969-1970

Treatment ^a	Kilograms of Crude Protein Consumed Per Head Per Day				
	.8 1	1.0 4	1.0 5	1.0 5	Urea
Source of Supplemental Protein	---	CSM			
No. animals	18.0	18.0			18.0
Average initial fat thickness (mm.)	4.9	4.4			4.4
Live grades*: Average initial condition	8.7	8.4			8.2
Average condition, end roughage phase	9.5	9.5			9.5
Average final condition	11.3	11.5			11.2
Carcass characteristics					
U.S.D.A. grade	11.7	12.2			11.6
Dressing percent	58.6	59.2			59.0
Marbling	5.3	5.5			4.8
Ribeye area (sq. cm.)	66.5	68.4			65.8
Fat thickness (mm.)	11.1	11.7			12.3
Kidney fat percent	3.3	3.4			3.4
Yield grade	2.7	2.8			2.9
Percent retail cwt.	50.4	50.0			50.2
Separable lean (kg.)	120.2	120.7			118.1

^aThere were no significant ($P < .05$) differences between treatment means.

*Medium 6-8, Good 9-11, Choice 12-14.

**Slight-4, Small-5, Modest-6.

III. FEED COST AND RETURNS

Feed consumption and feed costs per 45.5 kg. gain for 1970-1971 and 1969-1970 trials are shown in Tables VII and VIII, respectively. Feed consumption per 45.5 kg. gain during the roughage phase was not significantly influenced by levels of crude protein during either 1970-1971 or 1969-1970. However, during the 1970-1971 trial, heifers allotted to Treatment IV (4.75 lb. corn, 1.25 lb. cottonseed meal) required 415 kg. (914 lbs.) of feed per 45.5 kg. gain during fullfeed phase which was significantly greater than feed requirements of heifers allotted to the other four treatments (Table VII). A similar trend was observed in 1969-1970: however, feed requirements of heifers allotted to the various treatments were not significantly different (Table VIII). When overall feed requirements (roughage and fullfeed) for both trials were evaluated, no apparent trend in feed requirements could be determined.

Feed costs per 45.5 kg. gain reflected feed consumption. From a feed cost standpoint, heifers allotted to Treatment IV in 1970-1971 caused significantly greater ($P < .05$) feed costs during fullfeed phase than heifers allotted to the other four treatments. A similar trend was exhibited in 1969-1970.

Overall analysis of feed costs per 45.5 kg. gain revealed no significant difference between treatments during 1970-1971. However, an unexplained significantly greater ($P < .05$) feed cost for heifers allotted to Treatment IV during 1969-1970 occurred.

TABLE VII
 FEED CONSUMPTION AND COSTS PER 45.5 KG. OF GAIN FOR FEEDER HEIFER-CALVES FED DIFFERENT LEVELS
 AND SOURCES OF CRUDE PROTEIN WITH UREA-LIMESTONE TREATED CORN SILAGE, 1970-1971

Treatments	Kilograms of Crude Protein Consumed Per Head Per Day				
	$\frac{.8}{I}$	$\frac{.9}{II}$	$\frac{.9}{III}$	$\frac{1.0}{IV}$	$\frac{1.0}{V}$
Source of Supplemental Protein	---	CSM	Urea	CSM	Urea
No. animals	36.0	36.0	36.0	36.0	36.0
Feed consumption per 45.5 kg. gain, kg. (D.M. basis)					
Roughage phase	331.0 ^{b,c}	317.0 ^b	332.0	324.0	332.0 ^{b,c}
Fullfeed phase	331.0 ^{b,c}	362.0 ^b	322.0 ^c	415.0 ^a	350.0 ^{b,c}
Overall average	332.0	329.0	319.0	347.0	338.0
Feed cost per 45.5 kg. gain, * Dollar					
Roughage phase	15.31 ^{b,c}	14.74 ^b	14.87 ^c	15.46 ^a	15.35 ^{b,c}
Fullfeed phase	26.63 ^{b,c}	29.21 ^b	25.91 ^c	33.41 ^a	28.19 ^{b,c}
Overall average	19.85	18.81	18.78	20.00	19.62

a,b,c Means with the same superscript do not differ significantly ($P < .05$).

* Feed costs were as follows: Corn silage (urea-limestone treated) 8.42/ton; Corn 1.80/bushel; Alfalfa hay 55.90/ton; Urea 71.50/ton; and Cottonseed meal 91.50/ton.

TABLE VIII
 FEED CONSUMPTION AND COSTS PER 45.5 KG. OF GAIN FOR FEEDER HEIFER CALVES FED DIFFERENT LEVELS
 AND SOURCES OF CRUDE PROTEIN WITH UREA-LIMESTONE TREATED CORN SILAGE, 1969-1970

Treatment	Kilograms of Crude Protein Consumed Per Head Per Day				
	$\frac{.8}{1}$	$\frac{1.0}{4}$	$\frac{1.0}{5}$	Urea	
Source of Supplemental Protein	---	CSM			
No. animals	18.0	18.0	18.0		
Food consumption per 45.5 kg. gain, kg. (D.M. basis)					
Roughage phase	379.0	369.0	380.0		
Fullfeed phase	403.0	474.0	445.0		
Overall average	382.0	384.0	388.0		
Feed cost per 45.5 gain, * Dollar					
Roughage phase	13.76	14.94	14.00		
Fullfeed phase	27.35	32.60	30.42 ^b		
Overall average	15.60 ^b	17.50 ^a	16.09 ^b		

^{a, b} Means with the same superscript do not differ significantly ($P < .05$).

* Feed costs were as follows: Corn silage (urea-limestone treated) 8.43/ton; Corn 1.43/bushel; Alfalfa hay 45.80/ton; Urea 73.00/ton; and Cottonseed meal 106.20/ton.

There was no significant difference among treatments in average return per head during 1969-1970 as shown in Tables IX and X.

TABLE IX
FINANCIAL RETURNS FROM FEEDER HEIFERS FED DIFFERENT LEVELS AND SOURCES OF
CRUDE PROTEIN WITH UREA-LIMESTONE TREATED CORN SILAGE, 1970-1971

Treatment ^a	Kilograms of Crude Protein Consumed Per Head Per Day				
	$\frac{.8}{I}$	$\frac{.9}{II}$	$\frac{.9}{III}$	$\frac{1.0}{IV}$	$\frac{1.0}{V}$
Source of Supplemental Protein	---	CSM	Urea	CSM	Urea
Average purchase price per cwt. dollar	28.64	28.64	28.64	28.64	28.64
Average selling price per cwt. dollar	31.96	32.09	31.61	31.98	31.97
Average purchase cost per head, dollar	139.48	139.76	137.76	140.04	140.04
Average selling price per head, dollar	256.52	257.51	254.91	251.01	256.30
Average feed cost per head, dollar	60.39	59.08	60.99	59.71	61.70
Average returns per head over initial and feed costs based on U.S.D.A. grade, dollars	56.65	58.67	56.16	51.26	54.56

^aThere were no significant ($P < .05$) differences between treatment means.

TABLE X
FINANCIAL RETURNS FROM FEEDER HEIFERS FED DIFFERENT LEVELS AND SOURCES OF
CRUDE PROTEIN WITH UREA-LIMESTONE TREATED CORN SILAGE, 1969-1970

Treatment	Kilograms of Crude Protein Consumed Per Head Per Day			
	$\frac{.8}{1}$	$\frac{1.0}{4}$	$\frac{1.0}{5}$	Urea
Source of Supplemental Protein	---	CSM		
Average purchase price per cwt., dollar	27.72	27.72		27.72
Average selling price per cwt., dollar	29.49	30.05		29.65
Average purchase cost per head, dollar	145.26	143.12		143.62
Average selling price per head, dollar	240.69	249.25		241.47
Average feed cost per head, dollar	45.61	55.02 ^a		47.69
Average return per head over initial and feed costs based on U.S.D.A. grade, dollar	47.82	51.12		50.16

^aMeans with the same superscript do not differ significantly ($P < .05$).

CHAPTER V

SUMMARY AND CONCLUSIONS

Research reported herein was designed and carried out to determine the effects upon feeder heifers of two sources (urea and cottonseed meal), of protein fed at two different levels. A control and four treatment rations were used and there were three lots of cattle per treatment. There were two feeding phases. The first, the so-called roughage phase, used a ration of corn silage ad libitum plus six pounds of concentrate per head per day and lasted 110 to 140 days. It was only in the first phase that the treatments differed among the various lots. The second phase extended beyond phase one until the heifers met a previously determined fat thickness. In the second phase the cattle received 1.8 kg. of hay per head per day and a full feed of a mixture of eight parts of corn to one part of cottonseed meal with no nutritional or management differences among the lots.

During the first phase, the control concentrate consisted of 2.7 kg. per head per day of corn only, delivering 0.8 kg. of crude protein per heifer daily. Treatments II and III were similar to Treatment I except that the supplement contained either 0.27 kg. cottonseed meal or 0.05 kg. urea, replacing equal amounts of corn and bringing the crude protein intake to approximately 0.9 kg. per head per day. Treatments IV and V were also similar, in the first phase, to Treatment I but contained either 0.55 kg. cottonseed meal or 0.09 kg. urea, replacing equal

amounts of corn and bringing the crude protein intake to approximately 1 kg. per head per day.

The following observations were made from the study:

1. Average daily gains were significantly ($P < .05$) higher for the cattle fed the concentrate containing cottonseed meal during the roughage phase. During the full feed phase, the cattle fed urea in the concentrate during the roughage phase gained significantly ($P < .05$) faster. However, there was no overall significant difference shown. These significant ($P < .05$) differences were shown only in the 1970-1971 trial with the same trend shown in the 1969-1970 trial.

2. The amount of feed required per 45.5 kg. of gain was significantly higher ($P < .05$) during the fullfeed period for the cattle fed the high level of cottonseed meal (Treatment IV) as a source of crude protein during the roughage phase in the 1970-1971 trial. There were no other significant differences in either the roughage phase or overall average in feed efficiency.

3. Average daily dry matter consumption was significantly ($P < .05$) lower during the roughage phase with the heifers fed the urea as a source of crude protein in the concentrate mix in the 1970-1971 trial. The overall dry matter consumption showed no significant difference between treatments in either trial.

4. Carcass characteristics were not affected by the level or source of crude protein fed during the roughage phase.

5. Feed cost per 45.5 kg. gain during the fullfeed phase in the 1970-1971 trial was significantly higher ($P < .05$) with the cattle fed the high level of cottonseed meal in the concentrate during the roughage

phase and in the overall average during the 1969-1970 study.

6. Average feed cost per head was significantly higher for the cattle receiving the high level of cottonseed meal in the concentrate during the roughage phase in Trial I.

7. Returns above initial and feed costs were approximately the same for all treatments with no significant differences demonstrated.

It may be concluded from the summary of data presented and discussed that overall feedlot performance and carcass characteristics of feeder heifers allotted to the various crude protein levels and sources during the roughage phase showed no significant economic difference when fed to slaughter. Therefore, a daily ration of 6 lbs. cracked corn plus urea-limestone treated silage fed ad libitum with a crude protein intake of 0.8 kg., per day, is adequate for growing beef heifers during a roughage feeding phase.

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LITERATURE CITED

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APPENDIX

TABLE XI

ANALYSIS OF VARIANCE FOR OVERALL AVERAGE DAILY GAIN OF HEIFERS FED
DIFFERENT LEVELS AND SOURCES OF CRUDE PROTEIN WITH
UREA-LIMESTONE TREATED CORN SILAGE, 1970-1971

Source	df	SS	MS	F
Total	179	20.82		
Tmt	4	.30	.075	.635
Grade	2	.02	.010	.085
<u>Error</u>	<u>173</u>	<u>20.50</u>	<u>.118</u>	<u> </u>
(T) (G)	8	.44	.055	.452
Residual	165	20.06	.1216	

TABLE XII

ANALYSIS OF VARIANCE FOR OVERALL AVERAGE DAILY GAIN OF HEIFERS FED
DIFFERENT LEVELS AND SOURCES OF CRUDE PROTEIN WITH
UREA-LIMESTONE TREATED CORN SILAGE, 1969-1970

Source	df	SS	MS	F
Total	53	4.2587		
Tmt	2	.0123	.00615	.77
Grade	2	.1974	.987	11.95*
<u>Error</u>	<u>49</u>	<u>4.0490</u>	<u>.0826</u>	
(T) (G)	4	.4278	.1070	1.33
Residual	45	3.6212	.0805	

* $P < .05$.

VITA

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