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Effect of addition of limestone to urea-treated corn silage on performance of feeder heifers

Richard P. Clarisse

To the Graduate Council:

I am submitting herewith a thesis written by Richard P. Clarisse entitled "Effect of addition of limestone to urea-treated corn silage on performance of feeder heifers." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Husbandry.

J.A. Corrick Jr, Major Professor

We have read this thesis and recommend its acceptance:

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Accepted for the Council:
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(Original signatures are on file with official student records.)

February 21, 1972

To the Graduate Council:

I am submitting herewith a thesis written by Richard P. Clarisse entitled "Effect of Addition of Limestone to Urea-Treated Corn Silage on Performance of Feeder Heifers." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Husbandry.

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We have read this thesis and recommend its acceptance:

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EFFECT OF ADDITION OF LIMESTONE TO UREA-TREATED CORN SILAGE ON PERFORMANCE OF FEEDER HEIFERS

A Thesis

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the Graduate Council of

The University of Tennessee

In Partial Fulfillment

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Master of Science

by

Richard P. Clarisse

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ABSTRACT

The purpose of this experiment was to determine if the addition of 10 pounds of limestone per ton of green chop at ensiling to urea-treated corn silage would result in improved feedlot performance and carcass characteristics of feeder heifers.

Sixty Angus and Hereford heifers with an average initial weight of 467 pounds were involved in two experiments at The University of Tennessee's Knoxville Experiment Station. Two treatments (1) 10 pounds of urea per ton of green chop and (2) 10 pounds each of urea and limestone per ton of green chop were used in the two-year study.

In one trial two replications per treatment were involved and in the other, three. Six animals per pen (replication) were involved in both trials.

The results indicated that both rations were acceptable and feedlot performance was not significantly influenced by either treatment studied; however, marbling scores and USDA grades were significantly greater among animals consuming the limestone treated silage. Therefore it may be concluded that either ration may be effectively utilized for growing-finishing feeder heifers.

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CHAPTER I

INTRODUCTION

Whole plant corn silage is regarded as one of the most valuable forage crops available for growing-finishing rations of beef cattle. The high energy content, yield per acre, acceptability to animals, adaptability to mechanization, and relative low cost contribute to the popularity of silage. Also, it can be harvested at various stages of maturity with little effect on dry matter digestibility (Johnson and McClure, 1968), or animal performance (Chamberlain et al., 1971). However, due to the low crude protein content of corn silage and the high cost of commercial protein supplements, the use of urea has become accepted as a useful nitrogen source in silage rations for cattle. Urea has been added to silage at the time of ensiling to facilitate feed handling. In conjunction, attempts have been made to improve silage fermentation by addition of minerals.

The purpose of this study was to determine if the addition of 0.5 percent limestone with 0.5 percent urea to silage when ensiled would improve animal performance compared to cattle fed urea-treated silage.

CHAPTER II

REVIEW OF LITERATURE

I. UREA

Urea was discovered by Rouelle in 1773 and first synthesized by Wohler in 1828. As a result of nitrogen utilization trials using sheep, Zuntz in 1891 suggested that ruminants were able to convert nonprotein nitrogen (NPN) to protein (Loosli and McDonald, 1968). Tillman (1967) briefly described urea metabolism as a sequence of events:

1. Microorganism urease in the rumen hydrolyzes urea to ammonia and carbon dioxide.
2. Ammonia nitrogen combines with alpha-keto acids to form amino acids.
3. Amino acids are converted to microorganism protein.
4. Microorganism protein is digested into amino acids further down the intestinal tract and there absorbed.

Hart et al. (1939) initiated urea research in the United States and demonstrated that growing calves could make satisfactory gains utilizing the NPN in urea. Beeson and Perry (1952) reported that 30 to 60 percent of the protein in a weaned calf growing ration could be supplied with urea, producing equal gains and lower feed costs compared with true protein supplements. Klostaman et al. (1953) indicated that in beef cattle fattening rations, a mixture of one pound of urea and seven to eight pounds corn and cob meal were equivalent in nitrogen to six pounds of soybean meal. Beeson and Perry (1969) reported that 50 to 100 percent of supplementary protein in cattle and sheep rations may be provided by urea. However, only one-third of the total protein in the ration may be supplied by NPN; the remaining portion should come from grains and roughage. It was demonstrated that levels above this created a depression in feed efficiency and weight gain.

II. UREA TOXICITY

Gallup et al. (1953) orally administered a single does of 15 to 20 grains of urea per 100 pounds body weight to cattle which had been fasted for two days and observed toxicity symptoms. This was substantiated by Davis and Roberts (1959) who produced toxicity symptoms upon administering 18 grams of urea per 100 pounds body weight. When increased to 30 grams per 100 pounds body weight, this level of urea proved fatal to the animals. When toxicity symptoms were present, a 5 percent aqueous solution of acetic acid was an effective antidote in alleviating the symptoms. Typical toxicity symptoms were described as follows: animals exhibited uneasiness, muscle and skin tremors, excess salivation, difficult breathing, incoordination or ataxia, bloat, tetany and finally death.

According to Whitehair et al. (1955) conditions predisposing cattle to disturbances related to urea feeding are: (1) starved or fasted cattle consuming too much urea-containing feed, (2) rapid consumption of these feeds, (3) animals not previously fed urea, (4) feeds with excess or improperly mixed urea, and (5) high-roughage, low-energy rations causing poor utilization of urea.

III. UREA TREATED SILAGE

One limiting factor regarding the use of corn silage is the relatively low crude protein content of 2.3 percent (Morrison, 1956). However, its high content of readily available carbohydrates enables it to be used with urea for more efficient conversion of NPN to protein.

Cullison (1944) compared sorghum silage containing ten pounds of urea per ton with untreated silage in a wintering ration fed to Angus and Hereford cows. The animals fed the treated silage maintained their weight over a 78-day test period, while those fed untreated silage lost weight. He also observed that palatability was superior with the treated silage. In contrast, Wise et al. (1944) observed lower feed consumption and weight gains in lactating dairy cows fed corn silage treated with 0.5 percent (10 pounds per ton) urea than cows fed untreated silage. Davis et al. (1944) reported that the palatability of sorghum silage fed to dairy cattle was increased when left untreated or treated with 10 pounds of urea per ton than that treated with 30 pounds of urea per ton. At a level of 50 pounds urea per ton, the animals refused to consume the silage. Bentley et al. (1955) indicated that 17 to 25 pounds urea per ton of corn silage was palatable, nontoxic and its feeding value was comparable to untreated corn silage and soybean oil meal. Investigations by Khalil (1969) demonstrated only slight differences in intake among corn silages treated with 10, 15, or 20 pounds per ton when fed to growing and finishing heifers. When supplemented with limited concentrates, performance and carcass characteristics were not significantly affected by the levels of urea studied. Coppock and Stone (1965) recommended ensiling 5 kilograms of urea per metric ton maize silage when silage was the only forage fed to cattle. This resulted in increased crude protein content of the silage so only grain was required to supplement the ration.

Klosterman et al. (1953) indicated that corn silage containing 17 pounds urea per ton failed to produce gains and feed efficiency in steers equal to those obtained with corn silage plus soybean oil meal. Similar results were obtained in wintering yearling heifers and mature cows, indicating that urea lowered the feeding value of corn silage (Goode et al., 1955).

Bentley et al. (1955) reported no difference in gains among steers fed urea treated maize silage and those fed silage plus soybean meal. Conrad and Hibbs (1961) demonstrated that lactating dairy cows fed 0.7 percent urea treated corn silage utilized considerably less dietary nitrogen for body retention and milk production when compared with cows fed grain and alfalfa hay. Hillman (1969) obtained satisfactory performance in lactating dairy cows fed corn silage containing 0.5 percent urea when the NPN content of the ration did not exceed 0.045 pounds urea per 100 pounds body weight. Klosterman et al. (1961) obtained 11 percent higher gains and 8.5 percent greater feed efficiency by feeding beef cattle corn silage treated with 0.5 percent each of urea and ground limestone than those fed untreated silage. However, Klosterman et al. (1961) found that urea utilization was more efficient when mixed with corn grain and silage at feeding time.

IV. LIMESTONE AND UREA-LIMESTONE TREATED SILAGE

As described by Olson et al. (1966), calcium carbonate added to corn silage at a rate of 0.5 to 1.0 percent during ensiling increased organic acid production in the fermentation process. Neutralization of some of the acids during the fermentation process enables lactic acid bacteria to act over a longer period of time, thereby producing greater quantities of lactic acid, which contributed to improved palatability of the silage.

Klosterman et al. (1963) reported a series of experiments involving the use of limestone and urea as silage additives. Laboratory experiments comparing dolomitic limestone, calcium carbonate, dicalcium phosphate and urea were conducted to determine their effect on lactic acid and acetic acid levels in corn silage fermented in glass jars. Results of four years of tests indicated that the addition of limestone, limestone and urea, and calcium carbonate all greatly increased the percentages of both organic acids. Analyses indicated that the urea and limestone treatment increased lactic acid content by 78 percent. When ensiled in concrete silos, analyses yielded similar results. A feeding trial in 1958-59 comparing dolomitic limestone treated corn silage with untreated silage was conducted using 63 steers. Performance of the animals was not affected by the treatments. In 1959-60, 81 heifer calves were used to compare untreated silage with silage treated with 0.5 percent ground limestone and 0.5 percent urea. Average daily gains were significantly greater among the animals receiving the treated silage compared to the untreated ration. However, carcass characteristics were not influenced by treatments. Eighty-five Hereford heifer calves were used in 1960-61 to compare the two treatments described in the 1959-60 experiment. In addition, each of the two treatments was divided into three lots fed 0.5, 1.0, and 1.5 pounds soybean meal plus ground ear corn. Although results did not differ significantly, gains and feed efficiency were greater among the animals fed the treated silages. The results indicated that in addition to the increased organic acid content, the increased nitrogen from urea may have contributed to improved performance. In 1961-62 the final experiment in the series was conducted to compare the two silages described previously, but with different concentrate levels. Results indicated that effects of the silage treatments were greater when low concentrate levels were fed than with higher levels. Animals receiving the treated silage exhibited superior performance and produced both improved USDA carcass grades and dressing percentages.

In a study using sheep, Johnson and McClure (1968) fed corn silage treated with 0.5 percent limestone and 0.5 percent urea, and observed that the treatment did not influence the digestibility of dry matter. More recent experiments (Klosterman et al., 1969) using fattening steers and heifers were conducted to determine: (1) the feeding value of corn silage treated with 20 pounds urea, 10 pounds pulverized limestone and 2 pounds defluorinated rock phosphate per ton plus one-half full feed of ground shelled corn; (2) to determine if supplentation with natural protein could improve the ration; and (3) to determine if a high urea mixed supplement fed with the treated silage would produce any harmful effects. In addition to the silage and ground corn fed all animals, the supplements compared were dehydrated alfalfa meal, soybean meal, and a mixed protein supplement containing 11.2 percent urea. All supplements were fed at a rate of one pound per head daily. Thirty-six steers and 44 heifers were used in this test which continued for 119 days, after which they were slaughtered. Average daily gains of the steers and heifers combined were 2.67, 2.68, 2.68 and 2.72 pounds for the animals fed corn only, alfalfa, soybean meal, and mixed supplement, respectively. Feed efficiency was directly related to rate of gain. Differences in carcass characteristics appeared related to sex only, with no significant differences due to treatment. The treated silage ration (14.3 percent protein on a dry matter basis) plus ground shelled corn could not be improved by additional protein supplementation.

CHAPTER III

EXPERIMENTAL PROCEDURE

I. SOURCE AND DESCRIPTION OF DATA

Data for this study were collected from 60 good and medium Angus, Hereford and crossbred heifers with an average initial weight of 467 pounds, purchased at East Tennessee graded feeder calf sales. The study was conducted by The University of Tennessee Animal Husbandry-Veterinary Science Department at the University's Knoxville-Blount Farm Experiment Station.

The study consisted of two experiments over a two-year period, 1966-1968. The experiment during 1966-67 consisted of two treatments of 12 animals each divided into two lots of six animals each. The second experiment conducted during 1967-68 consisted of two treatments of 18 animals each, divided into three lots of six head each. The purpose of these experiments was to determine if the addition of 0.5 percent ground limestone to corn silage treated with 0.5 percent urea would result in improved animal performance compared to corn silage treated only with 0.5 percent urea.

II. CLASSIFICATION OF DATA

The feedlot period consisted of two phases: a 140-day silage phase during which the animals fed were fed the treated silages, ad lib., plus six pounds of concentrate per head per day and a full feed phase during which all animals were full fed a concentrate consisting of eight parts corn and one part cottonseed meal plus 3.8 pounds mixed hay daily. The full-feed phase continued until the animals attained a condition grade of high good or low choice, determined by visual evaluation.

At the onset of each experiment, each animal was identified, weighed, condition graded and implanted with 24 milligrams diethylstilbestrol. For the duration of each experiment, animals were weighted at 14 day intervals for 56 days and at 28 day intervals thereafter. All animals were also condition evaluated at the termination of the silage and full feed phases.

At the conclusion of the full feed period, the cattle were individually weighed and condition scored, then trucked to a local packing plant. After official sale weights were obtained, the animals were slaughtered and hot carcass weights were recorded and subsequent dressing percentages were determined. Following a 48-hour chilling period, USDA grades, including values for maturity, kidney fat, conformation and marbling scores were assigned each carcass by a USDA meat grader. Ribeye area and fat thickness over the twelfth rib were determined according to procedure described by the American Meat Science Association (Schoonover, 1967).

III. TREATMENTS

The experimental treatments were as follows:

Treatment I. During the 140-day silage period, animals were fed corn silage treated with 0.5 percent urea (10.0 pounds per ton), *ad lib.*, plus six pounds of concentrate daily. The concentrate was composed of five parts cracked shelled corn and one part cottonseed meal. However, in the 1967-68 study, after 84 days on test, the cottonseed meal was removed from the rations and replaced with corn in an attempt to avoid exceeding published crude protein requirements for growing and finishing heifers (N.R.C., 1963). In the 1966-67 study, the ration also included two pounds of mixed hay per head per day. Following the silage period, the animals were placed on a full feed of concentrate (eight parts corn, one part cottonseed meal) plus 3.8 pounds mixed hay per head daily for 41 and 55 days for 1966-67 and 1967-68 trials, respectively.

Treatment II. Treatment II was identical to Treatment I except the silage was treated with 0.5 percent (10 pounds per ton) ground limestone in addition to 0.5 percent urea. In 1966-67, after 42 days on test, the concentrate ration for Treatment II was altered to 5.75 pounds corn and 0.25 pounds cottonseed meal in an attempt not to exceed protein requirements.

The urea and limestone were added to the silage by scattering the specified amount over the top of each wagon load just prior to blowing the green chop into the silos. It has been demonstrated that the unloading and blowing mechanisms of the silage wagons and silage blower resulted in satisfactory mixing of the additives throughout the silage as indicated by periodic laboratory analyses.

Dry matter content of silages involved were as follows: 1966-67, urea treated silage, 29.52 percent, urea plus limestone treated silage, 27.33 percent; 1967-68, urea treated silage 43.37 percent, urea plus limestone treated silage, 35.70 percent.

IV. FEEDING OF EXPERIMENTAL ANIMALS

Animals were fed twice daily with increases or decreases of silage levels determined by the quantity of uneaten silage left in the feed bunks since the previous feeding. The concentrate was mixed with the silage and hay was distributed throughout the feed bunks. In addition, the animals consumed salt, dicalcium phosphate and water on a free choice basis.

V. STATISTICAL ANALYSES

Performance and carcass data in this study were analyzed using analysis of variance according to the Statistical Analysis System as described by Barr and Goodnight (1970).

CHAPTER IV

RESULTS AND DISCUSSION

I. PERFORMANCE

Average Daily Gain

Average daily gains for the silage periods and overall were not significantly affected by the treatments in either year. However, the gains during the 1966-67 experiment were significantly greater ($P < .05$) than the 1967-68 trials (Tables I and II). Regression of initial weight also exerted a significant influence influence on gains (Table III). It was observed that animals which gained faster during the silage phase tended to gain slower during the full-feed period.

Condition Grades

Condition scores at the end of the silage period and the termination of each trial were not significantly influenced by treatment ($P > .05$). The animals in the 1967-68 trial had significantly higher final condition scores ($P < .05$). Regression of initial weight, shown in Table II, indicated that animals which weighed more at the onset of each experiment tended to have significantly higher condition scores at the end of the silage period ($P < .05$); however, this influence was not significant for final condition grades.

TABLE I

LEAST SQUARE MEANS FOR FEEDLOT PERFORMANCE OF FEEDER HEIFERS AS INFLUENCED BY TREATMENT (1966-67, 1967-68)

	Initial Wt.	Initial Condition	Roughage Wt.	Roughage Condition	ADG Roughpage Period	Final Wt.	Final Condition	ADG Full-feed	ADG Overall
<u>Year</u>									
1966-67	489.76	8.30	748.39[a]	10.71	2.01[a]	820.72	11.11	1.75	1.95[a]
1967-68	451.76	8.99	710.94	10.78	1.74	823.10	11.92[a]	2.04[b]	1.83
<u>Tmt</u>									
I	471.53	8.60	725.64	10.70	1.84	816.54	11.42	1.88	1.85
II	471.12	8.66	733.63	10.80	1.89	827.28	11.65	1.92	1.91

[a] $P < .05$

[b] $P < .01$

TABLE II

FEEDLOT PERFORMANCE OF FEEDER HEIFERS, 1966-67, 1967-68, AND TWO YEAR AVERAGE

Treatment	1966-67		1967-68		2 Yr. Average	
	I	II	I	II	I	II
Animals on test	12	12	18	18	30	30
Days on test	181	181	195	195	—	--
Avg. initial wt., lbs.	490	490	452	453	467	468
Avg. initial condition	8.4	8.3	8.8	8.9	8.6	8.7
Avg. weight, end roughage per.	774	788	687	691	722	730
Avg. condition, end roughage period	11.0	11.0	10.4	10.7	10.6	10.8
ADG, roughage period	2.03	2.13	1.68	1.70	1.82	1.87
Avg. final weight	846	855	796	810	816	828
Avg. final condition	11.3	11.4	11.6	12.0	11.5	11.8
ADG, full feed period	1.76	1.63	1.98	2.17	1.89	1.95
ADG, overall	1.97	2.02	1.77	1.84	1.85	1.91

TABLE III

MULTIPLE REGRESSION COEFFICIENTS OF INITIAL
WEIGHT ON FEEDLOT PERFORMANCE

Traits	1966-67	1967-68	2 Yrs. Combined
Initial condition	0.0027	0.0039	0.0032
Wt., end silage	1.5036	1.3524	1.4366
Cond., end silage	0.0036	0.0182	0.0127
ADG, silage period	0.0083	0.0025	0.0031
Final wt.	1.4473	0.0129	0.0077
ADG, full-feed	-0.0014	-0.0037	-0.0024
ADG, overall	0.0025	0.0008	0.0017

Feed Consumption, Costs and Returns

Average daily feed intake and dry matter consumption are presented in Tables, IV, V, and VI. Total feed intake was similar for both treatments in both years. Feed efficiency was greater among the animals in 1966-67 trial, but due to ration differences between the two years, feed costs were slightly greater in 1967-68. Returns over initial and feed costs were greater in 1967-68, primarily due to a greater margin and higher selling prices.

II. CARCASS CHARACTERISTICS

USDA Grade

The summary of average, USDA grades for heifers fed the two treatments are shown in Table VII. In 1967-68 animals fed urea plus limestone treated silage graded significantly higher ($P < .05$) than those fed silage treated with urea only. Regardless of treatment, animals in 1967-68 graded significantly higher ($P < .05$) than those in 1966-67 (Tables VIII and IX).

Dressing Percent

Differences in dressing percent, shown in Tables VII, VIII and IX, were not significantly different due to either treatments or years.

Marbling Score

Average marbling scores for heifers are given in Table VI. When analyzed on a two-year basis, marbling scores were significantly higher

TABLE IV

FEED CONSUMPTION, COSTS AND RETURNS, 1966-67

Treatment	I	II
Number of animals	12	12
Days on test	181	181
Feed consumption, lb/day		
Silage period		
Silage	24.80	22.30
Corn	5.02	5.52
CSM	0.97	0.48
Hay	2.00	2.00
Total	32.80	30.30
Full-feed period		
Corn	14.10	14.00
CSM	1.80	1.70
Hay	3.80	3.80
Total	19.70	19.50
Dry matter per cwt gain, lb		
Silage period	711	617
Full-feed period	969	1034
Overall	763	694
Feed cost per cwt gain, $		
Silage period	16.11	14.42
Full-feed period	30.98	33.06
Overall	19.12	17.85
Animal cost, cwt, $	23.88	23.88
Animal sale price, cwt, $	23.05	23.05
Return per head over initial and feed cost, $	9.89	14.92

TABLE V

FEED CONSUMPTION, COSTS AND RETURNS, 1967-68

Treatment	I	II
Number of animals	18	18
Days on test	195	195
Feed consumption, lb/day		
Silage period		
Silage	20.40	24.00
Corn	5.40	5.40
CSM	0.60	0.60
Total	26.20	30.00
Full-feed period		
Corn	13.00	12.80
CSM	1.60	1.60
Hay	3.90	3.90
Total	18.50	18.30
Dry matter per cwt, lb		
Silage period	832	818
Full-feed period	848	767
Overall	837	801
Feed costs per cwt gain, $		
Silage period	14.22	14.99
Full-feed period	22.44	20.25
Overall	16.81	16.74
Animal cost, cwt, $	22.94	22.94
Animal sale price, cwt, $	24.60	24.60
Return per head over initial and feed costs, $	34.29	35.48

TABLE VI

FEED CONSUMPTION, COSTS AND RETURNS, TWO YEARS COMBINED

Treatment	I	II
Number of animals	30	30
Feed consumption, lb/day		
Silage period		
Silage	22.30	23.30
Corn	5.20	5.40
CSM	0.75	0.55
Hay	0.80	0.80
Total	29.05	26.05
Full-feed period		
Corn	13.40	13.30
CSM	1.68	1.64
Hay	3.86	3.86
Total	18.94	18.80
Dry matter per cwt gain, lb		
Silage period	784	738
Full-feed period	922	848
Overall	807	758
Feed cost per cwt gain, $		
Silage period	14.08	14.76
Full-feed period	25.86	25.37
Overall	17.73	17.18
Return per head over initial and feed cost, $	24.53	27.26

TABLE VII

CARCASS CHARACTERISTICS OF FEEDER HEIFERS, 1966-67, 1967-68, AND TWO YEAR AVERAGE

Treatment	1966-67		1967-68		2 Yr. Average	
	I	II	I	II	I	II
Animals on test	12	12	18	18	30	30
Days on test	181	181	195	195	—	--
USDA grade	10.2	10.8	11.1[a]	12.2[a]	10.7	11.6
Dressing percent	59.0	60.6	58.7	58.9	58.8	59.6
Fat thickness, mm	10.4	11.8	11.7	13.5	11.2	12.8
Marbling score	4.0	4.6	4.7	5.6	4.4[b]	5.2[b]
Percent kidney fat	3.0	3.8	2.5	2.7	2.7	2.9
Ribeye area	10.4	10.6	9.9	10.2	10.1	10.4

[a,b]Means with same superscript significantly different ($P < .05$).

TABLE VIII

LEAST SQUARE MEANS FOR CARCASS TRAITS OF FEEDER HEIFERS AS INFLUENCED BY TREATMENT, 1966-67 AND 1967-68, BY YEARS

		Percent Kidney Fat	Marbling Score	Ribeye Area Sq. In.	Carcass Fat mm	Dressing Percent
1966-67						
Tmt. I	10.18	2.94	3.84	10.62	10.42	59.01
Tmt. II	10.74	3.14	4.51	10.39	11.82	60.66
1967-68						
Tmt I	11.05	2.49	4.60	9.91	11.91	58.39
Tmt II	12.22[a]	2.68	5.48	10.13	13.37	58.96

[a] $P < .05$

TABLE IX

LEAST SQUARE MEANS FOR CARCASS TRAITS OF FEEDER HEIFERS AS INFLUENCED BY TREATMENT, 1966-67, 1967-68

	USDA Grade	Percent Kidney Fat	Marbling Score	Ribeye Area Sq. In.	Carcass Fat mm	Dressing Percent
<u>Year</u>						
1966-67	10.37	2.86	4.10	10.48	10.11	59.90
1967-68	11.70[a]	2.72	5.09[a]	10.06	13.32[a]	58.61
<u>Tmt</u>						
I	10.58	2.72	4.19	10.26	11.01	58.68
II	11.46[a]	2.91	4.97[a]	10.25	12.44	58.79

[a] $P < .05$

(P < .05) for the urea plus limestone treatment and for all animals in 1967-68 compared with 1966-67 (Tables VIII and IX).

Ribeye Area

Average ribeye areas (sq. in.) for heifers are presented in Table VII. These values varied slightly, but differences were not significantly affected by treatment (Tables VIII and IX).

Fat Thickness

Average carcass fat thickness measurements made at the 12th rib are presented in Table VII. There was no significant influence due to treatment but the 1967-68 animals had significantly more carcass fat (P < .05) than the 1966-67 heifers.

CHAPTER V

SUMMARY AND CONCLUSIONS

The objective of this two-year study was to determine if limestone added to urea ensiled with whole plant corn green chop would improve performance and carcass characteristics of growing-finishing beef heifers in Tennessee.

The two experiments involved 60 Angus and Hereford calves with an average initial weight of 467 pounds, 24 in 1966-67 and 36 in 1967-68. The animals were divided into two treatments with two pens of six animals each per treatment in the 1966-67 study, and three pens of six animals each per treatment in 1967-68. Each trial consisted of a 140-day silage feeding period in which animals were fed corn silage, ad libitum, plus six pounds concentrate per head per day. This was followed by a full-feed period, during which the animals were given a full feed of concentrate plus limited hay. The full-feed period was continued until the heifers attained condition grades of high good and low choice. The heifers were weighed periodically and graded at the beginning and end of each feeding period. The animals were then marketed, slaughtered and carcass data were obtained.

The corn silage utilized in Treatment I was ensiled with 10 pounds per ton or 0.5 percent urea. The silage used in Treatment II had been ensiled with 10 pounds urea plus 10 pounds ground limestone per ton green chop.

There were no significant differences (P < .05) in feedlot performance due to treatment. However, in 1967-68 the animals fed the urea plus limestone treated silage exhibited significantly higher marbling scores and hence higher USDA grades (P < .05).

Results of this study indicated that eigher ration may be utilized in the production of beef heifers. The addition of limestone increased the marbling score and hence the carcass grade. This could be beneficial to producers selling cattle on a grade and yield basis.

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APPENDIX

TABLE X

LEAST SQUARE MEANS FOR FEEDLOT PERFORMANCE OF FEEDER HEIFERS AS INFLUENCED BY TREATMENT, 1966-67 AND 1967-68, BY YEARS

	Initial Wt.	Initial Condition	Roughage Wt.	Roughage Condition	ADG Roughage Period	Final Wt.	Final Condition	ADG Full-Feed Period	ADG Overall
1966-67									
Tmt I	491.20	8.56	728.55	10.84	2.23	846.30	11.24	1.74	1.97
Tmt II	489.31	8.48	742.09	10.84	2.33	854.94	11.32	1.62	2.02
1967-68									
Tmt I	451.87	8.83	687.76	10.47	1.68	796.61	11.62	1.98	1.78
Tmt II	452.93	9.05	690.24	10.43	1.69	809.54	12.00	2.17	1.85

TABLE XI

MEANS AND STANDARD DEVIATIONS OF ANIMAL PERFORMANCE AND CARCASS CHARACTERISTICS

Trait Measured	1966-67		1967-68		2 Yrs. Combined	
	Mean	SD	Mean	SD	Mean	SD
Initial weight, lbs.	490.21	±43.23	452.08	±50.81	467.38	±51.14
Initial cond. score	8.38	± 0.92	8.94	±0.92	8.71	±0.96
Weight, 140 days, lbs.	781.25	±69.74	689.03	±66.44	725.92	±81.18
ADG, 140 days, lbs.	2.08	± 0.24	1.69	±0.26	1.85	±0.32
Cond., 140 days	11.00	± 0.66	10.58	±1.20	10.75	±1.04
Weight, final, lbs.	850.79	±70.45	803.06	±67.50	822.15	±72.07
Condition, final	11.29	± 0.86	11.89	±2.89	11.60	±0.96
ADG, full-feed, lbs.	1.70	± 0.40	2.07	±0.34	1.92	±0.41
ADG, overall, lbs.	1.99	± 0.21	1.80	±0.22	1.88	±0.23
USDA grade	10.46	± 0.78	11.64	±1.12	11.17	±1.15
Kidney fat, percent	3.06	± 0.76	2.60	±0.97	2.78	±0.91
Marbling score	4.17	± 0.70	5.60	±1.09	4.70	±1.05
Ribeye area, sq. in.	10.52	± 0.92	10.03	±1.21	10.23	±1.12
Carcass fat, mm	11.12	± 3.39	12.64	±3.94	12.03	±3.77
Dressing percent	59.84	± 2.33	58.66	±2.08	59.13	±2.24

TABLE XII

MULTIPLE REGRESSION COEFFICIENTS OF INITIAL WEIGHT ON CARCASS CHARACTERISTICS

Traits	1966-67	1967-68	2 Yrs. Combined
USDA grade	0.0013	0.0068	0.0037
Percent kidney fat	0.0048	0.0132	0.0068
Marbling score	-0.0006	0.0067	0.0026
Ribeye area, sq. in.	0.0055	-0.0026	0.0019
Carcass fat, mm	0.0414	0.0481	0.0444
Dressing percent	-0.0088	0.0044	0.0030

TABLE XIII

ANALYSIS OF VARIANCE FOR THE EFFECTS OF TREATMENT AND INITIAL WEIGHT ON FEEDLOT PERFORMANCE, 1966-67

		Mean Square							
Source	df	Initial Condition	Roughage Wt.	Roughage Condition	ADG Roughage Period	Final Wt.	Final Condition	ADG Full-Feed	ADG Overall
Treatment	1	0.0428	1099.9879	0.0001	0.0572	466.6068	0.0402	0.0880	0.0134
Initial wt.	1	0.3132	97139.6920**	2.9964*	0.5552*	90002.2755**	0.5307	0.0811	0.2637*
Residual	2	1.0270	242.3464	0.1506	0.0123	114.8433	2.0882	0.0377	0.0035

*P < .05

**P < .01

TABLE XIV

ANALYSIS OF VARIANCE FOR THE EFFECTS OF TREATMENT AND INITIAL WEIGHT ON CARCASS TRAITS, 1966-67

		Mean Square					
Source	df	USDA Grade	Percent Kidney Fat	Marbling Score	Ribeye Area Sq. In.	Carcass Fat mm	Dressing Percent
Treatment	1	2.0739	0.2554	2.6687	0.3332	11.7499	16.2423
Initial wt.	1	0.0696	1.0095	0.0166	1.3184	73.6336	3.3209
Residual	2	0.7022	0.1312	0.3352	1.5440	4.4218	2.1126

TABLE XV

ANALYSIS OF VARIANCE FOR THE EFFECTS OF TREATMENT AND INITIAL WEIGHT ON FEEDLOT PERFORMANCE, 1967-68

		Mean Square							
Source	df	Initial Condition	Roughage Wt.	Roughage Condition	ADG Roughage Period	Final Wt.	Final Condition	ADG Full-Feed	ADG Overall
Treatment	1	0.4314	55.5248	0.6207	0.0029	1504.9140	1.2867	0.3297	0.0392
Initial wt.	1	0.5252	62686.6140*	11.3072	0.2167	45162.7984**	5.6920	0.4714	0.0198
Residual	4	0.8077	1097.7084	8.8978	0.0565	513.2648	1.1255	0.1067	0.0137

*P < .05

**P < .01

TABLE XVI

ANALYSIS OF VARIANCE FOR THE EFFECTS OF TREATMENT AND INITIAL WEIGHT ON CARCASS TRAITS, 1967-68

		Mean Square					
Source		USDA Grade	Percent Kidney Fat	Marbling Score	Ribeye Area Sq. In.	Carcass Fat mm	Dressing Percent
Treatment	1	12.1289*	0.3027	7.0203	0.4530	19.1788	2.9092
Initial wt.	1	1.5886	5.9967	1.5548	0.2294	79.2803	0.6500
Residual	4	0.9440	3.5037	1.3220	2.1673	22.4423	3.6351

*P < .05

TABLE XVII

ANALYSIS OF VARIANCE FOR THE EFFECTS OF TREATMENT AND INITIAL WEIGHT ON FEEDLOT PERFORMANCE (1966-67, 1967-68)

		Mean Square							
Source	df	Initial Condition	Roughage Wt.	Roughage Condition	Roughage ADG	Final Wt.	Final Condition	Full-feed ADG	ADG Overall
Year	1	5.4400	15,892.9203*	0.0506	0.8072*	64.1341	7.3682*	0.9225**	0.1822*
Treatment	1	0.0654	919.4700	0.2470	0.0478	1,663.3230	0.7704	0.0175	0.0458
Year x treatment	1	0.3331	447.8882	0.2673	0.0233	60.2554	0.3291	0.3482	0.0011
Regression of initial wt.	1	0.8103	159,390.6379**	12.4220	0.7497**	133,456.4303**	4.5478	0.4485*	0.2272*
Residual	6	0.9110	1,505.7658	1.2248	0.0722	918.3465	0.8259	0.0664	0.0266

*P < .05

**P < .01

TABLE XVIII

ANALYSIS OF VARIANCE FOR THE EFFECTS OF TREATMENT AND INITIAL WEIGHT ON CARCASS TRAITS (1966-67, 1967-68)

		Mean Square					
Source	df	USDA Grade	Percent Kidney Fat	Marbling Score	Ribeye Area Sq. In.	Carcass Fat mm	Dressing Percent
Year	1	19.8222**	0.2180	11.0968*	2.0321	116.4167*	18.9108
Treatment	1	10.9656*	0.5533	8.6735*	0.0006	29.4692	17.7024
Year x treatment	1	1.2185	0.0011	0.1760	0.7445	0.0151	4.1078
Regression of initial weight	1	1.0739	5.6670	0.5397	0.2887	152.0584*	0.6759
Residual	6	0.8885	2.1573	1.2089	1.8024	17.5575	3.4758

*P < .05

**P < .01

TABLE XIX

SIMPLE CORRELATION COEFFICIENTS OF INITIAL MEASUREMENTS, PERFORMANCE AND CARCASS TRAITS, 1966-67

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Initial wt. (1)	1.000															
Initial cond. (2)	0.132	1.000														
Wt., 140 days (3)	0.932	0.144	1.000													
ADG, 140 days (4)	0.652	0.128	0.883	1.000												
Cond., 140 days (5)	0.548	0.500	0.596	0.534	1.000											
Wt., final (6)	0.888	0.137	0.972	0.880	0.613	1.000										
Cond., final (7)	0.176	0.678	0.266	0.326	0.538	0.224	1.000									
ADG, full-feed (8)	-0.148	-0.022	-0.078	0.026	0.098	0.159	-0.167	1.000								
ADG, overall (9)	0.513	0.105	0.746	0.894	0.519	0.850	0.213	0.471	1.000							
USDA grade (10)	0.078	0.053	0.193	0.307	0.000	0.260	-0.078	0.252	0.378	1.000						
Kidney fat (11)	0.279	0.058	0.287	0.242	0.131	0.261	0.172	-0.095	0.168	0.244	1.000					
Marbling score (12)	-0.031	0.235	-0.022	-0.003	0.094	0.032	0.060	0.228	0.099	0.729	-0.020	1.000				
Ribeye area (13)	0.263	0.198	0.342	0.373	0.287	0.415	0.343	0.322	0.475	-0.004	-0.074	-0.155	1.000			
Carcass fat (14)	0.527	0.373	0.521	0.406	0.292	0.486	0.300	-0.129	0.303	0.274	0.590	0.027	0.120	1.000		
Dressing percent (15)	-0.163	0.294	-0.082	0.040	-0.059	-0.024	0.251	0.242	0.145	0.417	0.444	0.419	-0.039	0.318	1.000	

TABLE XX

SIMPLE CORRELATION COEFFICIENTS OF INITIAL MEASUREMENTS, PERFORMANCE AND CARCASS TRAITS, 1967-68

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Initial wt. (1)	1.000															
Initial cond. (2)	0.304	1.000														
Wt., 140 days (3)	0.846	0.136	1.000													
ADG, 140 days (4)	0.150	-0.177	0.654	1.000												
Cond., 140 days (5)	0.344	0.133	0.534	0.502	1.000											
Wt., final (6)	0.780	0.149	0.960	0.675	0.526	1.000										
Cond., final (7)	0.244	0.272	0.433	0.459	0.680	0.424	1.000									
ADG, full-feed (8)	-0.190	0.053	-0.088	0.108	-0.002	0.194	-0.011	1.000								
ADG, overall (9)	0.042	-0.123	0.515	0.896	0.427	0.658	0.385	0.539	1.000							
USDA grade (10)	0.293	0.282	0.314	0.168	0.329	0.320	0.401	0.037	0.157	1.000						
Kidney fat (11)	0.232	0.245	0.390	0.394	0.427	0.349	0.381	-0.124	0.279	0.400	1.000					
Marbling score (12)	0.394	0.201	0.337	0.068	0.213	0.315	0.223	-0.058	0.029	0.876	0.426	1.000				
Ribeye area (13)	0.098	-0.134	0.234	0.296	-0.152	0.322	0.096	0.328	0.397	0.177	-0.144	0.100	1.000			
Carcass fat (14)	0.326	0.254	0.423	0.324	0.365	0.417	0.426	0.002	0.275	0.266	0.391	0.084	0.062	1.000		
Dressing percent (15)	0.117	0.322	0.164	0.136	0.234	0.168	0.276	0.023	0.130	0.533	0.304	0.353	0.214	0.273	1.000	

TABLE XXI

SIMPLE CORRELATION COEFFICIENTS OF INITIAL MEASUREMENTS, PERFORMANCE AND CARCASS TRAITS, TWO YEARS DATA

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Initial wt. (1)	1.000															
Initial cond. (2)	0.106	1.000														
Wt., end roughage (3)	0.897	-0.543	1.000													
ADG, roughage (4)	0.462	-0.226	0.829	1.000												
Cond. end roughage (5)	0.424	0.149	0.540	0.507	1.000											
Wt., final (6)	0.837	0.034	0.938	0.764	0.554	1.000										
Cond., final (7)	0.837	0.034	0.938	0.764	0.554	0.230	1.000									
ADG, full-feed (8)	-0.309	0.150	-0.316	-0.023	-0.067	0.001	0.057	1.000								
ADG, overall (9)	0.326	-0.150	0.688	0.896	0.472	0.767	0.177	0.227	1.000							
USDA grade (10)	-0.000	0.320	-0.091	-0.168	0.121	0.072	0.352	0.313	-0.032	1.000						
Kidney fat (11)	0.314	0.093	0.422	0.417	0.390	0.371	0.228	-0.210	0.316	0.172	1.000					
Marbling score (12)	0.081	0.302	-0.070	-0.222	0.086	0.054	0.266	0.219	-0.132	0.872	0.170	1.000				
Ribeye area (13)	0.214	-0.086	0.339	0.380	-0.012	0.394	0.103	0.178	0.463	-0.001	-0.063	-0.058	1.000			
Carcass fat (14)	0.284	0.335	0.260	0.152	0.288	0.343	0.415	0.047	0.174	0.326	0.378	0.144	0.330	1.000		
Dressing percent (15)	0.104	0.210	0.191	0.233	0.186	0.162	0.177	-0.011	0.226	0.270	0.392	0.208	0.171	0.221	1.000	

TABLE XXII

FEED COSTS

	Cost Per Ton, $	
	1966-67	1967-68
Corn silage	8.00	8.00
Ground shelled corn	55.70	46.78
Cottonseed meal	96.50	87.90
Alfalfa-grass mixed hay	35.00	35.00
Feed grade urea	97.42	92.80
Ground limestone	13.00	15.00

VITA

Richard P. Clarisse was born in Sodus, New York, on October 8, 1945. He attended Williamson Central School in Williamson, New York, and graduated in 1963. The same year he enrolled in the New York State College of Agriculture, Cornell University, Ithaca, New York, where he received a Bachelor of Science Degree in 1967. In March 1972 he received a Master of Science Degree from The University of Tennessee, with a major in Animal Husbandry.