176

August 4, 1972

To the Graduate Council:

I am submitting herewith a thesis written by James Emerson Cloar entitled "Three Methods of Producing Slaughter Bulls." 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.

Wm R. Backus
Major Professor

We have read this thesis
and recommend its acceptance:

C C Chamberlain

George M Merriman

Accepted for the Council:

Hilton A. Smith
Vice Chancellor for
Graduate Studies and Research

THREE METHODS OF PRODUCING SLAUGHTER BULLS

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

James Emerson Cloar

August 1972

ACKNOWLEDGEMENTS

The author wishes to express his gratitude and special appreciation to the following persons for their contributions to his education.

To Dr. W. R. Backus, Major Professor, for help in planning and leadership in the research as well as for his physical labor, timely advice, stimulating question and constructive criticism while a graduate student at the University of Tennessee.

To Drs. G. M. Merriman and C. C. Chamberlain for serving on the graduate committee and their understanding, encouragement and valuable guidance.

To Dr. C. C. Melton, Sam K. Winfree and Jimmy Ted Keeton for their physical labor, timely advice, stimulating questions, constructive criticism and friendship during his education at the University of Tennessee.

To Kathlynn B. Davis, E. B. (Sis) Camp, Sherman Taylor, Wayne Compton and Abdul Khalil for help in the collecting data.

To the beef cattle staff at Alcoa Farm for help in caring for the experimental animals.

To Messrs. Marvis Fryer and H. M. Crowder for their technical assistance in making chemical analysis of the feedstuffs.

To Marilyn Haga and associates of the Home Economics Department for conducting shear test.

To Mrs. Mary Mills, Mrs. Carol Amburn, Miss Nancy Huffstetler and Miss Kathy Gilbert for technical assistance and typing the thesis.

To Dr. N. W. Robinson for encouragement and guidance throughout the author's college career.

To his wife, Bonnie, for her patience, understanding, encouragement and love throughout his educational career.

To his parents, Mr. and Mrs. A. E. Cloar and Mrs. V. G. Crawford for their encouragement, patience, love and assistance through his educational career.

ABSTRACT

One Hereford-Angus cross, 8 Hereford and 27 Angus bulls from the University of Tennessee-Alcoa Farm were used in this study. Bulls were divided into two weight groups and randomly allotted within breed to one of three feeding regimes. Treatment I was 120 days of full feed of corn silage plus 6 pounds of concentrate 1 (5 parts cracked number 2 shelled corn and 1 part cottonseed meal) per head per day, then a full feed of concentrate 2 (8 parts cracked number 2 shelled corn and 1 part cottonseed meal) plus 10 pounds of corn silage per head per day. Treatment II's ration was the same as Treatment I but consisted of 60 days full feed of corn silage followed by a full feed of concentrate 2 plus 10 pounds of corn silage per head per day. Treatment III consisted of a full feed of concentrate 2 plus 10 pounds of silage per head per day for the entire feeding period.

Live weight and ultrasonic fat estimates were recorded initially and at two subsequent 28-day intervals, then at 14-day intervals until a final subcutaneous fat thickness estimate of 10 mm was attained or 515 days of age, or June 15, 1971.

Initially, there were no significant differences in weight, fat or animal age between treatments. After 60 days on test, Treatment III was significantly ($P < .05$) heavier and fatter than either, Treatments I or II, which were similar. There was a direct relationship between days on test and final weight ($r = .57$). At the end of the feeding period bulls on Treatment III were significantly ($P < .05$) fatter,

lighter and finished sooner than either Treatment I or II. There was no significant difference between overall average daily gain among treatments.

The average feed costs per 100 pound of live weight gains were \$19.06, \$18.12 and \$15.64 for Treatment III, II and I, respectively. These costs are also proportional to cost per 100 pound carcass gains since dressing percents were similar for all treatments.

Treatment significantly ($P < .05$) affected carcass fatness but did not affect the actual percent of trimmed retail cuts from the round, loin, rib and chuck. Average carcass grades were Low Choice for Treatments II and III and High Good for Treatment I when graded on a steer basis.

Warner-Braztler shear data from broiled loin steaks were similar for each treatment. Most consumers (92.3 percent) indicated they would purchase the same quality beef again. Flavor was very acceptable with the following results: 'Very Good', 89.2 percent; 'Good', 71.7 percent; 'Fair', 3.1 percent. No responses reported the 'bull beef' to have a poor flavor. Consumers, overall, rated 93.3 percent of the roasts and steaks produced from the young bulls on this study as 'tender'.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

The efficiency of American Agriculture is reflected by an abundant food supply unequaled in today's world. Cattle are highly prized for their ability to produce succulent, nutritious muscle. Beef accounts for 58.9 percent or 113.7 pounds of the 'red meat' consumed per capita annually in the United States (Smalling, 1972).

Beef producers must take advantage of new technology and knowledge to increase production efficiency and maintain consumer appeal. A great deal of research has dealt with the growth and efficiency of bulls as a market animal. Today 'consumerism' is demanding beef that is lean, tender, nutritious and of acceptable quality. Producers are encouraged to feed cattle for extended periods and may encounter decreased efficiency after a certain degree of fattening is attained. Since bulls have proved to be more efficient in the production of lean beef than either steers or heifers, it is pertinent to study the acceptability of 'bull beef' as a retail product.

The objectives of this study are to report (1) the production economics, (2) carcass traits and (3) consumer acceptance of young 'bull beef'.

CHAPTER II

LITERATURE REVIEW

Growth

Growth of muscle, the major body tissue, follows an outward trend from the fast-growing central nervous system to the slow-growing subcutaneous fat (Palsson and Verges, 1952 and McMeekan, 1959). Conversely, Moulton *et al*. (1922a) showed fat to be the most rapid growing tissue, muscle intermediate and bone the slowest. They also indicated that as animals grew older the weight of the thin cuts increased at a more rapid rate than the primal cuts. Luitingh (1962) reported the body developmental order of a steer to be (in decreasing order): shoulder, round, chuck, loin, plate, neck, brisket and fat depots in the flank, cod, kidney and heart.

Zinn (1967) reported that rib-lean tissue had the greatest relative growth rate over a 270-day feed trial followed by chuck, round and loin. It was agreed that primal cuts developed faster than thin cuts up to a certain stage of maturity. Deposition of fat in the growth of meat animals was shown to be normal unless they were on a submaintenance ration. Fatty deposits appeared in young animals around the viscera and kidney first. With increasing age and caloric intake, the intermuscular fat (seam fat), subcutaneous fat and the intramuscular fat (marbling) are formed (Andrews, 1958; Callow, 1948 and Zinn, 1967). Henrickson *et al*. (1962) reported that the percentage of lean meat in the carcass tended to decrease as the animal advanced in age.

Moulton et al. (1922a, 1922b) reported that the changes in the proportional composition of cuts and total body composition was dependent on fat content. Age and plane of nutrition were positively related to body fat content. Luitingh (1963) showed that each 1 percent increase in the liveweight of steers between 600 and 1200 pounds increased the carcass weight by 1.13 percent. Dressing percentage also increased as age of animal and plane of nutrition increased, thus indicating the importance of weight and plane of nutrition on carcass composition. Callow (1947) reported that younger animals had less fat than previously expected. Early maturing cattle (Aberdeen-Angus) had more fat than late maturing cattle (Welsh) of the same age. Increasing age of the bovine accounted for the increased growth and weight in organs and body parts serving as fat depots.

By using monozygotic twin beef steers, Winchester and Howe (1955) demonstrated that slaughter weight had a greater influence on carcass composition than did age of the animal.

Dinkel et al. (1969) and Gregory et al. (1965) agreed that from the time a calf weighed 300 kg until it weighted 600 kg the point at which a kilogram of weight was added did not affect the trimmed retail cuts when expressed on a liveweight basis.

Effects of Bovine Sex on Performance and Carcass Characteristics

It is almost impossible to partition the effect of sex, age and nutrition on performance because under normal conditions of adequate nutrition these three factors may be closely related. Sex is one of the major sources of variation affecting growth, development, physical and chemical composition and value of the bovine carcass. This is true regardless of when sex is determined, either at conception or at castration.

Robertson (1966) and Brody (1945) stated the advantages of castration as follow:

1. To prevent indiscriminate mating and to control breeding systems.
2. To reduce restlessness, spontaneous activity and to facilitate fattening.
3. To improve carcass quality.
4. To improve disposition.
5. To prolong the animal's feeding life.

Advantages of not castrating animals are as follow:

1. To improve average daily gain, rate of gain in weight and feed efficiency.
2. To maintain the male hormonal effects.
3. To maximize carcass yield traits.
4. To eliminate immediate post-operative problems.

Sex hormones play a vital role in determining physiological maturity, growth and carcass traits. Estrogens, androgens, thyroid hormone levels and the products of the adrenal cortex all have a part in the expression of sex differences.

Price and Yeates (1971) showed that regardless of the nutritional status, there was no significant difference in growth rate between bulls and steers during the prepubertal-growth period. Lack of the androgen effect was then attributed to the paucity of testicular androgens available to the bulls during this period. Many researchers have demonstrated that the expression of male characteristics was a reflection of androgen production. After puberty was reached, the difference in growth rate between bulls and steers was generally a direct function of the level of nutrition.

Wythe et al. (1963) recognized the fact that bulls gain faster and more efficiently than steers. This seems to be partially due to the hormone testosterone, resulting in greater muscle growth and development in bulls than in steers. Androgenic hormones are known to stimulate protein anabolism chiefly through nitrogen retention. Kochakian (1937) found that the administration of androgens to castrated dogs caused an increase in nitrogen retention but no change in energy metabolism. This could be explained by the fact that the male hormones increased protein synthesis at the expense of fat deposition. Research by Klosterman et al. (1954a), Robertson et al. (1967) and Turton (1969) comparing bull and steer carcasses substantiates the nitrogen retention theory.

Joubert and Dreyer (1965) suggested that the level of nutrition may partly dictate the magnitude of the bull-steer growth rate differential, with higher planes of nutrition resulting in larger differences and low planes of nutrition and resulting in small or negative differences. Work by Price and Yeates (1971) substantiates this deduction. They fed for different levels of gain getting a greater marginal response from bulls as the rate of gain level increased. Bulls are generally reported to be more efficient than steers in converting feed to live weight according to Brannang (1966) and Robertson et al. (1969). Price and Yeates (1971) found bulls to be more efficient and to produce more muscle and less fat than steers.

According to Price and Yeates (1971) added dietary fat significantly increased ($P < .05$) the deposition of carcass fat by steers but had no such effect in bulls. It would appear from these data that bulls and steers may have different metabolic pathways for dietary fat. Steers simply increased their body fat deposition while bulls grew faster on less feed, depositing less body fat in the process. Many investigators have found that the sex of a calf has a significant influence on average daily gain from birth to weaning. Bull calves usually have a faster growth rate than steers which grow faster than heifers. The same holds true for birth weights. Differences in average daily gain from birth to weaning between males and females generally ranged from 0.1 pounds to 0.3 pounds (Brinks et al., 1961 and Taylor et al., 1960).

Marlowe (1965) reported that bulls grew 6 percent faster than steers and 13 percent faster than heifers. In a review of sex differences, Smith and Warwick (1954) found the average difference between Hereford male and female calves at weaning was 36 pounds while the difference in weaning weight of Angus male and female calves was 31 pounds. McLaren (1970) found that the effect of sex on calf-weaning weight was highly significant ($P < .01$) and accounted for 4 to 15 percent of the variation in weaning weight in the various breed-management groups. Numerous researchers have indicated that bulls gain faster than steers, and steers gain faster than heifers. Differences in average daily gain due to sex appear to be consistent regardless of breed, type, age or weight for a given group of animals. Arizona Annual Production Reports (1945-1946) presented some of the earlier work comparing bulls and steers. Bulls consistently outgained steers with a substantial saving in feed per 100 pounds of gain.

Cahill _et al_. (1956) fed bulls to 1000 and steers to 900 pounds in two treatments with and without Diethystilbesterol (DES). DES increased the carcass grades of bulls but decreased the carcass grade of steers. DES also increased the percentage of fat in bulls but decreased fat deposition in steers.

Arthaud and Adams (1964) individually fed bulls, steers and heifers a pelleted concentrate ration in 210- and 259-day feeding trials beginning 30 days post-weaning. Initial weight, average daily gains and total digestible nutrients per pound of gain for bulls, steers and heifers were 485, 2.08 and 5.08; 414, 1.77 and 6.52; and 406, 1.48 and 6.86 pounds, respectively.

Williams (1965) used 30 Angus and 15 Hereford bulls, steers and heifers allotted to sire-progeny trios in a study to investigate sex effects on feedlot performance. The results indicated that during the roughage phase, bulls gained significantly ($P < .05$) more than steers or heifers on significantly ($P < .05$) less feed per 100 pounds of gain. During the finishing phase, bulls gained significantly ($P < .05$) more pounds per day than steers (0.33) and heifers (0.57). Differences in feed required per 100 pounds of gain were highly significant ($P < .01$) among sexes in bulls, steers and heifers, respectively. For both periods, differences in gains and feed conversion were significant ($P < .05$) among sexes. Condition grades of bulls were significantly ($P < .05$) lower than those of heifers or steers. Steers required 128 pounds more feed (air-dry basis) and heifers required 183 pounds more feed per hundred pounds of gain than bulls.

Bulls proved superior in average daily gain to both steers and heifers (Hedrick, 1968). He reported 1260 bulls had an average daily gain of 2.29 pounds per day, 1024 steers had an average daily gain of 2.09 pounds per day and 1688 heifers had an average daily gain of 1.69 pounds per day. Bulls were also superior to heifers and steers in live weight gain and feed conversion, while steers and heifers were similar. Fields, Schoonover and Nelms (1964) found bulls 23 pounds heavier at weaning and 86.6 pounds heavier at slaughter than steers.

In a three-year study, Klosterman *et al.* (1958) found that bulls consistently performed better than steers on less feed per 100 pounds of gain. Fields (1971) reported that 350 bulls were superior in all cases to 373 steers in average daily gain. Matsushima and Spragus (1963) observed a high average daily gain of 2.95 pounds for bulls and a high average daily gain of 2.75 pounds for steers while Brannang (1966) observed a low average daily gain of 1.65 pounds for bulls and low average daily gains of 1.46 pounds for steers. Fields (1971) also observed that bulls were superior to steers in feed conversion or total digestible nutrients per pound of gain. His research gave bulls a 17 percent average daily gain advantage over steers. Hedrick (1968) and Brannang (1966) gave bulls an average daily gain advantage of 14 and 15 percent, respectively. According to Fields (1971), bulls were 13 percent more efficient in converting feed to live weight than steers. Bidart (1970) found even more variable sex differences when total feed consumption was compared to relative gains in pounds of edible product. Bulls consumed 6.0 Mcal of digestible energy per kilogram (kg) of edible product compared with 12.8 Mcal per kg for steers.

Marion et al. (1971) used three groups (Hereford steers, Hereford bulls and Hereford-Brown Swiss crossbred bulls) of 18 cattle each in a 140-day feeding trial. He concluded that within the experiment and within age groups, bulls were superior to steers in average daily gain, feed efficiency and economy of gain.

Warwick, Davis and Hiner (1970) evaluated the performance of 29 pairs of monozygotic bovine male twins which were fed to approximately 900 pounds slaughter weight. Eleven twin pairs were fed with both members of that pair as either bulls or steers while 18 pairs were split with one member of each pair fed as a bull, the other as a steer. Bulls had an advantage of 23 percent over steers in rate of gain and 16 percent in efficiency of gain.

Brown, Bartee and Lewis (1962) compared performance of 11 bulls and 11 steers representing five sires. All test animals were fed the same ration for 168 days. Performance differences between bulls and steers were not significant, but steers tended to gain more than bulls to 120 days and required more feed per pound of gain.

Glimp et al. (1971) used 60 male Hereford calves and 60 male Angus calves. The calves within each breed group were randomly assigned to six treatment groups based on their sex conditions: (1) intact males, (2) short scrotum at birth, (3) short scrotum at weaning, (4) castration at birth, (5) castration at weaning and (6) Russian castration (Baiburtcjan, 1961). The short scrotum treatment was induced by pushing the testicles against the body cavity and applying a rubber ring flush with the body, thus removing the scrotum but retaining the testes. The Russian castration method was performed at weaning by making a lateral incision through the scrotum and testicle and removing the parenchyma, leaving the remains of the testicles and epididymis intact. Castration was accomplished by using a rubber ring at birth, with the rubber ring placed over the scrotum against the body cavity and the testicles descended. A knife was used for surgical removal of the testicles at weaning. Intact and short-scrotum-at-birth males gained faster ($P < .05$) than Russian castrates during the first 70 days of feeding in the feedlot. Short-scrotum-at-birth males gained faster ($P < .05$) than other sex treatment groups during the last 70 days on feed, and intact males also gained faster ($P < .05$) than the three castrate treatment groups during this period. These differences resulted in faster gains for short-scrotums-at-birth males for the total feedlot period ($P < .05$). Intact males, short-scrotum-at-weaning males and castrates at weaning gained faster ($P < .05$) than the castrates at birth and Russian castrates for the total feedlot period. Russian castrates showed some stagginess.

Kocenov (1962) and Cobic (1968) studied the effect of castration on Simmental bulls and steers. Kocenov (1962) castrated the males at 2 to 3, 5 to 6 or 11 to 12 months and fattened the cattle to 20 months of age while Cobic (1968) castrated at 8 months of age and fed to a constant live weight of 470 kg. In both tests, bulls out performed any of the castrates. The 5 to 6 month castrates excelled in the steer group while the 11 to 12 month castrates out produced the 2 to 3 month castrates. Cobic (1968) concluded that steers need 3 to 8 percent longer to reach a constant live weight and the plane of nutrition enhanced the expression of bulls superior gain and feed conversion.

Champagne et al. (1964, 1969) studied the effect of castration. They used 60 half-sib weanling male Herefords divided into three sex threatments: (1) early castrates, (2) late castrates, and (3) bulls in 1964. In 1969 he used 60 half-sib weanling male Herefords divided into five sex treatment groups. Twenty individuals were left as bulls while ten each of the others were castrated with a knife at birth, 2 months, 7 months or 9 months of age. The feedlot performance agreed with Klosterman et al. (1954). Differences among castrate groups were insignificant; however, bulls gained more rapidly and efficiently than all castrated groups ($P < .01$).

Witt and Andreaue (1965) used 10 pairs of monozygotic bovine male twins. One member of each pair was castrated at 6 months of age and all were individually fed until 18 months of age. The bull twin mate outproduced his steer mate by 77.4 kg of live weight gain, and was 18.3 percent superior in feed conversion.

Carcass Characteristics

Glimp et al. (1971) reported that the intact male and short scrotum treatment groups had leaner carcasses, but lower quality as measured by USDA grade than the three castrate treatment groups. Although some differences were detected in tenderness, trained taste panelists were unable to detect significant sex treatment differences in flavor, juiciness or overall acceptability of cooked steaks. No significant breed-sex treatment interactions existed for the growth and carcass traits measured in this study. Kocenov (1962) agreed with Glimp et al. (1971) that bulls had leaner carcasses with less marbling.

Quality Grade

Arthaud et al. (1969) found that steer carcasses graded low choice while their bull mates ranged between average and high good under similar management. Steer carcasses had more marbling, a finer texture and a more desirable rib color than bull carcasses. Berg and Butterfield (1968) found marbling scores were one to two degrees higher in steers than bulls. In some studies young bulls had enough marbling to grade Choice, provided they were not discriminated against for other reasons.

Yield

Brannang (1966) and Champagne et al. (1969) reported that bulls yielded up to 4.8 percent more boneless, trimmed retail cuts than steers. By using actual cutout figures, Champagne et al. (1969) concluded the USDA yield formula (Murphey et al., 1960) underestimates the true yield of bull carcasses by approximately 2 percent. Arthaud et al. (1969) reported that bull carcasses yielded 26.8 kg more trimmed retail product than steers, with indications that the biggest advantage was in percent chuck and ground beef. This was in agreement with Field, Schoonover and Nelms (1964), Nichols et al. (1964) and Champagne et al. (1969).

Berg and Butterfield (1968) reported that bulls had a much higher muscle to bone ratio in their carcasses than steers, but the percentage of bone was similar. Price (1971) reported that the eye muscle area expressed relative to carcass weight was significantly ($P < .05$) larger in the bulls. Also bulls had a very highly significant ($P < .001$) lower percentage of fat than the steers. There were highly significant differences ($P < .01$) in bone and muscle between bulls and steers.

Palatability

In all studies reported, bull meat showed less tenderness than steer meat. However, Cahill et al. (1964) observed the differences in tenderness disappeared after 13 days of aging. Hedrick, Thompson and Kraus (1969) indicated that chronological age may have a greater adverse effect on tenderness than sex. Fields et al. (1966) found no significant difference in tenderness between bulls and steers of 300 to 399 days of age. Steers 400 to 499 days of age had slightly higher tenderness ratings than bulls which were similar with respect to age and marbling.

Fields, Schoonover and Nelms (1964) showed that consumer acceptance rating for loin steaks from young bulls to be lower than those for steers. However, consumers selected bull chuck roasts by a ratio of 3 to 2 over steer chuck roasts. Consumers who bought steaks (90 and 91 percent) and those who bought roasts (88 and 92 percent) from bulls and steers, respectively, indicated that they would make the same selection when buying again.

Arthaud et al. (1969) reported that steer beef required 1.3 kg less shear force than bull beef, but bull meat was more variable than that from steers because of considerable overlaping in tenderness scores.

Brannang (1960) reported that 53 percent of the cattle slaughtered in Sweden and 39 percent in Germany (Boyazoglu and Massman, 1967) were young bulls.

Price (1971) through objective and subjective tests concluded that in terms of practical meat quality there were no differences between bulls and steers.

Brown, Bartee and Lewis (1962) obtained trained taste panel scores for flavor, texture, aroma, tenderness, juiciness and uncooked color of the 9th to 12th rib sections from bulls and steers and found no significant differences due to sex. Shear values taken before and after cooking reflected no significant differences ($P < .05$) in tenderness between bull and steer meat.

Effect of Bovine Nutrition on Performance and Carcass Characteristics

Klosterman, Moxon and Cahill (1959) reported that the level of corn silage included in the ration had no apparent effect upon the amount of protein required by cattle being fattened.

Jacobson and Fenton (1956) studied the effect of three levels of nutrition on the quality of beef from Holstein dairy cattle. They found that as the level of nutrition increased the weight of the muscle and fat in the carcass increased. Warwick, Davis and Hiner (1964), using monozygotic bovine beef twins, found a significant ($P < .05$) relationship between the percent average daily gain of the twin member receiving the high concentrate and the member receiving the low concentrate level.

Hammes et al. (1964) discovered that the feeding of a high moisture grass silage caused poor feedlot performance. Performance improved markedly when the silage was supplemented with 8 pounds of ground ear corn. Rate of gain for the steers fed corn silage as 80 to 100 percent of forage dry matter intake plus a limited amount of cottonseed meal, was lower than for those fed a conventional high grain fattening ration. The differences were not significant. Feed efficiency was highest for those lots fed corn silage at 80 to 100 percent of the forage dry matter plus limited protein supplement.

Klosterman, Althouse and Cahill (1965) compared rations of full feed of ground ear corn and limited silage with a full feed of corn silage and no additional grain. Cattle fed the ear corn ration consistently gained significantly ($P < .05$) faster than those fed the silage ration. The increased gains were similar whether the ground ear corn was fed in the first, middle or last part of the feeding period.

Bidart, Koch and Arthaud (1970) found that bulls and steers required 6.0 vs 12.8 Mcal digestible energy per pound of gain expressed in edible product, while 20.3 and 15.8 Mcal digestible energy were required per kg of carcass trim ($P < .05$). Maintenance requirements were similar.

Carcass Traits

Guenther *et al.* (1965) reported lean deposition reached its maximum rate during the early part of the feedlot test and diminished as the animals approached maturity. Skeletal development was accomplished early in life and was related more to animals' age and duration of feeding time than to the nutritional treatment.

Jacobson and Fenton (1956) found no consistent effect of the level of nutrition on shear value, aroma or juiciness of the heat. Warwick, Davis and Hiner (1964) found carcass grade was greatly affected by ration. The pair-ration interaction was highly significant ($P < .01$) and accounted for 32.7 percent of the variance. Dressing percent was increased significantly ($P < .05$) when the ear corn ration was fed during the last period. Marbling scores were as high when ground ear corn was full fed early in the growing-fattening period as when fed just prior to slaughter (Klosterman, Althouse and Cahill, 1965). Conversely, Hammes et al. (1964) reported cattle fed high corn silage rations produced carcasses grading high good and low choice. These grades were not significantly different from those of the carcasses from cattle fed a conventional high-grain fattening ration.

Ultrasonic Estimates

Ultrasonic measurement is one method of monitoring body composition changes. The efficiency and problems of this method of body measurements are discussed within this section.

Davis, Temple and McCormick (1966), Temple, Ramsey and Patterson (1965), Watkins, Sherritt and Ziegler (1967), Davis et al. (1964), Hedrick et al. (1962), Ramsey, Cole and Hobbs (1962), Alexander, Naumann and Zobrisky (1961) and Temple et al. (1956) found high correlation coefficients (r) between ultrasonic fat thickness measurements over the longissimus dorsi muscle and actual carcass fat measurements at the same anatomical location. Davis, Temple and McCormick (1966) reported a relatively high degree of repeatability in ultrasonic estimates of fat thickness by two operators using two different ultrasonic devices.

Correlation coefficients between ultrasonic estimates and actual measurements ranged from 0.32 ($P < .01$) as reported by Stouffer et al. (1961) on 82 animals to 0.96 ($P < .01$) as reported by Davis et al. (1965) on 51 animals. Hedrick (1968) reported a mean correlation coefficient of 0.60 when he tested 1369 animals. Brackelsberg, Willham and Walters (1967) obtained simple correlations ranging from 0.21 to 0.90 between ultrasonic estimates and carcass measurements of fat thickness at the 12th and 13th rib interface on 380 bulls, steers and heifers.

Backus (1963) and Temple, Ramsey and Patterson (1965) attributed the major errors of ultrasonic research on large animals to (1) operator limitation, (2) interpretation and magnification of interpretation errors, (3) calibration and machine manipulation, (4) animal variation, and (5) tissue change during slaughter.

CHAPTER III

EXPERIMENTAL PROCEDURE

I. SOURCE OF DATA

Thirty-six bulls (27 Angus, 8 Hereford and 1 Hereford-Angus cross) from the University of Tennessee-Alcoa Farm were used in this study. The bulls were equally divided into a light and a heavy group. They were the progeny of nine sires and were as nearly alike within group in initial weight, fat thickness, age, type and condition scores as possible. Each weight group was randomly allotted into three treatment groups of six bulls each. All treatments were designed to produce a subcutaneous fat thickness of 10 mm at the 12th and 13th rib interface. Bulls that had not attained a fat thickness of 10 mm when they reached 515 days of age, or by June 15, 1971, were slaughtered regardless of fat thickness (Table I).

II. FEEDING DATA

The feeding trial was initiated after a 30 day adjustment period. Bulls were fed twice daily. Feed not consumed was weighed and subtracted from the total amount fed to obtain total feed consumption.

Three rations (treatments) were fed. They were designed to test the effect of length of time the bulls were fed silage (Table II). Ration 1 (Treatment I) was formulated to produce 10 mm of fat at the 12th rib in approximately 200 days. The treatment consisted of 120 days of *ad libitum* feeding of corn silage supplemented with 6 pounds of

TABLE I

EXPERIMENTAL DESIGN AND ALLOTMENT PARAMETERS

	Tmt. I 120 days Silage	Tmt. II 60 days Silage	Tmt. III 0 days Silage	Mean
No. of Animals				
Angus Bulls	9	9	9	
Hereford Bulls	3	3	2	
Cross-Bred Bulls	-	-	1	
Initial				
Age in Days	264	269	273	269
Weight lb.	514	509	524	516
Fat Estimates (mm)	2.25	2.23	2.50	2.33

TABLE II

RATIONS USED TO FATTEN SLAUGHTER BULLS

Feeding Period	Ingredient fed per head per day		
	No. 2 ground shell corn lb.	Corn silage lb.	Cottonseed meal lb.
No. 1 (1st 60 days)			
Tmt. I	5.0	*ad libitum*	1.0
Tmt. II	5.0	*ad libitum*	1.0
Tmt. III	*ad libitum*[a]	10.0	*ad libitum*[a]
No. 2 (2nd 60 days)			
Tmt. I	5.0	*ad libitum*	1.0
Tmt. II	*ad libitum*[a]	10.0	*ad libitum*[a]
Tmt. III	*ad libitum*[a]	10.0	*ad libitum*[a]
No. 3 (Final period)			
Tmt. I	*ad libitum*[a]	10.0	*ad libitum*[a]
Tmt. II	*ad libitum*[a]	10.0	*ad libitum*[a]
Tmt. III	*ad libitum*[a]	10.0	*ad libitum*[a]

[a]Ration of 8 parts corn to 1 part cottonseed meal.

concentrate 1 (5 parts ground corn and 1 part cottonseed meal) per head per day. Following the roughage feeding period, bulls were fed concentrate 2 (8 parts ground shelled corn and 1 part cottonseed meal) *ad libitum* plus 10 pounds of silage per head per day until slaughter. Ration 2 (Treatment II) was formulated to produce 10 mm of subcutaneous fat at the 12th rib and 13th rib interface in about 165 feeding days. This treatment consisted of 60 days of *ad libitum* silage plus 6 pounds of concentrate 1 per head per day followed by an *ad libitum* feeding of concentrate 2 plus 10 pounds of silage per head per day until slaughter. Ration 3 (Treatment III) was an *ad libitum* feeding of concentrate 2 plus 10 pounds of silage per head per day for the entire feeding period.

The proximate analysis of the feedstuffs is given in Table III on both an as-fed and a dry-matter basis.

III. PERFORMANCE DATA

Individual bull weights and ultrasonic fat thickness estimates were recorded at the beginning and every 28 days during the first 60-day feeding period. Data was recorded at approximately 14-day intervals for the remainder of the trial. Individual cattle were removed from the trial and sent to slaughter when they attained the predetermined fat thickness. Cattle were removed from feed before the afternoon feeding and were held without feed or water until the next morning before recording the final weight.

A Branson Sonoray Model 12 was utilized to estimate fat thickness of all test animals. The location of the measurement was between the

TABLE III

CHEMICAL ANALYSIS OF FEED INGREDIENTS

Ingredient	Basis	% Dry Matter	% Crude Protein	% Ash	% Ether Extract	% Crude Fiber	% NFE
Ground Corn (5 to 1) XCSM[a]	As Fed	90.99	14.28	2.08	3.75	3.71	67.17
	Dry Matter		19.69	2.28	4.12	4.08	73.82
Ground Corn (8 to 1) XCSM[a]	As Fed	91.07	14.65*	2.01	3.38	3.50	67.53
	Dry Matter		16.09	2.21	3.71	3.84	75.15
Corn Silage	As Fed	30.27	3.71	1.53	0.88	6.39	5.37
	Dry Matter		12.88	5.33	3.08	22.19	56.52

*This figure is approximately 2 percent higher than expected. This may be attributed to sampling error or error in proximate analysis procedure.

[a]Cottonseed meal.

12th and 13th rib and approximately three-fourths of the length of the *longissimus dorsi* from the chine end. The point of measurement was determined by palpation of the posterior edge of the 12th rib and the lateral edge of the *longissimus dorsi* muscle. Readings were made to the nearest millimeter, directly from the oscilloscope of the sonoray.

IV. CARCASS DATA

Test animals were slaughtered at the University of Tennessee Meat Laboratory. The animals were trucked from the University of Tennessee-Alcoa Farm (approximately 15 miles) to the University meats laboratory on the morning they were slaughtered. Individual hot carcass weights were recorded after dressing. Carcasses were chilled and aged for seven days at 2 to 4°C. The left side was ribbed between the 12th and 13th ribs at 24-hours post mortem. The exposed cross section of the *longissimus dorsi* muscle at the 12th rib surface was traced on acetate paper. The area of the *longissimus dorsi* muscle was determined to the nearest 0.01 square inch with a compensating polar planimeter. Subcutaneous fat thickness over the *longissimus dorsi* muscle was measured to the nearest millimeter at a point three-fourths the length of the *longissimus dorsi* from the chine end as described by Ramsey *et al.* (1962).

The carcass parameters necessary for determining both quality and yield grades were taken by experienced University of Tennessee personnel. Carcass quality grades were determined with no reference to sex condition or discount for stagginess.

The carcasses were broken into wholesale cuts as described by Wellington (1953). The round, loin, rib and chuck were cut into trimmed, partially boneless retail cuts as described by Brungardt and Bray (1963) and all cuts were weighed to the nearest tenth of a pound. Subcutaneous fat in excess of three-eights inch (9 mm) was trimmed. Intermuscular fat was removed when it was possible to do so without dividing the muscle of the cut. The chine bones were removed from the blade pot roasts and sections of ribs and sternum were removed from the arm pot roasts. The chine bones and rib ends were removed from the rib roasts. The sacral vertebrae were removed from the sirloin steaks and all bones were removed from the rump roasts.

Fat color was scored with the use of Munsell color paddles. Muscle firmness, texture, color and marbling texture were all recorded. A one-inch thick club steak was taken at the thirteenth rib surface and retained for Warner-Bratzler shear data. The frozen steaks were allowed to thaw overnight at room temperature. Then steaks were grilled on a rotating gas grill to an internal temperature of 68°C (first side to 54°C, turned and cooked to 62°C, then turned to be finished to 68°C) then allowed to cool to room temperature (approximately one hour). Three 2.54 cm cores were sheared by the Warner-Bratzler shear device. The means were used in the statistical analysis.

V. CONSUMER ACCEPTABILITY

The fabricated carcasses were sold to consumers for home use. The carcasses were sold as one-half carcass, or as equal divisions of one-half carcass. Therefore, each purchaser had an opportunity to have cuts from all areas on the side or carcass. A questionnaire was prepared and a telephone survey conducted to determine the acceptability of various cuts. The survey was used to evaluate the acceptance of bull meat for roast tenderness, steak tenderness (loin and round), flavor and lean-fat ratio (a copy of the questionnaire is found on page 26). Consumers were not informed that the carcasses were from bulls since it was felt that this would introduce prejudice into their evaluation. The person answering the questionnaire by telephone was asked to evaluate the whole side and not a particular cut.

VI. METHOD OF ANALYSIS

The data was statistically analyzed according to methods described by Harvey (1960). When the effects were significant the means were compared using Duncan's New Multiple-Range Test. (Steel and Torrie, 1960). The following model was used:

$$Y_{ijkl} = \mu + t_i + (pt)_{ij} + w_k + e_{ijkl}$$

Where Y_{ijkl} = the observed value of a given dependent variable for the $_{ijkl}$th bull.

μ = the population means for that given variable.

t_i = the effect of the $_i$th treatment.

i = I, II and III.

$(pt)_{ij}$ = the nested effect of pen (weight group) within treatment.

w_k = the initial weight of the $_k$th bull.

e_{ijkl} = random error associated with the $_{ijk}$ bull.

CONSUMER PREFERENCE QUESTIONNAIRE

Animal Number______________________________ Customer__________________________

Treatment Number_________________________ Phone_____________________________

Amount purchased 1 carcass______________ 1 side_________ 1/2 side_________

Were the roasts tender________ neither tough not tender______tough_____?

Were the loin steaks tender_____neither tough nor tender_______________

tough________?

Were the round steaks tender______ neither tough nor tender_____________

tough________?

Was the taste of the beef very good_____ good_____ fair_________________

Poor_________?

Was the ground beef too lean_______ just right_______ too fat___________?

Would you buy more beef of this same quality? Yes_____ No______________

Why?____

What grade of beef do you normally buy?

Prime__________ Choice__________ Good__________ Other____________________

Additional comments concerning flavor, juiciness, tenderness and lean:fat ratio.____

____

____

____

____

CHAPTER IV

RESULTS AND DISCUSSIONS

I. FEEDLOT PERFORMANCE

Age and Days on Test

Bulls used in this study were similar in age, weight and ultrasonic fat-thickness estimates when the trial began. There was a significant ($P < .05$) difference among all treatments for days on test and final age in days as illustrated in Table IV. This is a reflection of treatment effect. The longer the bulls remained on silage the shorter the time required on the finishing ration. However, the fattening ration (0-days silage) finished bulls to the desired fat thickness 53 days quicker than did the 120-days silage ration.

Weights

Slaughter weights of the bulls were significantly ($P < .05$) influenced by treatment as illustrated in Table IV. Bulls produced by Treatment I were significantly ($P < .05$) heavier (51 pounds) than bulls produced by Treatment II. Bulls on Treatment III were significantly ($P < .05$) lighter (80 pounds) than ones produced by Treatment II. Differences in weight can be explained by variation in average daily gains and length of time on test.

Average Daily Gain

There was no significant ($P < .05$) difference among the three

TABLE IV

MEANS OF SELECTED FEEDLOT PERFORMANCE TRAITS BY TREATMENTS

	Tmt. I 120 days silage			Tmt. II 60 days silage			Tmt. III 0 days silage		
	Silage	Finish	Overall	Silage	Finish	Overall	Silage	Finish	Overall
No. of Bulls	12	12	12	12	12	12	12	12	12
Days									
Initial age	264			269			273		
Days on silage	120			60			0		
Days on finishing	--	73		--	109		--	140	
Days on test	--	--	193^{a}	--		169^{b}			140^{c}
Final age	--	--	459^{a}			437^{b}			409^{c}
Weight Data (lb.)									
Initial	514	769	514	509	622	509	--	524	524
Final	769	971	971^{a}	622	920	920^{b}	--	840	840^{c}
Increase	255	202	457	113	298	411	--	316	316
ADG	2.12	3.41	2.61	1.77	3.16	2.62	--	2.51	2.51
Fat Estimates (mm)[d]									
Initial	2.25	4.50	2.25	2.23	4.51	2.23	--	2.5	2.5
Final	4.50	8.76	8.76^{a}	4.51	9.61	9.61^{a}	--	11.38	11.38^{b}
Increase	2.25	4.26	6.51^{a}	2.28	5.10	7.38^{a}	--	8.88	8.88^{b}

[abc]Means on the same line bearing different superscripts letters differ significantly ($P < .05$)

[d]Estimated ultrasonically.

treatments in average daily gain, as presented in Table IV. There was a 0.35 pound gain per day margin at the end of the silage phase flavoring Treat I over Treatment II for the entire silage feeding period (120 days vs 60 days). Treatment I remained on silage 60 days longer than Treatment II. At the end of the first 60 days on silage the average daily gains were similar for Treatment I (1.75) and for Treatment II (1.77). The superior average daily gain for Treatment I for the entire silage feeding period may be due to the bulls' increased body size during the second 60-day period which made them better able to utilize the silage as an energy source.

Fat Estimates

Ultrasonic fat estimates are presented in Table IV. These estimates were similar for Treatments I and II at the end of the silage phase. Estimates for total fat gained were not significantly ($P < .05$) different for Treatments I and II. However, bulls produced on Treatment III had significantly ($P < .05$) more total fat (1.77 mm) than either Treatments I or II.

This may be explained by the design of the experiment which used the terminal factors of either 10 mm of subcutaneous fat thickness at the 12th and 13th-rib junction, 515 days of age or June 15, 1971. Bulls on Treatment III were not slaughtered when they reached 10 mm of fat thickness because they were too small to produce profitable carcasses. The bulls on Treatment I were older when they were slaughtered, and it appeared that the influence of the male hormones may have altered the composition of their gain and the desired thickness of subcutaneous fat was not attained within the time limitations imposed.

II. COST OF GAIN

Table V illustrates the feed cost per 100 pounds of live and carcass weight gains. The carcass gains were calculated assuming a dressing percentage of 56 for all bulls initially. Final carcass yield data were reported as chilled carcass weight. It is evident that as the consumption of silage decreased, the cost of total live and carcass weight gains increased. The cost of Treatment II may be slightly higher than expected because the light weight bulls remained on the finishing ration longer than anticipated.

These results indicate that either of the three systems of management may be utilized in the production of slaughter bulls. However, the availability and cost of various feedstuffs and the local marketing situation may determine the system most beneficial to the individual producer.

III. CARCASS TRAITS

Weight

Chilled carcass weights, round and trimmed round weights followed the same pattern as did the off-test live weights (Table VI). Treatment I produced significantly ($P < .05$) heavier cuts in all cases with Treatment III being significantly lighter as shown in Table VI. Actual kidney, heart and pelvic fat (KHP) weight was significantly ($P < .05$) influenced by treatment. There was a positive relationship ($r = .08$) between KHP and carcass fatness.

TABLE V

COST OF GAIN[a]

Item	Phase	Treatment I 120-days Silage	Treatment II 60-days Silage	Treatment III 0-days Silage
Feed cost per 100 lb. of live gain	Silage	$13.57	$15.49	--
	Finishing	17.79	18.84	$19.06
	Overall	15.64	18.12	19.06
Feed cost per 100 lb. of carcass gain[bc]		30.20	35.49	36.18

[a]Feed costs used were: Corn silage, $8 per ton; corn, $1.36 per bu.; cottonseed meal, $83 per ton. Concentrate 1 (5:1) cost per lb. = 3.31¢; concentrate 2 (8:1) cost per lb. - 3.25¢.

[b]Carcass weight were calculated by assuming a dressing percentage of 56 for the bulls when put on test.

[c]Based on chilled carcass weight.

TABLE VI

MEANS OF SELECTED CARCASS TRAITS BY TREATMENTS

Item	Tmt. I 120 days Silage	Tmt. II 60 days Silage	Tmt. III 0 days Silage
Weight (lb.)			
Chilled carcass	549.0^{a}	516.0^{b}	482.0^{c}
Carcass weight/day of age	1.19	1.20	1.18
Round	62.8^{a}	57.7^{b}	54.8^{c}
Trimmed Round	61.0^{a}	56.1^{b}	53.4^{c}
Actual Kidney, Pelvic and Heart fat	8.6^{c}	10.0^{a}	9.4^{b}
Yield and Carcass grade factors			
Percent Kidney, Heart and Pelvic Fat			
Estimated	3.03	3.13	3.46
Actual	3.17	3.78	3.80
Rib eye area (sq. in.)	11.58	10.89	10.63
Fat thickness (mm)	8.0^{a}	9.3^{b}	11.6^{c}
Conformation score[1]	14.7	13.9	14.6
Marbling at 12th rib[2]	4.5^{a}	4.9^{a}	5.2^{b}
Grade and muscle traits			
Carcass grade	11.0	11.6	11.6
Yield grade	1.9^{a}	2.2^{ab}	2.4^{b}
Muscle Firmness[3]	5.6	5.3	5.2
Muscle Texture[4]	5.7	5.4	5.3
Muscle Color[5]	5.7	5.3	5.0

[abc]Means on the same line bearing different superscript letters differ significantly ($P < .05$).

[1]Based on a 5 to 17 scale, 5 = high utility - 17 = high prime.

[2]Based on a 1 to 11 scale, 1 = devoid - 11 = very abundant.

[3]Based on a 1 to 7 scale, 1 = extremely soft - 7 = very fine.

[4]Based on a 1 to 7 scale, 1 = very coarse - 7 = very firm.

[5]Based on a 1 to 7 scale, 1 = black - 7 = very light cherry red.

Yield and Carcass Grade Factors

There was no statistical difference among treatments with respect to rib eye area, conformation score and estimated or actual percent kidney, heart and pelvic fat as presented in Table VI. Marbling scores at the 12th and 13th rib interface were statistically similar for Treatments I and II. However, the mean marbling scores from Treatment III were significantly ($P < .05$) higher than from Treatments I and II. Final ultrasonic fat estimates were positively correlated ($r = .77$) with actual carcass fat thickness in millimeters. Actual carcass fatness was significantly ($P < .05$) different from each treatment. Treatment III was 3.6 mm and 2.3 mm fatter than Treatments I and II, respectively. This may be attributed to increased energy levels in the early stages of the feeding trial, or to terminal factors other than 10 mm of fat thickness being used.

Grade and Muscle Traits

There was no statistical treatment differences in muscle firmness, texture or color. Average carcass grades for the three treatments were not significantly different. Mean carcass grades were High Good for Treatment I and Low Choice for Treatments II and III. Yield grades for Treatments I and II were not significantly ($P < .05$) different but were significantly ($P < .05$) higher for Treatment III. This is illustrated in Table VI.

IV. CARCASS COMPOSITION BY WHOLESALE AND RETAIL CUTS, WEIGHTS AND PERCENTAGE

Thin Cuts

There were no significant ($P < .05$) differences in the thin cuts, weights or percentages (Table VII). Collectively, the thin cuts accounted for about 22.0 percent of the carcass weight.

Thick Cuts

Table VII indicates that there was a significant ($P < .05$) difference among treatments in percentage of retail chuck. Treatment I had 2.4 percent more retail chuck than Treatment II which yielded the lowest percentage of chuck. This difference may be attributed to the development of the chuck and round produced by the greater degree of secondary sex characteristics expressed in the older bulls of Treatment I. The same pattern holds true for the percentage of round, loin, rib and chuck (RLRC). There was a 3.7 percent difference between the largest (Treatment I) and the smallest (Treatment II) in actual percentage of RLRC. There was only 1.1 percent difference in RLRC between Treatments I and III when estimated by the United States Department of Agriculture equation for percent closely trimmed retail cuts.

V. CONSUMER EVALUATION OF BEEF

The consumer acceptance phase of this study was designed to assess the acceptability of bull carcasses and the treatment effect on their acceptability. The carcasses were sold by the University of Tennessee Food Processing Unit as a carcass, as a side or as equally

TABLE VII

CARCASS COMPOSITION BY WEIGHT AND PERCENTAGE OF WHOLESALE AND RETAIL CUTS

Item	Wholesale Cut by Weight Treatment			Wholesale Cut by Percentage Treatment			Retail Cut by Weight Treatment			Retail Cut by Percentage Treatment		
	I	II	III	I	II	III	I	II	III	I	II	III
Thick cuts												
Chuck	78.2^{a}	67.9^{b}	63.7^{c}	28.7^{a}	25.7^{c}	26.3^{b}	48.1^{a}	40.5^{b}	38.0^{c}	17.7^{a}	15.3^{c}	15.7^{b}
Rib	24.7^{a}	23.2^{a}	21.7^{b}	9.1	8.8	9.0	22.0^{a}	20.5^{a}	19.3^{b}	8.1	7.8	8.0
Loin	38.8	37.0	36.0	14.3	14.1	14.9	31.9	30.0	28.3	11.8	11.4	11.7
Round	62.8^{a}	57.3^{b}	55.4^{c}	23.1^{a}	21.7^{b}	22.9^{c}	39.8	37.3	35.8	14.6	14.1	14.8
RLRC[1]	204.3^{a}	185.4^{b}	176.7^{c}	75.2^{a}	70.3^{b}	73.1^{a}	141.8^{a}	128.2^{a}	121.4^{b}	52.2^{a}	48.5^{c}	50.2^{b}
Estimated percent of boneless, closely trimmed retail cuts from RLRC (USDA Formula)										51.3	50.6	50.2
Thin cuts												
Shank	9.2	8.6	7.7	3.4	3.3	3.2	--	--	--	--	--	--
Brisket	11.0	12.8	11.0	4.1	4.9	4.5	--	--	--	--	--	--
Plate	21.9	21.1	19.3	8.1	8.0	8.0	--	--	--	--	--	--
Flank	17.2	17.3	15.4	6.4	6.6	6.3	--	--	--	--	--	--
Sub-Total	59.3	59.8	53.8	22.0	22.8	22.0	--	--	--	--	--	--

[1]Round, Loin, Rib and Chuck.

[abc]Means on the same line within a category, bearing different superscript letters differ significantly ($P < .05$).

divided side. Therefore, each purchaser had an opportunity to consume and evaluate a portion of all retail cuts. The customers were a cross-section of the Knoxville community. Information concerning the slaughter animal's management was not revealed because it was felt the customers might be prejudiced against young bull beef. Consumers were requested to evaluate the retail cuts for tenderness, fatness and flavor after they had consumed cuts from the entire carcass. They were also asked if they would comment on whether or not they would purchase the same quality beef again. A sample of the questionnaire used is shown on page 26. Sixty-five valid questionnaires were returned from 72 inquiries. The remaining questionnaires were eliminated because responses were not applicable in evaluating the acceptance of bull beef. The results of these questionnaires are presented in Table VIII, and Figures 1 and 2.

Roast Evaluation

Overall results of the tenderness evaluation of the roasts indicate that they were the most acceptable cuts (Table VIII). Roasts produced by Treatment III were scored 100 percent 'tender' by consumers. Regardless of treatment, 95.4 percent of the consumers rated the roasts as 'tender.' None of the consumers indicated that the roasts were 'tough.' Tenderness acceptance of Treatments II and III may be attributed to slightly younger ages and decreased consumption of silage.

Fields, Schoonover and Nelms (1964) found that consumers preferred the leanness of bull chuck roast over steer chuck roast. The tenderness evaluation of these data shows that bulls in this study were more tender

TABLE VIII

SUMMARY OF CONSUMER EVALUATION OF MAJOR RETAIL CUTS

Retail Cuts	Acceptance Score	I: 120 days silage + 73 days Finishing		II: 60 days silage + 109 days Finishing		III: 140 days Finishing		Total	
		No.	%	No.	%	No.	%	No.	%
Roast	Tender	21	91.4	19	95.0	22	100	62	95.4
	Neither	2	8.6	1	5.0	--	--	3	4.6
	Tough	--	--	--	--	--	--	--	--
Steaks									
Loin	Mean shear value	19	--	18	--	17	--	18	--
Loin	Tender	21	91.4	18	90.0	21	95.5	60	92.3
	Neither	2	8.6	2	10.0	1	4.5	5	7.7
	Tough	--	--	--	--	--	--	--	--
Round	Tender	21	91.3	17	85.0	22	100.0	60	92.3
	Neither	1	4.3	3	15.0	--	--	4	6.2
	Tough	1	4.3	--	--	--	--	1	1.5
Mean Tenderness	Tender		91.2		90.0		98.5		93.3
	Neither		7.4		10.0		1.5		6.2
	Tough		1.4		--		--		0.5
Gound Beef	Too lean	1	4.3	--	--	--	--	1	1.5
	Just right	22	95.7	17	85.0	20	90.9	59	90.8
	Too fat	--	--	3	15.0	2	9.1	5	7.7

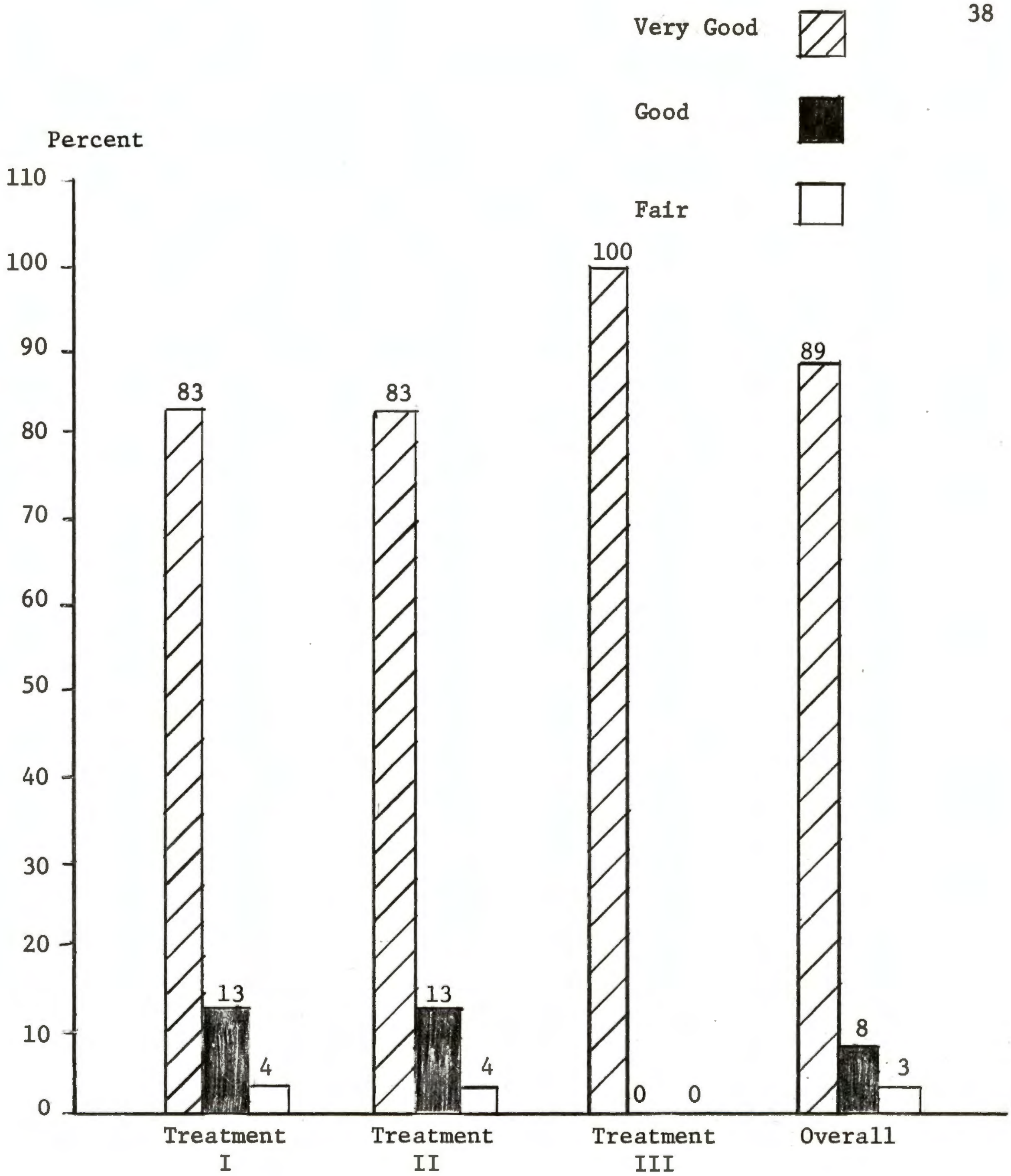

Figure 1. Distribution of degrees of flavor acceptability by treatment.

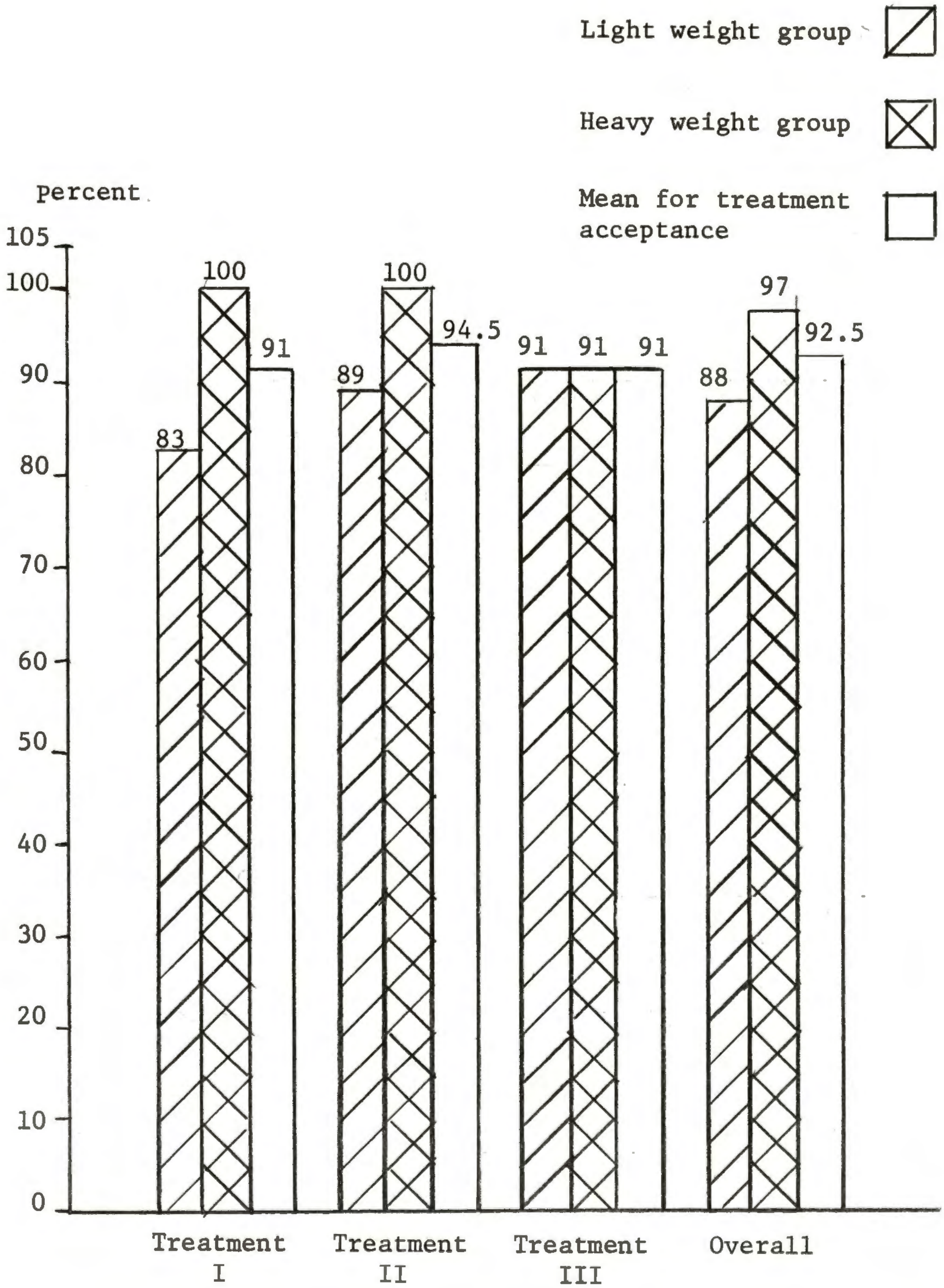

Figure 2. Percent repeat customers by weight groups within treatments.

than those evaluated by Fields, Schoonover and Nelms (1964).

Steaks

Steaks were evaluated as two groups: (1) loin and (2) round steaks. The shear values measured by the Warner-Bratzler scale which is widely accepted as an objective measure of meat tenderness paralleled the family panel scores for 'tenderness' of the loin steaks of Treatments I and II. However, Treatment III had a one pound lower shear value and a 5.5 percent higher tenderness acceptance score than Treatments I or II. Shear value tended to decrease as total silage intake decreased. The cattle with a lower total silage intake (Treatment III) were slightly younger bulls.

Round steaks from Treatment III and the heavy weight group for Treatments I and II were scored 60 percent 'tender' and 40 percent 'neither tender nor tough'. There was only one 'tough' observation for steaks, and it was found in the light weight group of Treatment I.

Kiehl et al. (1958) using paired comparisons of loin steaks from different beef grades found a great deal of consumer inconsistency of preference between replications. This is in agreement with this study because no carcass was judged completely tough by consumers of both sides of a given carcass. These data show that 92.3 percent of the steaks were judged 'tender' which surpasses the data of Fields, Schoonover and Nelms (1964) who found that 63 percent of the consumers judged bull steaks 'tender'.

Ground Beef

The consumer reaction to ground beef from all treatments was 90.8

percent 'Just Right' and 7.7 percent 'Too Fat' as shown in Table VIII (page 37). The 1.5 percent 'Too Lean' observed in this study was due to the purchaser's request that the ground beef be extra lean and was processed as 'Too Lean' to be of acceptable consistency. All the 'Too Fat' observations were in the light-weight group of Treatments II and III. Both treatments consumed a lesser amount of silage and a greater amount of concentrate 2, thereby tending to deposit adipose tissue instead of lean muscle.

Flavor

Figure 1 (page 38) illustrates the flavor acceptability by treatments. Treatment III was scored 100 percent 'Very Good' while both Treatments II and III were judged 83 percent 'Very Good'. This would indicate that the full feed of concentrate and age affected the flavor acceptance of 'bullocks'.

Repeat Customers

Figure 2 (page 39) presents the percentage of consumers that would purchase the same quality beef again. Overall, 92.5 percent of the purchasers who returned valid questionnaires said that they would purchase the same quality of beef again. This was in agreement with Fields, Schoonover and Nelms (1964), who found bull beef approximately 90.0 percent acceptable for repeat customers.

Reasons for Rejection

The main causes for rejection were that the beef was too fat, not cut as desired, the bones were too large or the consumer was unhappy with flavor.

It should be noted that in calculating percentages one observation equals 4.3 to 5.0 percent of the total treatment sample.

CHAPTER V

SUMMARY AND CONCLUSIONS

One Hereford-Angus cross, 8 Hereford and 27 Angus bulls from the University of Tennessee-Alcoa Farm were used in this study. Bulls were divided into two weight groups and randomly allotted within breed to one of three feeding regimes. Treatment I was 120 days of full feed of corn silage plus 6 pounds of concentrate 1 (5 parts cracked number 2 shelled corn and 1 part cottonseed meal) per head per day, then a full feed of concentrate 2 (8 parts cracked number 2 shelled corn and 1 part cottonseed meal) plus 10 pounds of corn silage per head per day. Treatment II's ration was the same as Treatment I but consisted of 60 days full feed of corn silage followed by a full feed of concentrate 2 plus 10 pounds of corn silage per head per day. Treatment III consisted of a full feed of concentrate 2 plus 10 pounds of silage per head per day for the entire feeding period.

Live weight and ultrasonic fat estimate were recorded initially and at two subsequent 28-day intervals, then at 14 day intervals until a final subcutaneous fat thickness estimate of 10 mm was attained or 515 days of age, or June 15, 1971.

Initially, there were no significant differences in weight, fat or animal age between treatments. After 60 days on test, Treatment III was signifcantly ($P < .05$) heavier and fatter than either, Treatments I or II, which were similar. There was a direct relationship between days on test and final weight ($r = .57$). At the end of the feeding period bulls on Treatment III were significantly ($P < .05$) fatter, lighter and finished sooner than either Treatment I or II. There was no significant difference between overall average daily gain among treatments.

The average feed costs per 100 pounds of live weight gains were \$19.06, \$18.12 and \$15.64 for Treatments III, II and I, respectively. These costs are also proportional to cost per 100 pound carcass gains since dressing percents were similar for all treatments.

Treatment significantly ($P < .05$) affected carcass fatness but did not affect the actual percent of trimmed retail cuts from the round, loin, rib and chuck. Average carcass grades were Low Choice for Treatments II and III and High Good for Treatment I when graded on a steer basis.

Warner-Bratzler shear data from broiled loin steaks were similar for each treatment. Most consumers (92.3 percent) indicated they would purchase the same quality beef again. Flavor was very acceptable with the following results: 'Very Good', 89.2 percent; 'Good', 7.7 percent; 'Fair', 3.1 percent. No responses reported the 'bull beef' to have a poor flavor. Consumers, overall, rated 93.3 percent of the roasts and steaks produced from the young bulls on this study as 'tender'. Thus it should be concluded that it is economically feasible to produce 'young bull beef'. Even though other researchers have found 'bull beef' to be less tender than steer and heifer beef; this study found it very acceptable in tenderness and flavor (93.3 percent).

LITERATURE CITED

LITERATURE CITED

Alexander, M. A., H. D. Naumann and S. E. Zobrisky. 1961. Estimation of rib-eye area and fat thickness of beef cattle with ultrasonics. J. Anim. Sci. 20:917 (abstr.).

Andrews, F. N. 1958. Fifty years of progress in animal physiology. J. Anim. Sci. 17:1064.

Arizona Annual Report. 1945-1946. The effect of castration and hormone administration upon carcass beef production. Fifty-six and fifty-seventh Ann. Rpt. Ariz. Agri. Exp. Sta.

Arthaud, V. H. and Charles H. Adams. 1964. Effect of sex on production carcass traits. Nebr. Beef Cattle Prog. Rep.

Arthaud, V. H., C. H. Adams, D. R. Jacobs and R. M. Koch. 1969. Comparison of carcass traits of bulls and steers. J. Anim. Sci. 28:742.

Backus, Wm. R. 1963. Problems in ultrasonic research on large animals. Proc. Reciprocal Meat Conf. 16:251.

Berg, R. T. and R. M. Butterfield. 1968. Growth patterns of bovine muscle, fat and bone. J. Anim. Sci. 27:611.

Bidart, J. B., R. M. Koch and V. H. Arthaud. 1970. Comparative energy use in bulls and steers. J. Anim. Sci. 30:1019.

Brackelsberg, P. O., R. L. Willhan and L. E. Walters. 1967. Probing beef cattle to predict carcass fatness. J. Anim. Sci. 26:713.

Brannang, E. 1960. Castration experiment with SRB twins. Anim. Breeding Abstr. 28:1200.

Brannang, E. 1966. The effect of castration and age of castration on the growth rate, feed conversion and carcass traits of Swedish red and white cattle. Lantbrukshogskolansonnaler. 32:329.

Brinks, J. S., R. T. Clark, F. J. Rice and N. M. Kieffer. 1961. Adjusting birth weight, weaning weight and pre-weaning gain for sex of calf in range Hereford cattle. J. Anim. Sci. 20:363.

Brown, C. J., J. D. Bartee and P. K. Lewis, Jr. 1962. Relationships among performance records, carcass cut-out data and eating quality of bulls and steers. Ark. Agr. Exp. Sta. Bul. 655.

Brody, S. 1945. Bioenergetics and Growth. Rinehold Publishing Co., New York, New York.

Brungardt, V. H. and R. W. Bray. 1963. Estimate of retail yield of the four major cuts in the beef carcass. J. Anim. Sci. 22:177.

Cahill, V. R., L. E. Kunkel, E. W. Klosterman, F. E. Deatherage and E. Wierbicki. 1956. Effect of diethylstilbesterol implantation on carcass composition and the weight of endocrine glands of steers and bulls. J. Anim. Sci. 15:701.

Cahill, V. R. 1964. Effect of sex differences in beef carcass relative to cutability and palatability. Proc. Reciprocal Meat Conf. 17:35.

Callow, E. H. 1947. Comparative studies of meat. II. The changes in the carcass during growth and fattening, and their relation to chemical composition of the fatty and muscular tissues. J. Agri. Sci. 38:174.

Champagne, J. R., J. W. Carpenter, J. F. Henteges, Jr., A. Z. Palmer and T. J. Cunha. 1964. Effects of age of castration on feedlot performance and carcass characteristics of bulls and steers. J. Anim. Sci. 23:859 (Abstr.).

Champagne, J. R., J. W. Carpenter, J. F. Henteges, Jr., A. Z. Palmer and M. Koger. 1969. Feedlot performance and carcass characteristics of young bulls and steers castrated at 4 ages. J. Anim. Sci. 29:887.

Cobic, T. 1968. Castration experiments with Tugoslav Simmental cattle. I. The effect of castration on growth and live-weight gains. Anim. Prod. 10:103.

Davis, D. L., C. F. Parker, E. W. Klosterman and H. W. Ockerman. 1965. Ultrasonic and visual appraisal for estimating carcass value of beef cattle. J. Anim. Sci. 24:861 (Abstr.).

Davis, J. K., R. A. Long, R. L. Saffle, E. P. Warren and J. L. Carmon. 1964. Use of ultrasonics and visual appraisal to estimate total muscling in beef cattle. J. Anim. Sci. 23:638.

Davis, J. K., R. S. Temple and W. C. McCormick. 1966. A comparison of ultrasonic estimates of rib-eye area and fat thickness in cattle. J. Anim. Sci. 25:1087.

Dinkel, C. A., D. A. Busch, D. E. Schafer, H. J. Tuma, J. A. Minyard and W. J. Costello. 1969. Changes in composition of beef carcasses with increasing animal weight. J. Anim. Sci. 28:316.

Fields, R. A. 1971. Effect of castration on meat quality and quantity. J. Anim. Sci. 32:849.

Fields, R. A., G. E. Nelms and C. O. Schoonover. 1966. Effect of age, marbling and sex on palatability of beef. J. Anim. Sci. 25:360.

Fields, R. A., C. O. Schoonover and G. E. Nelms. 1964. Performance data carcass yield and consumer acceptance of retail cuts from steer and bulls. Wyoming Agr. Exp. Sta. Bul. 417.

Glimp, H. A., M. E. Dikeman, H. J. Tuma, J. E. Gregory and L. V. Cundiff. 1971. Effect of sex condition on growth and carcass traits of male Hereford and Angus cattle. J. Anim. Sci. 33:1242.

Gregory, K. E., L. A. Swiger, V. H. Arthaud, R. B. Warren, D. K. Hallet and R. M. Koch. 1962. Relationship among certain live and carcass characteristics of beef cattle. J. Anim. Sci. 21:720.

Guenther, J. J., D. H. Bushman, L. S. Pope and R. D. Morrison. 1965. Growth and development of the major carcass tissues in beef calves from weaning to slaughter weight, with reference to the effect of plane of nutrition. J. Anim. Sci. 24:1184.

Hammes, R. C., J. P. Fontenot, H. T. Bryant, R. E. Blaser and R. W. Engel. 1964. Value of high-silage ration for fattening beef cattle. J. Anim. Sci. 23:795.

Harvey, W. R. 1960. Least squares analysis of data with unequal subclass number. A.R.S. 20:8.

Hedrick, H. B. 1968. Bovine growth and composition. Mo. Agr. Exp. Sta. Bul. 928.

Hedrick, H. B., W. E. Meyer, M. A. Alexander, S. E. Fobrisky and H. P. Naumann. 1962. Estimation of rib-eye and fat thickness of beef cattle with ultrasonics. J. Anim. Sci. 21:362.

Hedrick, H. B., G. B. Thompson and G. F. Krause. 1969. Comparison of feedlot performance and carcass characteristics of half-sib bulls, steers and heifers. J. Anim. Sci. 29:687.

Henrickson, R. L., W. B. Blackman and K. Urban. 1962. Carcass composition as influenced by animal age. 36th Annual Livestock Feeders' Day Report. Okla. Agr. Exp. Sta. Misc. Pub. MP 67:17.

Jacobson, M. and F. Fenton. 1956. Effects of three levels of nutrition and age of animal on quality of beef. I. Palatability, cooking data, moisture, fat and nitrogen. Food Res. 21:415.

Joubert, D. M. and J. H. Dreyer. 1965. Bull vs. steer on a moderate plane of nutrition in a group feeding trial. Proc. S. Afr. Soc. Anim. Prod. 7:151.

Klosterman, E. W., P. G. Althouse and V. R. Cahill. 1965. Effect of corn silage or ground ear corn full fed at various stages of growth and fattening upon carcass composition of beef cattle. J. Anim. Sci. 24:454.

Kiehl, E. R., V. J. Rhondes, D. E. Brady, H. D. Naumann. 1958. St. Louis Consumers' Eating Preferences for Beef Loin Steaks. Univ. of Mo. Res. Bul. 652.

Klosterman, E. W., V. R. Cahill, L. E. Kunkle, and A. L. Moxon. 1958. Influence of sex hormones upon feedlot performance and carcass quality of fattening cattle. Ohio Agr. Exp. Sta. Res. Bul. 802.

Klosterman, E. W., L. E. Kunkle, P. Gerlough and V. R. Cahill. 1954. The effect of age on castration upon rate and economy of gain and carcass quality of beef calves. J. Anim. Sci. 13:817.

Klosterman, E. W., A. L. Moxon and V. R. Cahill. 1959. Effect of stilbestrol and amount of corn silage in the ration upon the protein requirements of fattening steer calves. J. Anim. Sci. 18:1243.

Kocenov, D. A. 1962. The effect of castration at various ages on growth and beef characters of young cattle. Anim. Breeding Abstr. 32:1840.

Kocharian, C. D. 1937. Testosterone and testosterone acetate and the protein and energy metabolism of castrate dogs. Endocrinology 21:750.

Koger, T., H. Elliott, F. G. Harbaugh and R. M. Durham. 1960. Sex effects on carcass and productive traits in fattening beef calves. J. Anim. Sci. 19:1238.

Luitingh, H. C. 1963. The efficiency of beef production in terms of carcass weight increase as influenced by the ration concentration and the age of steers. J. Agri. Sci. 61:127.

Luitingh, H. C. 1962. Development changes in beef steers as influenced by fattening age and type of ration. J. Agri. Sci. 58:1.

Marion, P. T., J. K. Riggs, S. P. Hammack, and Z. L. Carpenter. 1971. Feedlot performance and carcass characteristics of Brown Swiss crossbred bulls, Hereford bulls and steers. Texas Agr. Exp. Prog. Rept. No. 2983.

Marlowe, T. J., C. C. Mast, R. R. Schalles. 1965. Some non-genetic influences on calf performance. J. Anim. Sci. 24:494.

Matsushima, J. K. and J. I. Sprague. 1963. Bulls produce leaner, lower grading carcasses in CSU feeding study. Anim. Sci. Res. Highlights, Colo. Agr. Exp. Sta. Gen. Ser. 785:6.

McLaren, J. B. 1970. Procedures for developing selection indexes from BCIA data. Unpublished Ph.D. Dissertation. Auburn University, Auburn, Ala.

McMeekan, C. P. 1959. Principles of Animal Production. Whitcombe and Tombe. Ltd.

Moulton, R. C., P. F. Trowbridge and L. D. Haigh. 1922a. Studies in animal nutrition. II. Changes in proportions of carcass and offal on different planes of nutrition. Mo. Agr. Exp. Sta. Res. Bul. 54.

Moulton, R. C., P. F. Trowbridge and L. D. Haigh. 1922b. Studies in animal nutrition. III. Changes in chemical composition on different planes of nutrition. Mo. Agr. Exp. Sta. Res. Bul. 61.

Murphey, C. E., D. K. Hallett, W. E. Taylor and J. C. Pierce, Jr. 1960. Estimating yield of retail cuts from carcasses. J. Anim. Sci. 19:1240 (Abstr.).

Nichols, J. R., J. H. Ziegler, J. M. White, E. M. Kesler and J. L. Watkins. 1964. Production and carcass characteristics of Holstein-Friesian bulls and steers slaughtered at 800 or 1000 pounds. J. Dairy Sci. 47:179.

Palsson, H. and J. B. Verges. 1952. Effects of the plane of nutrition on growth and the development of carcass quality in lambs. Part II. Effects on lambs of 30 lb. carcass weight. J. Agr. Sci. 42:93.

Price. M. A. 1971. Infertile bulls vs. steers. IV. Meat quality. J. Agri. Sci. Camb. 77:325.

Price, M. A. and N. T. M. Yeates. 1971. Infertile bulls vs. steers. I. The influence of level of nutrition on relative growth rate. J. Agri. Sci. Camb. 77:307.

Price, M. A. and N. T. M. Yeates. 1971. Infertile bulls vs. steers. II. Feed conversion efficiency and the effects of a high fat diet. J. Agri. Sci. Camb. 77:313.

Price. M. A. and N. T. M. Yeates. 1971. Infertile bulls vs. steers. III. Carcass characteristics. J. Agri. Sci. Camb. 77:317.

Ramsey, C. B., J. W. Cole and C. S. Hobbs. 1962. Relation of beef carcass grades, proposed yield grades and fat thickness to separable lean, fat and bone. J. Anim. Sci. 21:193.

Robertson, I. S. 1966. Castration in farm animals: its advantages and disadvantages. Vet. Rec. 78:130.

Robertson, I. S., J. C. Wilson and P. G. D. Morris. 1967. Growth, carcass composition and sexual development in bulls, steers and cattle castrated by Biaburtcjan's Method. Vet. Rec. 79:88.

Robertson, I. S., J. C. Wilson and P. G. D. Morris. 1967. Growth in castrated cattle. Growth, carcass composition and sexual development in bulls, steers and cattle castrated by Baiburtcjan's method. Vet. Rec. 81:88.

Smalling, J. D. 1972. Unpublished data. University of Tennessee (Mimeograph).

Smith, H. J. and E. J. Warwick. 1955. New methods and techniques to aid in selecting beef cattle breeding stock. University of Tennessee Prog. Rept. p. 14.

Steel, R. G. D. and J. H. Torrie. 1960. Principles and Procedures of Statistics. McGraw-Hill Book Company, Inc., New York, Toronto, London.

Stouffer, J. R., R. V. Wallentine, G. H. Wellington, and A. Dickman. 1961. Development and application of ultrasonic methods of measuring fat thickness and rib eye area in cattle and hogs. J. Anim. Sci. 20:759.

Taylor, J. C., R. C. Carter, C. M. Kincaid, B. M. Priode and J. A. Gaines. 1960. Estimates of genetic and phenotypic parameters in beef cattle. IV. Repeatability of cow performance. J. Anim. Sci. 19:700.

Temple, R. S., C. B. Ramsey and T. B. Patterson. 1965. Errors in ultrasonic evaluation of beef cattle. J. Anim. Sci. 24:282 (Abstr.).

Temple, R. S., H. H. Stonaker, D. Harvey, G. Pasakany and M. H. Hazaleus. 1956. Ultrasonic and conductivity methods for estimating fat thickness in live cattle. Proc. Western Sec. An. Soc. Anim. Prod. 7:477.

Turton, J. D. 1969. The effect of castration on meat production from cattle, sheep and pigs, p. 1. In D. N. Rhodes (Ed.) Meat Production from Entire Male Animals. J. & A. Churchill Ltd. London.

Warwick, E. J., R. E. Davis and R. L. Hiner. 1964. Response of monozygotic bovine twins to high and low concentrate rations. J. Anim. Sci. 23:78.

Warwick, E. J., P. A. Pulman, R. L. Hiner and R. E. Davis. 1970. Effects of castration on performance and carcass characters of monozygotic bovine twins. J. Anim. Sci. 31:296.

Watkins, J. L., G. W. Sherritt and J. H. Ziegler. 1967. Predicting body tissue characteristics using ultrasonic techniques. J. Anim. Sci. 26:470.

Wellington, C. J. 1953. Recommended procedures for cutting beef. Proc. Recip. Meat Conf. Ann. Rpt. 6:73.

Williams, J. N. II. 1965. Performance, carcass characteristics and ultrasonic estimates of changes in muscle and fat of bulls, steers and heifers. Unpublished Ph.D. dissertation. University of Tennessee, Knoxville, Tennessee.

Winchester, C. F. and P. E. Howe. 1955. Relative effects of continuous and interrupted growth on beef steers. U.S.D.A. Tech. Bul. 1108.

Witt, M. and D. Andreaue. 1965. Effect of castration in male monozygotic cattle twins. Anim. Breeding Abstr. 33:2082.

Wythe, L. D., Jr., P. T. Marion, B. E. Conrad and E. M. Neal. 1963. Young bulls versus steers for beef production. Tex. Agr. Exp. Sta. and Mech. College of Tex. Misc. Pub. 670:94.

Zinn, D. W. 1967. Quantitative and qualitative beef carcass characteristic as influenced by time on feed. Ph.D. dissertation. University of Missouri, Columbia, Missouri.

VITA

James Emerson Cloar was born in Paris, Tennessee on April 4, 1948. In 1955 he moved to Munfordville, Kentucky, where he graduated from Munfordville High School in 1966. In June of that year he entered the University of Tennessee, Martin. He received his Bachelor of Science degree in Agriculture in August, 1970. The following September he entered Graduate School at the University of Tennessee at Knoxville receiving a Master of Science degree in Agriculture with a major in Animal Husbandry in August, 1972.

He is married to the former Bonnie June Lamport of Jackson, Tennessee and has one child, James Alan Cloar.