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Performance and Carcass Characteristics of Feeder Heifer Calves Fed Different Amounts of Concentrates with Urea-Limestone Treated Corn Silage

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To the Graduate Council:

I am submitting herewith a thesis written by Gordon Bobby Idol entitled "Performance and Carcass Characteristics of Feeder Heifer Calves Fed Different Amounts of Concentrates with Urea-Limestone Treated Corn Silage." 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 Science.

James A. Corrick, Jr., Major Professor

We have read this thesis and recommend its acceptance:

C.C. Chamberlain, J.B. McLaren, Charles S. Hobbs

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(Original signatures are on file with official student records.)

December 1, 1969

To the Graduate Council:

I am submitting herewith a thesis written by Gordon Bobby Idol entitled "Performance and Carcass Characteristics of Feeder Heifer Calves Fed Different Amounts of Concentrates with Urea-Limestone Treated Corn Silage." 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.

James A. Covich, Jr.
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We have read this thesis and recommend its acceptance:

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PERFORMANCE AND CARCASS CHARACTERISTICS OF FEEDER HEIFER CALVES FED DIFFERENT AMOUNTS OF CONCENTRATES WITH UREA-LIMESTONE TREATED CORN SILAGE

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Gordon Bobby Idol

December 1969

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ABSTRACT

Two feeding trials, one in 1967-68 and the other in 1968-69, were conducted at the University of Tennessee's Blount Farm to determine the effect of feeding different amounts of concentrates with urea-limestone treated corn silage on the performance and carcass characteristics of feeder heifer calves. A total of 288 animals were involved in the study. Treatments included delaying the feeding of a 6 lb. concentrate supplement for 0 (control), 56, 84, 112, 140 and 168 days during a period of high roughage feeding. Two other treatments involved the feeding of 2 or 4 lb. of concentrate during the entire roughage phase. After the roughage phase all animals were given a fullfeed of concentrate until they graded high-Good to low-Choice. They were then slaughtered at local packing plants.

Daily gains were highest when the heifers were fed 4 or 6 lb. of concentrate during the entire roughage phase. Delaying the feeding of the concentrate supplement for as long as 84 days resulted in gains slightly less in magnitude but not significantly ($P > .05$) lower than those of the two highest gaining groups of heifers. The amount of feed required per hundred pounds of gain was lowest for the heifers fed 2 or 4 lb. of concentrate. Average daily dry matter consumption decreased with increased delay of concentrate feeding. Dressing percent and percent kidney fat was highest for the heifers fed 4 or 6 lb. of concentrate. Fat thickness, marbling scores, and U.S.D.A. carcass grades were highest for heifers

fed 6 lb. of concentrate during the entire roughage phase. The treatments had little or no effect on ribeye area. Final condition grades generally decreased with decreases in total amount of concentrate fed. Feed cost per hundred pounds of gain was lowest for heifers fed 2 lb. of concentrate. Returns above feed and initial costs were highest for heifers fed 6 lb. of concentrate for the entire roughage phase.

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CHAPTER I

INTRODUCTION

The number of beef cattle operations in Tennessee is rapidly increasing. Tennessee presently ranks eighth in number of beef cows per square mile. As new producers enter the field, they are soon faced with the problems that veterans have tried to solve for many years. One of these problems is that of cutting costs. Although increased feeding on a year-round basis in the Southwest has a tendency to stabilize market fluctuations, cattle producers and feeders are still at the mercy of an ever changing market when they are ready to sell their products. Except for possible hedging with cattle futures, there is little that the producer can do to control the market. However, he can take certain steps to lower his overall costs of production.

One of these is the feeding of urea. Cattle feeders have found that the feeding of urea to cattle has materially lowered the cost of one of the most expensive items in present day rations, that of supplemental protein. Whether added to the ration as part of a protein or concentrate supplement, directly to the whole ration, or to silage at the time of ensiling, urea has proved to be an adequate substitute for all or part of the expensive protein supplements usually needed for a balanced ration.

Another approach involves cutting energy costs for the energy portion of the ration is becoming increasingly more expensive. This is

especially true in Tennessee where a relatively small portion of the land area is devoted to intensive farming, and concentrates, chiefly corn and grain sorghum, are expensive. At present there is no suitable cheap substitute for corn energy as there is with urea in protein supplements; therefore, a system of feeding which involves the use of a minimum amount of concentrates with maximum performance would definitely be of value to cattlemen, particularly cattle feeders.

The purpose of this study was to determine if delayed concentrate feeding or reduced levels of concentrate feeding would produce more economical gains and improved carcass characteristics in feeder heifer calves compared to the feeding system presently recommended by the University's Department of Animal Husbandry-Veterinary Science.

CHAPTER II

LITERATURE REVIEW

I. CONSTANT AMOUNTS OF ENERGY

Levels in Feedstuffs and Rations

> Prior to 1908 practically all experimental work in studying methods of beef production was conducted to determine the rations that would give the heaviest daily gains and the highest gains for a pound of feed consumed regardless of cost of production. This line of work met the needs of the beef industry when feeds were cheap, but with the general rise in the price of all farm and commercial feeds, it became necessary to change the line of investigational work. In seeking some means of reducing the cost of producing beef, it was found that by limiting the grain ration to 1/2 or 2/3 of a fullfeed during the first two months of the feeding period, the total cost of production was also materially reduced while the total gain and final value on the market were not reduced in the same proportion. This was especially true when corn silage formed a part of the roughage. . . . Cattle feeders all over the country are beginning to appreciate the value of silage and the time is not far distant when cattle feeders will have to build a silo or quit the business (Tomhave, 1916).

Interestingly enough, this prophecy has, to a large degree, come true. Tennessee producers now feed a large amount of roughage material, especially silage, to cattle.

Various workers have attempted to measure the energy content of silage fed with or without corn. Klosterman et al. (1966) found that urea, dicalcium phosphate and limestone treated corn silage had a net energy of 59.8 and 68.3 therms per hundredweight of dry matter when fed to steers and heifers, respectively. Values for corn were 75.3 and 73.3,

respectively. Fox et al. (1968) found that untreated corn sialge had a NE(m + p) of 63.2 therms per 100 lb. of dry matter when fed to steers. Fowler et al. (1968) observed that corn silage having 32 percent dry matter contained a NE(m + p) per 100 lb. air dry matter of 63.2 therms. The value for corn was 72.3.

Effects of Low Energy Consumption

Edwards et al. (1968) observed that rations of untreated and urea treated corn silage fed ad libitum with 1.5 lb. of cottonseed meal per head per day resulted in the slowest gains and slightly lower yield grades when compared to rations containing corn at the rate of 1 percent of body weight in addition to corn silage.

A ration of corn silage supplemented only with 3.25 lb. soybean meal plus minerals produced higher average daily gains than a ration of corn silage supplemented with 32.5 lb. corn, 0.32 lb. urea, and minerals (Van Arsdell et al., 1953). However, corn silage supplemented with 2.25 lb. of soybean meal, 1 lb. molasses, and minerals produced higher average daily gains than either of these rations. Tomhave (1920) reported that cattle fed corn silage ad libitum plus cottonseed meal gained faster than those fed corn silage, cottonseed meal and corn at the rate of 15 lb. during the last 84 days. The author concluded that a ration of silage and protein supplement would produce carcasses of sufficient quality to satisfy market demands of his day. In an earlier study Tomhave (1917) found that a ration of corn silage supplemented with 2.5 lb. of cottonseed meal per 1000 lb. live weight for the first 84 days and 3.5 lb.

during the last 56 days produced carcasses about equal to those produced on corn supplemented rations.

Hawkins et al. (1967b) observed that steers and heifers fed corn silage required a significantly longer time to reach desired finish, gained slower, had lower feed costs, 2 percent less dressing percentage, and less fat thickness than similar cattle fed 1 percent of body weight in shelled corn plus corn silage. Ralston et al. (1966) compared a low energy ration containing 69 percent total digestible nutrients with higher energy rations containing 72 and 78 percent TDN for finishing Hereford steers. No significant differences were observed in average daily gain, marbling score, carcass grade, backfat, ribeye area or estimated trimmed cut yield of the calves fed the three levels of TDN.

Hammes et al. (1964) found that corn silage plus limited supplement and no corn resulted in higher feed efficiencies than for corn supplemented rations. Slaughter grades were equal. These results may have been affected by the fact that the corn silage was made from a high grain yielding variety.

The grade of feeder cattle may make a difference when low energy levels are fed. Corn silage alone fed to steer calves of standard and choice grades produced different results. Choice calves gained less when fed the unsupplemented corn silage ration than those fed 0.5, 1.0 and 1.5 lb. of total concentrate daily per 100 lb. of body weight. Standard grade calves fed the low energy ration gained slightly higher than calves fed a ration containing 0.5 lb. of total concentrate per 100 lb. of body weight (Minish, 1967).

Other workers (Raleigh and Wallace, 1962; Minish et al., 1966; and Hawkins et al., 1967a) reported lower average daily gains with zero levels of concentrates than with roughage rations supplemented with grain.

Low energy (maintenance) rations may decrease the digestibility of organic matter, nitrogen free extract, and energy (Elam, 1958). Brown et al. (1968) found that nitrogen retention was significantly lower at maintenance levels than for intermediate or high levels of en energy. Stone and Fontenot (1965) reported that apparent digestibility of crude protein and ether extract were not significantly different when steers were fed low, medium and high levels of available energy.

Effects of Supplemental Energy Feeding

Corn fed at the rate of 1 percent of body weight of the cattle produced gains similar to those of cattle fed a ration containing no corn in a study conducted by Edwards (1968). Similar results were observed by Young et al. (1962) when a corn silage ration was supplemented with 1.25 percent shelled corn and compared to delayed fullfeeding of corn after 98 days. Pinney et al. (1966) compared the feeding of corn at rates of 0.5 percent, 1.0 percent and 1.5 percent of body weight as a supplement to corn silage fed ad lib. Daily gain increased with increased feeding of corn. Carcass grades were the same for all levels of corn feeding. Richardson et al. (1953) observed higher daily gains and dressing percentages for steers fed 3 or 5 lb. of milo with silage than for those fed 1 lb.

Corrick and Hobbs (1968) found that average daily gains were similar for heifers fed urea-limestone treated corn silage and 6 lb. of concentrate. This ration was supplemented with either 7 lb. of alfalfa silage, 13 lb. alfalfa silage, or 2 lb. of alfalfa hay.

Dry matter intake usually increases when more grain is fed. In comparing a silage ration with a silage plus 1 percent of body weight in corn ration, Hawkins (1967) found that dry matter intake per unit of body weight increased when a silage ration was supplemented with corn at the rate of 1 percent body weight.

In the previously cited work Minish et al. (1966) report the results of feeding the following restricted levels of grain: 0.0, 0.5, 1.0, and 1.5 lb. of concentrate per 100 lb. of body weight in addition to a fullfeed of silage. Average daily gain of Choice feeder cattle increased significantly with increasing concentrate levels up to 1.0 lb. concentrate, then rose slightly up to the 1.5 lb. level. Addition of 1.0 lb. per 100 lb. body weight resulted in the best performance. Dressing percentage was higher for the 1.0 and 1.5 levels than for the lower level.

Levels of 1 percent and 1.5 percent of body weight of corn were fed to steer calves in addition to a fullfeed of sudex silage and average daily gains were similar for both rations (Henderson and Newland, 1966).

Klosterman et al. (1959) observed no significant differences in average daily gains or carcass grades when calves were fed either 5 lb. concentrate plus silage, 10 lb. concentrate plus silage, or a fullfeed of corn. The amounts of estimated net energy required per unit of gain

were significantly different. As the amount of corn in the ration increased, the amount of energy required per unit of gain increased.

Small amounts of supplemental grain may have some effect upon the digestibility of certain nutrients. Hill and Noller (1963) compared rations of corn silage alone, corn silage plus 1.2 lb. of a 44 percent soybean protein supplement and a ration of corn silage plus 1.2 lb. of ground corn daily. The digestion coefficient for the crude protein of the corn supplemented ration was lower than the coefficients for the other two rations. Swift et al. (1947) reported that increasing carbohydrates in the form of starch in lamb rations reduced the digestible crude fiber and digestible protein. In a study with steers, Stone and Fontenot (1965) reported that increased available energy resulted in increased digestibility of dry matter, organic matter, energy and nitrogen free extract. Digestibility of crude fiber decreased with increases in available energy.

Conversely, Arias et al. (1951) found that a small amount of readily available carbohydrate aided cellulose digestion. Fontenot et al. (1955) noted that the addition of cerelose at levels of 350, 700 and 1050 g. to steer wintering rations containing 8 percent protein decreased the apparent, but not true, digestibility of protein, depressed the digestibility of crude fiber and increased the digestibility of nitrogen free extract.

In addition, other effects may be noted with increased energy. Fontenot et al. (1955) found that adding cerelose to an 8 percent protein ration significantly lowered nitrogen retention. When the ration

contained 10 percent protein, nitrogen retention was increased. A slight increase in nitrogen retention was observed when the basal ration contained 12 percent protein. The estimated biological value of the nitrogen was increased by cerelose addition. Erwin et al. (1963) noted that increasing the energy from 70 to 81 therms per 100 lb. of diet of steers caused a significant loss of liver vitamin A and significantly reduced the amount of feed required per unit of gain.

Since feeding grain in liberal amounts to feeder cattle involves considerable expense, increased performance must result in sufficient in return to offset the cost. In a study conducted by Kolari et al. (1963) feeding corn alone resulted in higher daily gains and better feed efficiency than feeding corn plus corn silage. However, carcass grades were identical. Corrick and Hobbs (1968) observed similar results.

An early work illustrates the common problem encountered in feeding lower energy rations. Jones et al. (1923) compared liberal corn supplementation to no corn supplementation of a basal ration containing cottonseed meal and hulls. The cattle receiving only the basal ration failed to reach the desired finish by the end of the feeding period and had almost ceased to gain by that time. As corn increases in most rations so does the average daily gain (Gerlaugh and Gay, 1937; Klosterman et al., 1965).

As illustrated above (Kolari et al., 1963) feed efficiency is usually increased with increased energy content of the ration. This hypothesis was substantiated when Albert et al. (1965) compared two energy levels, 60 and 73 percent total digestible nutrients fed to

steers. In an early study Gerlaugh and Gay (1938) concluded that a three-fourths fullfeed of corn and cob meal plus alfalfa hay would require a slightly longer feeding period to yield similar financial returns than a fullfeed of corn and cob meal.

Sometimes liberal grain feeding may not cause an increase in performance. Klosterman et al. (1959) found that when a fullfeed of corn was compared to a half-feed of corn plus a fullfeed of corn silage, daily gains were not significantly different.

Elam et al. (1958) and Putnam et al. (1966) reported high energy rations resulted in lower digestibility of crude protein, ether extract and crude fiber. On the other hand, Stone and Fontenot (1965) reported that digestibility of crude protein and ether extract were not affected by high energy levels.

Concentrate to Roughage Ratios in Cattle Rations

Many workers have studied the performance of cattle fed various proportions of concentrates in their rations. The effects of some of these ratios upon feedlot performance, carcass characteristics, nutrient digestibility and rumen acid concentrations are summarized below.

Garrett et al. (1962) conducted a unique trial in which they studied the relationship of daily energy intake to daily weight gain. Correlation coefficients of 0.97, 0.90 and 0.92 were found between daily gain and therms of energy gain per day.

Sometimes a high energy ration may not result in better feedlot performance than a high roughage ration. This was true in a study

conducted by Anthony et al. (1961). Although feeding efficiency was better for the high energy ration than for the high roughage ration, average daily gain was significantly lower for the high energy ration. Megli et al. (1965) reported that average daily gains of lambs fed a 95 percent roughage ration were higher than for lambs fed a 75 percent roughage ration. Pope et al. (1957) compared concentrate to roughage ratios of 35:65, 50:50, 65:35 and 80:20. They found that steers gained fastest when fed the 35:65 ratio.

Numerous workers have studied various concentrate-roughage ratios. Dowe et al. (1955) compared various ratios of concentrate-alfalfa and reported the highest daily gains from a 2:1 ratio. In addition, they observed that as the concentrate fraction of the ration increased, the total feed intake decreased. Whiting (1957) and Keith et al. (1952) reported faster gains when steers were fed a 2:1 concentrate-hay ratio. Concentrate-roughage ratios of 1:1, 1:2, 1:3, 2:1, 3:1 and 4:1 produced similar gains when fed to steers (Keith et al., 1955).

Hartman et al. (1958) observed similar rates of gain in lambs fed rations varying from 71 to 45 percent in concentrate content. McCroskey et al. (1958) compared these concentrate to roughage rations: 35:65, 50:50, 65:35 and 80:20. Small nonconsistent differences were recorded. Bucy and Bennion (1962) studied three levels of concentrates, 70, 85 and 95 percent, and observed that steers fed the lower concentrate ration gained slightly better than steers fed the higher concentrate rations. Cartwright et al. (1958) fed steers a high concentrate ration containing 60 percent milo and a low concentrate ration containing 20 percent milo.

They reported that the concentrate level had little effect on the growth of the steers. Anthony et al. (1960) recorded slight but nonsignificant increases in average daily gain when steers and heifers were fed 0, 10 and 30 percent coastal Bermudagrass hay in their rations.

Some workers have found that a 1:1 concentrate to roughage ratio produces the fastest gains (Pope et al., 1957, and Luitingh, 1961). One of these (Pope et al., 1957) observed that heifers gained fastest when fed this ration while steers gained fastest on a 35:65 ration.

Numerous workers have reported that as the energy level of the ration increases, daily gain increases (Jones et al., 1958; Newland and Henderson, 1965; Hironaka and Bailey, 1958; Woods and Scholl, 1962; Richardson et al., 1961; Oltjen et al., 1968; Beardsley et al., 1959; and Cmarik et al., 1957).

The higher concentrate rations generally resulted in better feed efficiency than did lower concentrate rations. This was observed by Keith et al. (1952), Hartman et al. (1958), Newland and Henderson (1965), Hironaka and Bailey (1968), Henrick et al. (1965) and Guenther et al. (1965). Luitingh (1961) found that feed efficiency of eight-month old calves and two and three-year old steers was higher when fed rations with a 1:1 ratio. McCroskey et al. (1958) found only small differences in feed efficiency when steers and heifers were fed rations with ratios of 35:65, 50:50, 65:35 and 80:20. On the contrary, Anthony et al. (1960) noted lower efficiency with decreased roughage feeding.

Oltjen et al. (1968), Miller et al. (1967) and Guenther et al. (1965) report higher dressing percentages of cattle fed high energy

rations than those fed lower energy rations. Cmarik et al. (1957) report no differences in dressing percentages of cattle fed 45, 55 or 65 percent ground shelled corn in their rations. Whiting (1957) observed that a ratio of 1:2 produced lower dressing percentages than ratios of 1:1 and 2:1. Newland and Henderson (1965) record decreasing dressing percentages with increases of concentrate level from 50 to 71 percent.

Ely and Noble (1964) (with lambs), Hedrick et al. (1954) and Hendrickson et al. (1959) report increasing fat deposition with increasing amounts of concentrate. Miller et al. (1967) report no significant differences in fat cover between carcasses of Holstein steers that had been fed 91.3 percent or 25.8 percent ground corn. Cartwright et al. (1958) found that steers were only slightly fatter when fed a 60 percent milo ration than when fed a 20 percent milo ration.

Steers fed an energy level sufficient to support rapid gains produced carcasses with more marbling than steers that gained moderately due to limited energy (Hendrickson et al., 1959; Hendrickson et al., 1961; Henrick et al., 1965). Miller et al. (1967) and Richardson et al. (1961) found no significant differences in marbling scores with increases in energy content of the ration.

Increased energy in the ration resulted in higher slaughter grades according to Woods and Scholl (1962), Oltjen et al. (1959) (1961), Henrick et al. (1965) and Guenther et al. (1965). Slight and nonsignificant grade differences were recorded with increases of energy by McCroskey et al. (1958), Richardson et al. (1961), Cmarik et al. (1957), Anthony

et al. (1960), and Miller et al. (1967). Two workers (Bucy and Bennion, 1962) reported lower grades with increased energy.

Hendrickson et al. (1959) found that the yield of wholesale cuts, shear values and tenderness scores from steer carcasses showed very small treatment differences between rapidly and moderately gaining animals. The moderately gaining calves had 6 percent more lean than the rapidly gaining calves. Hedrick et al. (1954) recorded less separable lean with low winter gaining steers than with higher gaining steers. When compared on a weight constant basis, there were no significant differences in lean deposition of steers on high and moderate levels of energy according to Guenther et al. (1965). However, on an age constant basis, the high level steers produced more total lean than the moderate level steers. Yield of lean was also more for moderate gainers than for rapid gainers in a study conducted by Henrick (1965). Tenderness was about the same for both levels of gain in another study (Hedrick et al., 1954). Ribeye area has both been observed to be greater with a high level of energy (Guenther et al., 1965) and show no significant increases (Miller et al., 1967). Hedrick et al. (1954) report increased energy while Hendrickson et al. (1961) and Henrick et al. (1965) report no significant differences between energy levels.

The effects of various energy ratios on nutrient digestibility have been studied by Parrott et al. (1968) who fed milo and alfalfa hay to steers. It was found that grain levels of 40 percent or less had no effect on cellulose digestibility. At 50 percent and above, cellulose digestibility was decreased by increasing increments of grain.

Digestible energy was highest for the 75 percent level, similar among the 80 percent through 95 percent levels, and reduced at the 100 percent level of grain.

Dowe et al. (1955) studied corn-alfalfa ratios of 1:1, 2:1, 3:1, 4:1 and 5:1. As corn in the ration increased, the apparent digestibility of dry matter and ether extract increased. The apparent digestibility of nitrogen free extract, crude fiber and protein were similar for all ratios. The differences in apparent digestibility for all nutrients were not statistically different. Baird et al. (1967) found that the digestion of protein in the ration decreased significantly with increasing grain.

Total volatile fatty acid (VFA) concentration was found to increase with increases in energy content of the ration of sheep (Brown et al., 1958). Davison (1965) observed that total VFA concentrations increased significantly ($P < .01$) and rumen pH decreased with increases in concentrates of cattle rations up to 60 percent (90 percent for rumen pH) after which they decreased with increases in concentrates. Baird et al. (1967) recorded only small differences in total VFA concentration and rumen pH when concentrate to forage ratios of 0:100, 25:75, 50:50, and 75:25 were fed to beef cattle. The 50:50 ratio produced slightly higher concentrations than the other ratios. When ratios of 80:20 and 20:80 were fed to lambs, total VFA concentrations were less for the lambs fed the 80:20 ratio than for the lambs fed the 20:80 ration (Luther and Trenkle, 1963).

The ratio of acetate to propionate may become narrower with increases in percentage of concentrate of a ration (Parrott et al., 1968; Bath and Rook, 1963; Brown et al., 1958; and Luther and Trenkle, 1963). One study showed no effect on the acetate to propionate ratio with increases in concentrates in the ration of cattle (Baird et al., 1967). The concentration of butyrate in one study (Davison et al., 1964) increased with increases in concentrates, while in another study (Brown et al., 1958) it was not affected.

II. VARIED AMOUNTS OF ENERGY

Two Phase System

Feeding grain for only part of the finishing period has one very important advantage--it reduces the total cost of the ration. However, the question is, "Will performance compare favorably with that of cattle on higher energy rations?" Miller et al. (1967) found that Holstein steers fed a ration containing 25.8 percent corn until they reached a weight of 748 lb., then switched to a ration of 91.3 percent corn for the remainder of the feeding period gained faster and were more efficient than steers fed the 91.3 percent corn ration for the entire period. McCampbell (1921) found that withholding corn for the first 120 days of a 210 day feeding period was more profitable than feeding corn the entire period; however, average daily gains were less for the steers fed the low grain ration. Kolari et al. (1963) reported that feeding corn during the last half of a feeding period did not materially lower average daily gain or affect feed efficiency when compared to a fullfeed of corn the entire period.

Tomhave (1920) observed that average daily gains of animals fed a corn silage ration supplemented with 15 lb. corn grain during the last 84 days of a 140 day feeding trial were higher than those fed a ration of silage with no corn supplement. Hale et al. (1962) observed similar results with hominy. Addition of corn at the rate of 1 percent of the body weight of the steers to a ration of urea-treated corn silage during the second half of the feeding period did not significantly affect average daily gain (Edwards et al., 1968). Other reports indicated only slight differences when two-phase systems were compared to limited grain feeding (Cochel, 1912, and Young et al., 1962).

Johnson et al. (1958) studied the effects of delayed concentrate feeding of steers. A roughage mixture consisting of 40 parts of alfalfa hay and 60 parts of corn silage was fed with a concentrate mixture containing 49 parts of ground barley, 24.5 parts of ground oats, 24.5 parts of dried molasses beet pulp and 2 parts of salt. The treatments involved the feeding of the roughage mixture alone for 0, 28, 56, 84, 112 and 140 days followed by addition of the concentrate mixture for the remainder of the 168 day feeding period. Steers that were fed both the concentrate and roughage mixture for the entire feeding period gained significantly faster than those fed only the roughage mixture for the first 84, 112 and 140 days. The latter treatment steers made 49.2 percent more economical gains than those fed both the concentrate and roughage mixture for the entire feeding period; however, they required 28 days more feeding time.

Neumann et al. (1963) compared the performance and carcass characteristics of Hereford steers fullfed a finishing ration of cracked shelled corn, soybean meal, limited silage and mixed hay to that of steers fed a growing ration of silage, soybean meal, and limited hay for 126 days, 189 days, or 250 days followed by a finishing period on the control ration. Carcass grades for the steers were high-Good, low-Choice and low-Choice, respectively. The number of days required to reach the desired slaughter condition were 214, 238, 283 and 295, respectively.

Sliding Scale System

This system entails a gradual increase of concentrates and concurrent decrease of roughage until the animals are on a full finishing ration toward the end of the period. Kolari et al. (1963) compared this feeding system with (1) a constant fullfeed of corn, (2) a constant amount of silage with corn fed ad libitum and (3) a two-phase system (roughage and fullfeed phase). The authors found very little differences in performance and carcass characteristics. Richardson et al. (1961) and Henderson and Newland (1967) observed similar results.

On the other hand, England and Taylor (1960) found that steers fed by the sliding scale method grew faster than those steers fed a constant amount of concentrate. Dowe et al. (1955) compared various concentrate-roughage ratios with a moving ratio in which the concentrate was increased one part each 28 days. The moving ratio produced the highest average dressing percentage.

CHAPTER III

EXPERIMENTAL PROCEDURE

This study was conducted at the University of Tennessee's Blount Farm at Knoxville. The experiment involved feeding various amounts of total concentrates with urea-limestone treated corn silage to feeder heifer calves. The study consisted of two trials (1967-68 and 1968-69) which were a continuation of a number of experiments at the Knoxville Station in which corn silage was fed as the principle ration constituent. The general purpose of these experiments has been to develop a system of feeding in which maximum use of low-cost roughage could be obtained and, at the same time, produce carcasses that are acceptable to packers and consumers.

Animals and Facilities

Weanling Hereford, Angus and crossbred heifer calves in both trials were purchased at area feeder calf sales and trucked to Blount Farm. In each trial 144 animals were stratified according to grade and weight and randomly assigned to treatment groups. One group within each treatment consisted of Good grade heavy calves, another of Good light calves, and the third consisted of Medium light calves. Average weight of the heifers was 451 and 477 lb., respectively, for the two trials. At the beginning of the trials each calf was implanted with 24 mg. of diethystilbestrol. No other special preliminary treatment was given.

After weighing the calves were put into pens each containing six animals. The floors of the pens were concrete; feed bunks and part of each pen were protected from the weather by barns.

Source of Data

For the first 56 days the animals were weighed every 14 days, then every 28 days thereafter. Water was turned off at 9:00 p.m. the night before each weigh day. Weights were taken at 7:00 a.m. the next morning. Weight records were entered in a record book each weigh day. Daily records of feed consumption were collected throughout the feeding periods. Carcass data were collected from the packing plants by observation in the coolers and from U.S.D.A. graders.

Rations

The urea and limestone was sprinkled over the top of each wagon load of green chop at the time of ensiling. The silage was fullfed twice each day. Both trials were divided into a roughage phase and a fullfeed phase. The roughage phase of 140 days (168 days for Treatment 6) in which the principle ration ingredient was urea-limestone treated corn silage was supplemented with different amounts of concentrates, chiefly ground shelled corn. In the fullfeed or finishing phase, a mixture of ground shelled corn and cottonseed meal was fed ad libitum, supplemented with alfalfa hay, until the heifers attained an estimated live grade of high-Good to low-Choice at which time they were slaughtered.

The experiment consisted of eight treatment rations. Treatment 1 heifers were fed corn silage ad libitum treated with 10 lb. of urea and

10 lb. of limestone per ton. In addition, 6 lb. of corn was fed for 140 days; thereafter 4 lb. of hay and a fullfeed of a concentrate mixture containing 8 parts corn and 1 part cottonseed meal were fed until the animals attained a live grade of high-Good or low-Choice, then they were slaughtered.

Treatments 2-8 were the same as Treatment 1 except that in Treatments 2-6 cottonseed meal was substituted for the daily corn supplement for varying periods of time, while in Treatments 7 and 8 the corn was reduced to 4 and 2 lb., respectively. Details of all treatments are summarized in Table I.

Salt and dicalcium phosphate were fed ad libitum to all animals. One-half of the concentrate mixture was poured over the silage at each feeding and mixed by hand. The ration provided 1.7-1.8 lb. crude protein equivalent per head per day.

Measurements and Statistical Analysis

Final weights were determined by weighing the animals on two successive days and taking the average of the two weights. Twelve hours prior to slaughter, feeding and watering were discontinued. After the second weighing, the animals were hauled ten miles to a Knoxville packing plant where they were slaughtered, and following a 48-hour chill period, carcass measurements were taken. These measurements included fat thickness over the ribeye muscle and area of the ribeye. Both measurements were taken between the twelfth and thirteenth ribs. Fat thickness was measured at a point over the ribeye muscle three-fourths of the distance

TABLE I

TREATMENT RATIONS FED FEEDER HEIFERS INVOLVING THE INITIAL WITHHOLDING OF THE DAILY CORN SUPPLEMENT FOR VARIOUS PERIODS OF TIME

Treatment	U.L.-Corn Silage *ad lib.*	CSM		Corn		Fullfeed
		Amt.	Days fed	Amt.	Days fed	
Control	0-140 days	0	0	6 lb.	0-140	after 140 days
T2	0-140 days	1 lb.	0-56	6 lb.	56-140	after 140 days
T3	0-140 days	1 lb.	0-84	6 lb.	84-140	after 140 days
T4	0-140 days	1 lb.	0-112	6 lb.	112-140	after 140 days
T5	0-140 days	1 lb.	0-140	0	0	after 140 days
T6	0-168 days	1 lb.	0-168	0	0	after 168 days
T7	0-140 days	0	0	4 lb.	0-140	after 140 days
T8	0-140 days	0	0	2 lb.	0-140	after 140 days

from the chine bone to the end of the muscle. Ribeye area was measured using a grid developed by Iowa State University. Carcass characteristics such as percent kidney fat, marbling, maturity, conformation grade and U.S.D.A. quality grade were determined by a U.S.D.A. meat grader.

Performance and carcass data were statistically analyzed by analysis of variance for randomized-complete block data according to the method of Steel and Torrie (1960). When significant differences were found, Duncan's Multiple Range was used for mean separation. Significance was measured at the 0.05 level of probability ($P < 0.05$).

CHAPTER IV

RESULTS AND DISCUSSION

I. PERFORMANCE

Average Daily Gain

In general, as the length of time without the introduction of corn increased, the overall average daily gain decreased (Table II).

Heifers fed 6 lb. of concentrate during the entire roughage phase produced the highest gains in both years. Average daily gains for 1967-68 and 1968-69 were 1.85 and 2.00 lb. per head per day, respectively. These gains were significantly higher than the gains of heifers where grain feeding was delayed for 112, 140 or 168 days.

Although the average daily gains of all heifers in 1968-69 were generally better than those in 1967-68, responses to various treatments were in the same order. The performance of the heifers in each trial are shown in Appendix Tables VII and VIII.

A comparison of the various treatments with the control (Treatment 1) shows that delaying corn feeding for as long as 84 days did not appreciably lower the overall average daily gains. Delaying corn feeding for 112, 140 and 168 days produced significantly slower overall gains than did Treatments 1, 2 and 3. When both trials are considered, the overall average daily gains of the heifers which received no grain for 168 days were significantly lower than those of all other heifers. Also,

TABLE II

PERFORMANCE OF FEEDER HEIFER CALVES FED DIFFERENT AMOUNTS OF CONCENTRATES WITH UREA-LIMESTONE TREATED CORN SILAGE, TWO-YEAR SUMMARY

Treatment	1	2	3	4	5	6	7	8
No. animals	36	36	36	36	36	36	36	36
Av. initial wt.	466	466	462	467	464	460	464	464
Av. wt., end roughage phase	715	687	676	658	655	692	694	690
Av. gain, roughage phase	249	221	214	191	192	229	230	226
Av. daily gain, roughage phase	1.78[a]	1.58[b]	1.53[b]	1.37[c]	1.37[c]	1.36[c]	1.65[ab]	1.62[b]
Av. wt., end fullfeed phase	840	816	814	798	781	788	814	814
Av. gain, fullfeed phase	125	129	138	140	126	97	119	124
Av. daily gain, fullfeed phase	2.26[ab]	2.33[ab]	2.48[a]	2.52[a]	2.26[ab]	1.87[c]	2.15[bc]	2.24[ab]
Overall av. gain	375	350	352	332	317	326	349	351
Overall av. daily gain	1.92[a]	1.79[ab]	1.79[ab]	1.70[bc]	1.63[c]	1.47	1.80[ab]	1.79[ab]

[abc]Means with the same superscript do not differ significantly ($P < .05$).

the feeding of 2 lb. or 4 lb. of corn during the roughage phase produced almost identical overall gains (1.80 and 1.79, respectively) and, although gains of the heifers fed 2 lb. of corn during the entire roughage phase tended to be lower than those of heifers fed 6 lb. of corn, the differences were nonsignificant. However, the heifers fed 4 lb. of concentrate gained 0.17 lb. per head per day less than those fed 6 lb. of concentrate.

Dry Matter Consumption

Daily dry matter consumption for both years was significantly higher in the 1968-69 trial than in the 1967-68 trial. There is no apparent explanation for this. Consumption in both years was highest for the heifers in Treatment 1.

In the 1967-68 trial, dry matter consumption of heifers in Treatments 1, 2, 3, 4, 5 and 6 decreased with decreases in the amount of corn in the ration. Treatments 7 and 8, in that order, ranked just after Treatment 1. In 1968-69 the various treatments ranked in the following order: 1, 3, 2, 4, 5, 6, 7 and 8. When both years were considered, the treatments were ranked as follows: 1, 2, 3, 4, 5, 7, 6 and 8 (Table III).

II. CARCASS CHARACTERISTICS

Dressing Percent

Average dressing percents for heifers on Treatments 1, 2, 3, 6, 7 and 8 were 58.90, 58.22, 57.94, 57.81, 58.62 and 58.04, respectively (Table IV). The differences were nonsignificant. Dressing percents of Treatments 1 and 7 were significantly higher than Treatments 4 and 5.

TABLE III

AVERAGE DAILY RATION AND DRY MATTER INTAKE FOR FEEDER HEIFER CALVES FED DIFFERENT AMOUNTS OF CONCENTRATES WITH UREA-LIMESTONE TREATED CORN SILAGE, TWO-YEAR SUMMARY

Treatment	1	2	3	4	5	6	7	8
No. animals	36	36	36	36	36	36	36	36
Av. daily ration, lb.								
Roughage phase								
Corn silage	24.7	28.2	30.4	31.7	33.0	33.5	25.7	28.7
Corn	5.7	3.5	2.4	1.2	--	--	3.7	1.5
Cottonseed meal	0.8	0.5	0.6	0.8	1.0	1.0	0.3	0.5
Fullfeed phase								
Hay	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
Corn	13.2	13.1	13.3	12.8	12.7	12.6	13.2	13.3
Cottonseed meal	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.7
Av. daily dry matter intake, lb.								
Roughage phase	14.7	14.3	14.2	13.8	13.5	14.4	12.9	12.4
Fullfeed phase	17.1	17.0	17.1	17.2	16.7	16.4	15.8	17.2
Overall average	15.4	15.1	15.0	14.8	14.3	13.9	14.1	13.7

TABLE IV

GRADES AND CARCASS CHARACTERISTICS OF FEEDER HEIFER CALVES FED DIFFERENT AMOUNTS OF CONCENTRATES WITH UREA-LIMESTONE TREATED CORN SILAGE, TWO YEAR-SUMMARY

Treatment	1	2	3	4	5	6	7	8
No. animals	36	36	36	36	36	36	36	36
Live grades[a]								
Av. initial type	8.0	8.0	8.1	8.0	8.1	7.8	8.2	7.8
Av. initial condition	8.7	8.6	8.7	8.6	8.7	8.5	8.4	8.4
Av. condition, end roughage phase	10.4	9.3	9.5	8.8	9.0	8.6	9.5	9.2
Av. final condition[b]	12.1[a]	11.7[ab]	11.4[abc]	10.9[bcd]	10.8[cd]	10.5[d]	11.6[ab]	11.4[abc]
Carcass characteristics								
U.S.D.A. grade	11.6[a]	10.6[c]	10.8[bc]	10.3[c]	10.6[c]	10.3[c]	11.4[ab]	10.9[c]
Dressing percent	58.9[a]	58.3[ab]	58.0[ab]	57.5[b]	57.5[b]	57.9[ab]	58.6[a]	58.1[ab]
Marbling score[c]	5.0[a]	4.1[cd]	4.3[bc]	3.9[cd]	4.1[cd]	3.6[d]	4.6[ab]	4.1[cd]
Ribeye area (sq. in.)	10.7[a]	10.7[a]	10.5[a]	10.8[a]	10.8[a]	10.5[a]	10.8[a]	10.9[a]
Fat thickness (in.)	0.49	0.42[a]	0.41[ab]	0.34[b]	0.32[c]	0.35[ab]	0.40[ab]	0.39[ab]
Percent kidney fat	2.9[a]	2.7[ab]	2.5[bc]	2.5[bc]	2.4[c]	2.3[c]	2.9[a]	2.6[bc]

[a] 6-8 Medium, 9-11 Good, 12-14 Choice.

[b] Means with the same superscript (abcd) do not differ significantly ($P < .05$).

[c] 1- devoid; 2- practically devoid; 3- traces; 4- slight; 5- small; 6- modest; 7- moderate; 8- slightly abundant; 9- moderately abundant; 10- abundant

Dressing percents for heifers on the latter treatments were 57.43 and 57.44, respectively. In 1967-68 Treatments 1, 2, 3, 4, 7 and 8 differences were nonsignificant. In 1968-69 Treatments 1, 5, 6, 7 and 8 differences were nonsignificant.

Fat Thickness (In.) Over the Ribeye Muscle

Carcasses in 1968-69 had significantly more fat over the ribeye muscle than those in the 1967-68 trial. Treatment 1 carcasses averaged 0.49 inches of fat for the two years and this was significantly greater than that of the carcasses from any of the other treatments. In 1967-68 there were no significant differences between treatment means. In 1968-69 Treatment 1 carcasses had 0.45 inches of fat which was significantly different from all other treatments.

Treatment 2, 3, 4, 7 and 8 carcasses did not differ significantly in fat thickness when both years were considered. In the 1968-69 trial there were no significant differences between the carcasses of Treatments 2, 3, 4, 6, 7 and 8. Means for these treatments were 0.38, 0.37, 0.32, 0.34, 0.37 and 0.33, respectively. The fat thicknesses of Treatments 2, 3 and 7 were significantly different from those of Treatment 5 in the 1968-69 trial and the two-year analysis.

Carcasses from Treatments 3, 4, 6, 7 and 8 were nonsignificantly different as to fat thickness. This was also true for the carcasses from Treatments 4, 5, 6 and 8.

The Treatment 1 ration produced carcasses with a significantly greater amount of fat than all other carcasses. However, Treatments 2,

3, 7 and 8 ranked close behind. Table IV, page 28, shows the two-year mean fat thicknesses of each treatment. Carcasses from Treatments 4, 5 and 6 had the least amount of fat over the ribeye muscle.

Marbling

Marbling scores were significantly higher in the 1967-68 trial than they were in the 1968-69 trial. Average marbling scores by years are shown in Appendix Tables XI and XII. The carcasses from Treatment 7 had the second highest average marbling score in 1967-68 and the highest in 1968-69. Treatment 1 carcasses had significantly higher marbling scores than all other treatments in 1967-68. In the other trial, differential marbling of carcasses from Treatments 1 and 7 were not significantly different. Both treatment means were significantly higher than all other treatment means. The analysis of both years showed that the means of Treatments 1 and 7 were not significantly different (Table IV). Treatment 1 scores were significantly different from all other treatment scores.

Carcasses from Treatments 1 and 7 had more marbling than the carcasses from the other treatments. The marbling scores from the other treatments in each year did not show a consistent pattern with decreases in the amounts of concentrates fed, except that Treatment 6 scores were the lowest in both trials.

Percent Kidney Fat

Estimated percent kidney fat for all treatment carcasses was significantly higher in the 1968-69 trial than in the 1967-68 trial.

The means of the 1967-68 and 1968-69 trials were 2.07 and 3.04 percent, respectively. In the 1968-69 trial there were no significant differences between treatments. Means in this year ranged from a high of 3.11 percent (Treatment 6) to a low of 3.00 percent (Treatments 4, 5 and 8). In contrast, the means of the 1967-68 trial ranged from 2.7 percent (Treatment 1) to 1.5 percent (Treatment 8).

The percent kidney fat for Treatments 1, 2 and 7 were 2.9, 2.7 and 2.9, respectively. These means were not significantly different. Treatment 1 means were significantly higher than the means of Treatments 3, 4, 5, 6 and 8. With the exception of Treatment 8, the rank of the means shows that as the amount of total concentrate consumption decreases, the estimated percent kidney fat decreases. These data indicate that estimated percent kidney fat was highest in the two treatments receiving the largest total amounts of concentrates (Treatments 1 and 7). Means of these two treatments were significantly different from all other treatments except Treatment 2. As the amounts of concentrate decreased so did the estimated kidney fat.

Ribeye Area

The mean ribeye area for all animals in the two trials was 10.22 and 11.18, respectively. The difference between the two years was significant. From a rank of the means for each year, it was apparent that the amount of concentrate eaten had very little, if any, effect upon the area of the ribeye muscle. The differences within each year were not significant in either trial.

Final Condition Grade

In the 1967-68 trial Treatment 1 animals graded significantly higher than those on Treatments 4 and 6. The other treatments did not differ significantly from Treatment 1. Treatments 2, 3, 4, 5, 7 and 8 produced grades significantly different from the grades of animals in Treatment 6.

In the 1968-69 trial the condition grades from Treatments 1, 2 and 7 were 12.19, 11.61 and 11.50, respectively. The differences were nonsignificant. Grades of Treatment 1 animals were significantly different from those of Treatments 3, 4, 5, 6 and 8.

The two-year analysis indicated that heifers on Treatment 1 graded higher than the ones on the other treatments. The mean condition grade for Treatment 1 heifers was 12.10. Generally, decreased amounts of concentrates fed were accompanied by decreased condition grades. One exception was Treatment 7. Table IV, page 28, shows the two-year mean condition grades of heifers on each treatment. The grades of animals on Treatments 1, 2, 3, 7 and 8 were not significantly different. Treatment 2 and 7 grades were significantly higher from those of Treatments 5 and 6. Treatments 3 and 8 were significantly higher than grades of heifers on Treatment 6.

U.S.D.A. Grade

Carcass grades were significantly higher in the 1967-68 trial than in the 1968-69 trial which reflects the higher marbling scores that year. Grades of carcasses from Treatments 1, 3 and 7 were consistently

higher than grades from the other treatments. In the 1967-68 trial, the grades from Treatments 3 and 7 were not significantly different while in the 1968-69 trial, the grades from Treatments 1, 3 and 7 did not show significant differences. When both years were considered, Treatments 1 and 7 and Treatments 3 and 7 were not significantly different.

There was no consistent pattern with regard to decreased animal consumption of concentrates but rather grades were more closely associated with marbling scores. Grades of carcasses from Treatments 2 and 5 were not significantly different from each other and ranged intermediate to the other treatment grades. Treatments 4, 6 and 8 produced carcasses of lower grades than the other treatments and these differences were not significant.

III. COSTS AND RETURNS

Table V shows the feed costs per hundredweight gain for each treatment. Feed costs for the animals that consumed smaller amounts of concentrates were generally lower. It should be pointed out that the animals on Treatment 6 had the highest feed cost per hundred pounds of gain and Treatment 8 heifers had the lowest ($16.61 and $14.46, respectively).

The returns per head above initial and feed costs for all treatments in both years are shown in Appendix Tables XIII and XIV. The large difference between years was due to a more favorable price margin during the 1968-69 trial. The average returns for both years are shown in Table VI. The returns for Treatment 1 heifers were highest.

TABLE V

FEED CONSUMPTION AND COSTS PER HUNDREDWEIGHT OF GAIN FOR FEEDER HEIFER CALVES FED DIFFERENT AMOUNTS OF UREA-LIMESTONE TREATED CORN SILAGE, TWO-YEAR SUMMARY

Treatment	1	2	3	4	5	6	7	8
No. animals	36	36	36	36	36	36	36	36
Feed consumption per cwt. gain, lb. (D.M. basis)								
Roughage phase	828	906	926	1011	985	974	790	769
Fullfeed phase	758	731	693	682	736	909	802	779
Overall average	804	840	837	870	887	959	792	768
Feed costs per cwt. gain,[a] $								
Roughage phase	14.20	14.16	13.84	14.39	13.43	13.43	12.86	11.34
Fullfeed phase	19.90	19.22	18.21	18.02	18.31	23.84	21.08	20.48
Overall average	16.10	16.01	15.53	15.88	15.76	16.61	15.60	14.47

[a]Feed costs were as follows:

	1967-68	1968-69
Corn silage	$ 8.00/ton	$ 8.00/ton
Corn	1.31/bu.	1.32/bu.
Alfalfa hay	35.00/ton	35.00/ton
Urea	92.80/ton	80.00/ton
Limestone	13.00/ton	13.00/ton
Cottonseed meal	87.90/ton	82.20/ton

TABLE VI

FINANCIAL RETURNS FROM FEEDER HEIFERS FED DIFFERENT AMOUNTS OF CONCENTRATES WITH UREA-LIMESTONE TREATED CORN SILAGE, TWO-YEAR SUMMARY

Treatment	1	2	3	4	5	6	7	8
Av. purchase price per cwt., $	23.33	23.33	23.33	23.33	23.33	23.33	23.33	23.33
Av. selling price per cwt., $	27.89	27.03	27.08	26.57	26.74	26.88	27.66	26.94
Av. purchase cost per head, $	108.67	108.87	107.82	108.91	108.21	107.96	108.31	108.12
Av. selling price per head, $	234.33	220.58	220.40	212.03	208.82	211.82	225.17	219.28
Av. feed costs per head, $	60.14	55.95	54.47	52.54	49.73	54.43	54.30	50.49
Av. returns per head over initial and feed costs based on U.S.D.A. grade, $	65.52	55.76	58.11	50.58	50.88	49.43	62.56	60.67

CHAPTER V

SUMMARY AND CONCLUSIONS

This study was conducted to measure differences in performance and carcass characteristics of feeder heifers fed varying amounts of concentrates with urea-limestone treated corn silage. The animals were fed a high roughage ration plus a concentrate supplement. The control group (Treatment 1) was fed 6 lb. of con-entrate during the entire roughage feeding phase. In five treatments the addition of the 6 lb. concentrate supplement was delayed for periods of 56, 84, 112, 140 and 168 days. Two treatments involved the feeding of 2 and 4 lb. of concentrates for the entire roughage phase. Following the roughage phase which was 140 days in length, a fullfeed of an 8:1 corn to cottonseed meal concentrate mixture was fed until the heifers graded high-Good to low-Choice, at which time they were slaughtered. The following results were observed:

1. Average daily gains were the highest for the heifers fed 6 lb. of concentrate during the entire roughage phase. Withholding the concentrate supplement for as long as 84 days did not significantly lower gains. Feeding 2 and 4 lb. of concentrate supplement the entire roughage phase produced gains that were nonsignificantly lower than those of heifers fed 6 lb. of concentrate.

2. The amount of feed required per hundred pounds of gain was lowest for the heifers that were fed 2 and 4 lb. of concentrate during

the roughage phase. Feed efficiency was better for heifers fed 6 lb. of concentrate the entire roughage phase than for those fed the concentrate supplement part of the period.

3. Average daily dry matter consumption decreased with increased delay of concentrate feeding. Heifers fed 6 lb. of concentrate the entire roughage phase had the highest average daily dry matter consumption and those fed 2 lb. had the lowest.

4. Dressing percents were highest for the heifers fed 6 and 4 lb. of concentrate the entire roughage phase. The effect of delaying concentrate feeding on dressing percent was not clear.

5. Fat thickness over the ribeye muscle was significantly greater for the carcasses of heifers fed 6 lb. of concentrate the whole roughage phase than for the carcasses of the other heifers. Delaying concentrate feeding for 140 days produced carcasses with the least amount of fat over the ribeye muscle.

6. Marbling scores were highest for the carcasses of heifers fed 6 lb. of concentrate during the entire roughage phase. These scores were not significantly different from the scores of heifers fed 4 lb. of concentrates. Delaying concentrate feeding for 168 days produced the lowest marbling scores in both trials. There were no significant differences between the carcasses of the other treatments as to marbling.

7. Percent estimated kidney fat was highest in the carcasses from heifers fed 4 and 6 lb. of concentrate during the entire roughage phase. There was a tendency for the percent kidney fat to decrease with decreases in the total amount of concentrate fed.

8. Ribeye area was not affected by delaying concentrate feeding or by feeding different levels during the roughage phase.

9. Final condition grades generally decreased with decreases in the total amount of concentrate fed.

10. U.S.D.A. grades for the carcasses of heifers fed 4 and 6 lb. of concentrate were consistently higher than the other groups in both trials.

11. Feed costs per hundredweight gain were highest for the heifers which were fed roughage for 168 days. Heifers fed 2 lb. of concentrate during the entire roughage period had the lowest feed cost per hundred pounds of gain.

12. Returns above initial and feed costs were highest for the heifers fed 6 lb. of concentrate during the entire roughage phase.

It is clear from the previous summary of results that the heifers in this study which were fed 2, 4 and 6 lb. of concentrate during the entire roughage phase outperformed and had higher quality carcasses when slaughtered than those from which the concentrate was withheld for a part of the roughage period. Since the treatment rations did not materially affect carcass muscling, the primary difference, in the case of the carcasses, of feeding more corn was an increase in carcass fat, especially marbling which is one of the primary factors presently considered in determining carcass quality. In most cases, withholding the concentrate supplement longer than 84 days was accompanied by decreased performance and carcass quality. It appears that it would be more

profitable to reduce the level of concentrate feeding during the entire roughage phase rather than to delay the initial feeding of the concentrate.

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APPENDIX

TABLE VII

PERFORMANCE OF FEEDER HEIFER CALVES FED DIFFERENT AMOUNTS OF CONCENTRATES WITH UREA-LIMESTONE TREATED CORN SILAGE, 1967-68

Treatment	1	2	3	4	5	6	7	8
No. animals	18	18	18	18	18	18	18	18
Av. initial wt.	453	453	449	452	449	451	453	451
Av. wt., end roughage phase	691	671	651	638	632	692	670	667
Av. gain, roughage phase	237	219	202	186	183	241	217	216
Av. daily gain, roughage phase	1.70^{a}	1.56^{ab}	1.44^{bc}	1.33^{bc}	1.31^{c}	1.43^{bc}	1.55^{ab}	1.54^{ab}
Av. wt., end fullfeed phase	810	796	780	770	756	749	790	790
Av. gain, fullfeed phase	119	124	129	131	124	57	120	123
Av. daily gain, fullfeed phase	2.17^{a}	2.26^{a}	2.35^{a}	2.39^{a}	2.26^{a}	2.11^{a}	2.18^{a}	2.24^{a}
Overall av. gain	357	343	331	318	307	298	337	339
Overall av. daily gain	1.83^{a}	1.76^{ab}	1.70^{abc}	1.63^{bc}	1.58^{bc}	1.53^{c}	1.73^{ab}	1.74^{ab}

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

TABLE VIII

PERFORMANCE OF FEEDER HEIFER CALVES FED DIFFERENT AMOUNTS OF CONCENTRATES UREA-LIMESTONE TREATED CORN SILAGE, 1968-69

Treatment	1	2	3	4	5	6	7	8
No. animals	18	18	18	18	18	18	18	18
Av. initial wt.	479	480	475	481	478	474	475	476
Av. wt., end roughage phase	739	702	700	677	678	691	718	712
Av. gain, roughage phase	260	222	225	196	220	217	243	236
Av. daily gain, roughage phase	1.86^{a}	1.59^{bc}	1.61^{b}	1.40^{de}	1.43^{cd}	1.29^{e}	1.74^{ab}	1.69^{ab}
Av. wt., end fullfeed phase	870	836	847	826	805	827	837	837
Av. gain, fullfeed phase	131	134	147	148	127	136	118	125
Av. daily gain, fullfeed phas	2.35^{ab}	2.40^{ab}	2.62^{ab}	2.66^{a}	2.26^{ab}	1.62	2.11^{b}	2.24^{ab}
Overall av. gain	392	356	372	345	326	353	361	362
Overall av. daily gain	2.00^{a}	1.82^{abc}	1.90^{ab}	1.76^{bc}	1.67^{c}	1.40	1.84^{abc}	1.85^{abc}

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

TABLE IX

FEED CONSUMPTION AND COSTS PER HUNDREDWEIGHT OF GAIN FOR FEEDER HEIFER CALVES FED DIFFERENT AMOUNTS OF UREA-LIMESTONE TREATED CORN SILAGE, 1967-68

Treatment	1	2	3	4	5	6	7	8
No. animals	18	18	18	18	18	18	18	18
Feed consumption per cwt. gain, lb. (D.M. basis)								
Roughage phase	818	836	902	943	939	875	869	843
Fullfeed phase	767	753	708	705	742	746	789	767
Overall average	801	806	827	845	860	851	841	816
Feed costs per cwt. gain,[a] $								
Roughage phase	14.99	14.02	14.27	14.40	13.73	12.75	14.44	13.04
Fullfeed phase	20.25	19.97	18.73	18.69	19.66	19.69	20.94	20.33
Overall average	16.74	16.18	16.01	16.18	16.13	14.08	16.75	15.69

[a]Feed costs were as follows:

Corn silage	$ 8.00/ton
Corn	1.31/bu.
Alfalfa hay	35.00/ton
Urea	92.80/ton
Limestone	13.00/ton
Cottonseed meal	87.90/ton

TABLE X

FEED CONSUMPTION AND COSTS PER HUNDREDWEIGHT OF GAIN FOR FEEDER HEIFER CALVES FED DIFFERENT AMOUNTS OF UREA-LIMESTONE TREATED CORN SILAGE, 1968-69

Treatment	1	2	3	4	5	6	7	8
No. animals	18	18	18	18	18	18	18	18
Feed consumption per cwt. gain, lb. (D.M. basis)								
Roughage phase	836	976	950	1079	1030	1072	711	694
Fullfeed phase	749	709	677	659	729	1071	815	791
Overall average	807	874	846	895	913	1066	742	719
Feed costs per cwt. gain,[a] $								
Roughage phase	13.40	14.30	13.41	14.38	13.12	14.10	11.28	9.63
Fullfeed phase	19.54	18.47	17.69	17.34	18.95	27.99	21.23	20.64
Overall average	15.45	15.84	15.05	15.58	15.38	19.13	14.44	13.24

[a]Feed costs were as follows:

Corn silage	$ 8.00/ton
Corn	1.32/bu.
Alfalfa hay	35.00/ton
Urea	80.00/ton
Limestone	13.00/ton
Cottonseed meal	82.20/ton

TABLE XI

GRADES AND CARCASS CHARACTERISTICS OF FEEDER HEIFER CALVES FED DIFFERENT AMOUNTS OF CONCENTRATES WITH UREA-LIMESTONE TREATED CORN SILAGE, 1967-68

Treatment	1	2	3	4	5	6	7	8
No. animals	18	18	18	18	18	18	18	18
Live grades[a]								
Av. initial type	7.3	7.2	7.0	7.2	7.2	7.0	7.3	7.0
Av. initial condition	9.0	8.9	9.0	8.6	8.7	8.6	8.7	8.6
Av. condition, end roughage phase	10.7	9.4	9.7	9.0	9.3	9.0	9.8	9.5
Av. final condition[b]	12.0[a]	11.7[ab]	11.3[ab]	11.1[b]	11.3[ab]	10.3	11.7[ab]	11.4[ab]
Carcass characteristics								
U.S.D.A. grade	12.2	10.8[bc]	11.1[ab]	10.6[bc]	10.9[b]	10.3[c]	11.4[a]	10.6[bc]
Dressing percent	58.9[a]	58.9[a]	58.5[ab]	57.6[bcd]	57.2[cd]	56.8[d]	58.5[ab]	58.1[abc]
Marbling score[c]	5.6	4.3[ab]	4.6[a]	4.4[ab]	4.5[ab]	4.1[b]	4.7[a]	4.5[ab]
Ribeye area (sq. in.)	10.2[a]	10.6[a]	9.8[a]	10.1[a]	10.2[a]	9.9[a]	10.5[a]	10.5[a]
Fat thickness (in.)	0.53[a]	0.47[a]	0.45[a]	0.37[a]	0.36[a]	0.37[a]	0.42[a]	0.45[a]
Percent kidney fat	2.7[a]	2.2[bc]	2.0[cd]	1.9[cd]	1.7[de]	1.5[e]	2.6[ab]	2.1[cd]

[a] 6-8 Medium, 9-11 Good, 12-14 Choice.

[b] Means with the same superscript (abcd) do not differ significantly ($P < .05$).

[c] 1- devoid; 2- practically devoid; 3- traces; 4- slight; 5- small; 6- modest; 7- moderate; 8- slightly abundant; 9- moderately abundant; 10- abundant

TABLE XII

GRADES AND CARCASS CHARACTERISTICS OF FEEDER HEIFER CALVES FED DIFFERENT AMOUNTS OF CONCENTRATES WITH UREA-LIMESTONE TREATED CORN SILAGE, 1968-69

Treatment	1	2	3	4	5	6	7	8
No. animals	18	18	18	18	18	18	18	18
Live grades[a]								
Av. initial type	8.7	8.8	9.2	8.7	9.0	8.5	9.0	8.5
Av. initial condition	8.4	8.3	8.4	8.5	8.6	8.3	8.0	8.3
Av. condition, end roughage phase	10.0	9.2	9.2	8.5	8.6	8.1	9.1	8.9
Av. final condition[b]	12.2[a]	11.6[ab]	11.4[bc]	10.6[cd]	10.2[d]	10.7[cd]	11.5[ab]	11.3[bc]
Carcass characteristics								
U.S.D.A. grade	10.9[a]	10.3[b]	10.5[ab]	10.0[b]	10.3[b]	10.2[b]	11.0[a]	10.3[b]
Dressing percent	58.9[a]	57.6[bc]	57.5[c]	57.3[c]	57.7[abc]	58.9[a]	58.7[ab]	58.0[abc]
Marbling score[c]	4.4[a]	3.8[bc]	3.9[b]	3.4[cd]	3.7[bcd]	3.1[d]	4.5[a]	3.7[bcd]
Ribeye area (sq. in.)	11.1[a]	10.8[a]	11.2[a]	11.5[a]	11.3[a]	11.1[a]	11.1[a]	11.3[a]
Fat thickness (in.)	0.45	0.38[a]	0.37[a]	0.32[ab]	0.28[b]	0.35[ab]	0.37[a]	0.33[ab]
Percent kidney fat	3.1[a]	3.1[a]	3.0[a]	3.0[a]	3.0[a]	3.1[a]	3.1[a]	3.0[a]

[a] 6-8 Medium, 9-11 Good, 12-14 Choice.

[b] Means with the same superscript (abcd) do not differ significantly ($P < .05$).

[c] 1- devoid; 2- practically devoid; 3- traces; 4- slight; 5- small; 6- modest; 7- moderate; 8- slightly abundant; 9- moderately abundant; 10- abundant

TABLE XIII

FINANCIAL RETURNS FROM FEEDER HEIFERS FED DIFFERENT AMOUNTS OF CONCENTRATES WITH UREA-LIMESTONE TREATED CORN SILAGE, 1967-68

Treatment	1	2	3	4	5	6	7	8
Av. purchase price per cwt., $	22.94	22.94	22.94	22.94	22.94	22.94	22.94	22.94
Av. selling price per cwt., $	25.20	24.74	23.34	24.15	24.02	23.71	24.76	24.29
Av. purchase cost per head, $	103.85	103.85	102.93	103.69	103.00	103.46	103.92	103.46
Av. selling price per head, $	204.08	196.87	182.06	185.88	181.70	177.49	195.56	191.84
Av. feed costs per head, $	59.86	55.51	53.00	51.38	49.54	41.88	56.44	53.14
Av. returns per head over initial and feed costs	40.37	37.51	36.13	30.81	29.16	32.15	35.20	35.24

TABLE XIV

FINANCIAL RETURNS FROM FEEDER HEIFERS FED DIFFERENT AMOUNTS OF CONCENTRATES WITH UREA-LIMESTONE TREATED CORN SILAGE, 1968-69

Treatment	1	2	3	4	5	6	7	8
Av. purchase price per cwt., $	23.71	23.71	23.71	23.71	23.71	23.71	23.71	23.71
Av. selling price per cwt., $	30.41	29.22	29.36	28.83	29.31	29.76	30.44	29.47
Av. purchase cost per head, $	113.49	113.89	112.70	114.13	113.41	112.46	112.70	112.78
Av. selling price per head, $	264.57	244.29	248.72	238.17	235.92	246.15	254.77	246.70
Av. feed costs per head, $	60.41	56.39	55.93	53.70	49.91	66.98	52.16	47.83
Av. returns per head over initial and feed costs	90.67	74.01	80.09	70.34	72.60	66.71	89.91	86.09

TABLE XV

ANALYSIS OF VARIANCE FOR AVERAGE DAILY GAIN OF HEIFERS FED DIFFERENT AMOUNTS OF CONCENTRATES WITH UREA-LIMESTONE TREATED CORN SILAGE, 1967-68

Source	df	SS	MS	F
Roughage phase				
Total	143	15.0003		
Treatments	7	2.1975	0.314	3.57*
Replications	2	0.2278	0.114	1.21
(T)(R)	14	1.2371	0.088	0.93
Residual	120	11.3379	0.094	
Fullfeed phase				
Total	143	26.1009		
Treatments	7	1.1306	0.162	0.534
Replications	2	0.4539	0.227	1.343
(T)(R)	14	4.2421	0.303	1.793
Residual	120	20.2743	0.169	
Overall				
Total	142			
Treatments	7	1.37	0.196	2.88*
Replications	2	0.26	0.130	2.00
(T)(R)	14	0.95	0.068	
Residual	119	7.73	0.065	

*($P < .05$)

TABLE XVI

ANALYSIS OF VARIANCE FOR AVERAGE DAILY GAIN OF HEIFERS FED DIFFERENT AMOUNTS OF CONCENTRATES WITH UREA-LIMESTONE TREATED CORN SILAGE, 1968-69

Source	df	SS	MS	F
Roughage phase				
Total	142	16.59		
Treatments	7	5.04	0.72	12.86*
Replications	2	1.11	0.55	6.79*
(T)(R)	14	0.79	0.056	0.69
Residual	119	9.65	0.081	
Fullfeed phase				
Total	142			
Treatments	7	13.26	1.894	4.47*
Replications	2	1.39	0.695	2.77
(T)(R)	14	5.94	0.424	1.68
Residual	119	29.89	0.251	
Overall				
Total	142			
Treatments	7	4.07	0.581	7.85*
Replications	2	0.22	0.110	2.29
(T)(R)	14	1.04	0.074	1.54
Residual	119	5.76	0.048	

*(P < .05)

TABLE XVII

ANALYSIS OF VARIANCE FOR AVERAGE DAILY GAIN OF HEIFERS FED DIFFERENT AMOUNTS OF CONCENTRATES WITH UREA-LIMESTONE TREATED CORN SILAGE, TWO-YEAR SUMMARY

Source	df	SS	MS	F
Roughage phase				
Total	286			
Treatments	7	6.3	.90	8.82*
Years	1	0.56	0.56	5.49*
(T)(Y)	7	0.94	0.134	1.31
Pens/T, Y	32	3.26	0.102	1.16
Animals, P,T,Y	239	21.10	0.088	
Fullfeed phase				
Total	286			
Treatments	7	10.58	1.511	4.01*
Years	1	0.11	0.11	0.29
(T)(Y)	7	3.82	0.546	1.45
Pens/T, Y	32	12.05	0.377	1.80*
Animals/P,T,Y	239	50.13	0.210	
Overall				
Total	285			
Treatments	7	4.87	0.696	9.04*
Years	1	0.55	0.550	7.14*
(T)(Y)	7	0.56	0.080	1.04
Pens/T, Y	32	2.47	0.077	1.35
Animals/P,T,Y	238	13.50	0.057	

*(P < .05)

VITA

Gordon Bobby Idol was born at Knox City, Texas, on November 11, 1942. He grew up at nearby Benjamin, Texas, and attended Benjamin Elementary and High School. In 1961 he entered Abilene Christian College at Abilene, Texas, where he received a B.S. degree with a major in Animal Husbandry in 1966. The next year he taught junior high science and senior high Spanish at Benjamin Rural School. In 1967 he received an assistantship with the University of Tennessee, Department of Animal Husbandry-Veterinary Science, to work on his Master's degree. Later, he taught eighth grade science for a short time at Galena Park Junior High School near Houston, Texas.

He is married to the former Miss Kay Davis of Healdsburg, California. His parents are Mr. and Mrs. Jack C. Idol, Sr., of Benjamin, Texas.