To the Graduate Council:

I am submitting a thesis written by Charles W. Grooms entitled "A Study of Breed Differences in Steers in the Obion County Junior Livestock Show During the Six-Year Period, 1973 to 1978." I have examined the final 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.

Robert R. Shrode

Robert R. Shrode, Major Professor

We have read this thesis
and recommend its acceptance:

Wm. R. Backus

Curtis C. Melton

Accepted for the Council:

Carl Minkel

Vice Provost
and Dean of The Graduate School

A STUDY OF BREED DIFFERENCES IN STEERS IN THE OBION COUNTY JUNIOR LIVESTOCK SHOW DURING THE SIX-YEAR PERIOD, 1973 TO 1978

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Charles W. Grooms

June 1987

ACKNOWLEDGMENTS

The author wishes to express his most sincere appreciation to the following:

To Dr. Robert Shrode, major professor and thesis advisor, for his sound and sincere advice with statistical analysis, data interpretation, manuscript review, and friendship.

To Drs. Curtis Melton and William Backus for serving on the graduate committee and for reviewing the manuscript.

To Dr. Clyde Lane for his assistance in the preparation and analysis of the data.

To Reelfoot Packing Company and Mr. Jack Mitchell, beef cooler supervisor, for his assistance in the collection of the carcass data.

To the Obion County Junior Livestock members for their youthful enthusiasm.

To the late Hunter Miller for his guidance and influence during the author's early experience in the Obion County Junior Livestock program.

To The University of Tennessee Agricultural Extension Service for granting the author educational leave and support while he was engaged in this study.

And to the author's wife, Judy, and son, Chris, for their patience, understanding and encouragement.

ABSTRACT

Four hundred twenty-five carcasses from Angus, Hereford, Charolais and other breeds (predominantly crossbreeds from Angus and Hereford dams) were utilized in a six-year (1973-1978) study of breed and year variation in beef carcass yield traits. These steers were entered in the Obion County Junior Livestock Show and Sale by 4-H and FFA members in the county. The steers consisted of 154 Angus, 104 Herefords, 38 Charolais, and 129 steers of other breeds.

Data on performance traits (carcass weight) indicated a superiority ($P<.01$) of Charolais as compared to the other-breeds group. Herefords had the lowest caracass weight. There was no difference between Angus and the other-breeds group.

Angus steer carcasses had the highest ($P<.05$) marbling score and carcass grade of all breed groups. Charolais and Herefore were the lowest with no difference between these breeds.

External fat thickness (measured over the twelfth rib) comparisons showed Charolais to have the least ($P<.05$) fat. Angus had more ($P<.05$) fat than did the other-breeds group. There was no difference between Herefords and the other-breeds group or between Angus and Herefords.

Charolais steers had the largest ($P<.05$) rib-eye area (REA). Herefords had the smallest REA. Angus and the other-breed group were similar in REA.

The highest ($P<.05$) percent retail cuts was yielded by the Charolais carcasses. Angus and Hereford had the lowest ($P<.05$) yield. There was no difference between Herefords and the other-breed group in percent retail cuts yield.

TABLE OF CONTENTS

CHAPTER		PAGE
I.	INTRODUCTION.	1
II.	REVIEW OF LITERATURE.	4
	Performance Traits.	4
	Factors related to preweaning performance	4
	Breed effects	6
	Factors related to postweaning performance.	7
	Carcass Quality Traits.	10
	Conformation.	10
	Marbling.	11
	Composite USDA quality grade.	12
	Retail Yield Traits	15
	Fat thickness	15
	Carcass weight.	16
	Rib-eye area (REA).	16
	Percent lean cuts	17
	General Brief Overview of Published Findings.	18
	Carcass weight.	18
	Marbling and quality grade.	19
	Rib-eye area (REA).	19
	Fat thickness and percent retail cuts	19
III.	EXPERIMENTAL PROCEDURE.	20
	Source of Information	20

CHAPTER PAGE

Packing Plant Data. 22

Method of Analysis. 22

IV. RESULTS AND DISCUSSION. 24

Estimates of Performance. 24

Hot carcass weight. 24

Carcass Quality Traits. 26

USDA marbling score 26

USDA quality grade. 26

Retail Yield Traits 28

Fat thickness 28

Rib-eye area (REA). 30

Predicted percent retail cuts 31

V. SUMMARY 32

LITERATURE CITED. 34

VITA. 40

LIST OF TABLES

TABLE		PAGE
1.	Means and Stardard Deviations of Selected Variables in a Sample of 425 Steer Carcasses	21
2.	Year and Breed Least-Squares Means of Carcass Performance Traits.	25
3.	Analysis of Variance of Carcass Weight.	26
4.	Breed and Year Least-Squares Means of Carcass Quality Traits.	27
5.	Analysis of Variance of Carcass Quality Traits.	28
6.	Breed and Year Least-Squares Means of Carcass Retail Yield Traits.	29
7.	Analysis of Variance of Carcass Retail Yield Traits	31

CHAPTER I

INTRODUCTION

As consumers have become more selective in their purchases of beef products, beef cattle producers have recognized the importance of carcass traits and eating quality. Along with consumer pressures, economic conditions have dictated that beef production become more efficient as a result of more effective breeding and management procedures.

Estimates of heritability of economic carcass traits are relatively high, and these traits can be measured objectively. Research has indicated that some external measurement can be used with a high degree of confidence to predict profitable slaughter size; with the increased cost of production, this has become very important.

As the competition for the world grain supplies increases, beef producers must become more efficient in the use of grain. Carcass yield of retail cuts is one measurement of this efficiency.

The Obion County Junior Livestock Show and Sale provides an opportunity for young people to see the results of selection and feeding programs. The local producers who provide steers for the show can use the carcass information obtained from the steers to guide them in adjusting their breeding programs.

The 33rd Annual Obion County Junior Livestock Show and Sale was held in 1986. There has been some type of steer show and sale

from time to time in Obion County since the late 1920's. During the early years it was called the Fat Calf Show.

The event as we know it today was actually begun in 1953 when Mr. Hunter Miller, then serving as Agriculture Representative for one of the local banks, purchased a group of steers at the Brownsville Feeder Calf Sale. The steers were numbered, and each of the young feeders randomly drew the numbers of steers they would feed. After four successful annual steer shows, the Obion County Fair was reorganized.

The Junior Livestock Association is guided by a group of Adult Advisors working with Extension Agents and high school teachers of vocational agriculture. The sponsorship of local businesses has contributed significantly to the success of this educational youth program.

The live animals have been judged for the past few years by a panel of three judges rather than by a single judge. It has been generally agreed that this system has worked extremely well. Another adjustment in the conduct of the show that prevented conflicts was making up of classes by live weight rather than by steer breed, as was the practice when the data analyzed for this study were collected.

The carcass award program was incorporated into the Obion County Show in 1973. Robert G. Latimer, Jr., M.D. of Union City, Tennessee, was very instrumental in starting and sponsoring the carcass show. This was done in cooperation with Reelfoot Packing Company and USDA graders.

In recent years, increasing numbers of steers sired by bulls of exotic breeds, primarily from Angus and Hereford dams, have been exhibited in the Obion County Junior Show. Since 1980, classes have not been made up on the basis of breed. For a few years, live weight was the criterion of classification, and hip height is currently used. In view of this change in the way classes are made up, it seemed desirable to study the data accumulated during the six-year period, 1973-1978, with breed differences in the recorded variables as the primary consideration.

CHAPTER II

REVIEW OF LITERATURE

Breed differences in beef carcasses have been of interest in many research studies. Carcass data from junior shows have given answers to some questions (Baker, 1976; Fortune, 1973).

Importation of new exotic breeds and the expanded use of artificial insemination have produced an array of crossbred steers for carcass evaluation. This has caused a need for information on the economically important traits of these breeds and of their crosses for comparison with the traditional British breeds. Published research findings concerning performance traits, carcass quality traits, and carcass yield traits were reviewed in preparation for the present study.

Performance Traits

Factors related to preweaning performance. Work by Botts et al. (1980) with 51 spring-born suckling Polled Hereford calves showed that milk intake declined from 6.14 to 3.37 kg/head/day from April to August and September. Calves born March 21 to 31 consumed the most ($P<.05$) milk. Calves born during the period April 1 to May 2 consumed the least ($P<.05$) forage.

In preweaning performance, bulls are generally superior to steers and heifers (BIF, 1972). The birth weight of calves is influenced by sex. Heifer calves are as much as five pounds lighter than bulls.

Baker (1964) found that calves born January to May consistently had a better average daily gain from birth to weaning than did calves born during other months. However, Singh et al. (1970) found that month of birth had no significant effect on preweaning performance in his data.

The weaning weight of calves is affected by the age of their dam. Cows ranging in age from eight to eleven years tended to produce the heaviest calves, while three-year-old cows produced the lightest calves in the data studied by Singh et al. (1970).

Marlowe and Gaines (1958) found the largest birth weight to be that of calves from two- to seven-year-old Hereford and Angus cows, birth weights of calves of cows older than seven years being smaller.

In a four-year study of Polled Hereford (120 bulls and 103 heifers) and Angus (291 bulls and 292 heifers) by Hammack and Shrode (1986), it was concluded that the general size component (from multivariate analysis) in immature animals may be a better indicator of mature size than is immature body weight. Also, the components contrasting shape might be used to distinguish between animals of varying body types but similar live weights.

Anderson et al. (1980) found that creep feeding increased weaning weights by 12.0 kg in Angus, 9.0 kg in Holsteins, 50.0 kg in Simmental-sired calves and 40.0 kg in Chianina-sired calves, and crossbred calves had faster and more efficient gains during the first month of the finishing period.

Martin et al. (1980) reported a tendency for carcasses of preweaning creep-fed steers to be less desirable in all of the quantitative traits associated with cutability percentage. Preweaning creep feeding resulted in a cutability percent of 48.8% as compared to 50.0% for non-creep-fed animals.

Breed effects. The effect of breed of sire was significant with respect to birth weight, weaning weight and weaning condition score; however, breed of dam had a significant effect on only birth weight and weaning weight. With respect to these three weights, breed-of-sire-by-breed-of-dam interaction was either nonsignificant or the amount of variation accounted for by it was small relative to the amount of variation accounted for by the main effects, breed of sire and breed of dam (Thrift et al., 1978).

Anderson et al. (1978) reported that Chianina-sired calves from Angus heifers were smaller at birth, and the difficulty-in-calving score was lower than that of calves from Chianina X Angus heifers. Simmental-sired heifers were heavier at weaning than were Angus heifers.

Dillard et al. (1980), in a study of straightbred and crossbred cattle involving the Angus, Charolais and Hereford breeds, reported that: a) Charolais additive effect (expressed as a deviation from Hereford) was positive ($P<.05$) on birth weight, average daily gain and weaning weight, b) Angus additive effect on birth weight was negative ($P<.01$), c) Charolais maternal contributions to preweaning traits exceeded those of Hereford and Angus and d) Angus maternal effect

significantly exceeded that of the Hereford on all traits except type score.

Jamison (1970) reported the average weaning weight of purebred and crossbred calves to be: Angus, 499 pounds; Hereford, 420 pounds; Shorthorn, 441 pounds; Angus X Hereford, 465 pounds; Shorthorn X Hereford, 470 pounds and Angus x Shorthorn, 465 pounds. Hereford calves tended to be lighter than crossbred calves in a Georgia study (Chapman et al., 1971).

Gregory et al. (1979), in a study of 1610 calves born and 1536 calves weaned during the period of 1975 to 1976 from four- to eleven-year-old Hereford and Angus dams, found that: 1) calves from Angus dams were superior ($P<.01$) to calves from Hereford dams in preweaning average daily gain (ADG), relative growth rate (RGR) and 200-day weight; 2) Hereford dams produced calves with significantly heavier birth weights and longer gestation lengths than did Angus dams.

It was reported by Bailey and Moore (1980) that pregnancy rate for Hereford cows bred to Brahmam sires was 10% lower ($P<.05$) than for straightbred Hereford or Angus X Hereford matings. In the same study it was found that the percentages of live calves were higher ($P<.05$) from straightbred Hereford and Red Poll X Hereford matings than from Hereford x Red Poll crosses.

Factors related to postweaning performance. Danner et al. (1980), in a feeding study using Angus X Hereford yearling steers, Charolais X British crossbred steer calves and Hereford heifer calves, evaluated

utilizing high moisture corn, corn silage and soybean meal. The systems were: A, 85% concentrate; B, 40% concentrate; C, two phases, first, all corn silage and second, 85% concentrate from the middle of the feeding period; D, same as C except change of diet made in the feeding period; and E, all corn silage fed continuously. Feeding was terminated when the cattle had approximately the same final weight. It was found that increasing the percentage of corn to total diet increased ADG; adjusting to constant carcass weight showed that increasing energy increased the fat thickness and reduced the percentage retail product with no effect on quality grade in yearling steers. In the Charolais-cross steers, increasing energy level increased quality grade, with no effect on yield grade or percent retail product. Energetic efficiency was slightly better on system C in yearlings. Steer calves exhibited best efficiency on system A.

Anderson et al. (1978) reported that there was no improvement in overall postweaning gain and efficiency from creep feeding, but number of days on feed was reduced for each creep-fed group.

O'Mary et al. (1979), in a study of Angus and Charolais X Angus steers, found that the crossbred steers had heavier birth weights, 205-day adjusted weaning weight, 240-day actual weights and final slaughter weights than did straightbred Angus. The ADG was higher and feed conversion more efficient in the crossbreds during the 120-day feeding period. In this study, feeding Angus 150 days and the crossbreds 180 days was insufficient to produce similarly finished carcasses.

Gortsema et al. (1974) studied 39 male Angus-Hereford crossbred calves, using three treatments: steers, normal bulls and short-scrotum (SS) bulls. These were fed to a weight of approximately 450 kg. The intact males (normal and SS bulls) gained weight more ($P<.05$) rapidly and more ($P<.05$) efficiently than did steers. Feed efficiency in this study was highly correlated with ADG, cold carcass weight per day of age and yield grade. Quality grade was greater ($P<.05$) in steers. All cutability traits were superior ($P<.05$) in the intact males.

It was found by Christian et al. (1965) that the ADG during the later stages of postweaning feeding, and the portion of trimmed valuable cuts in the carcass were found to increase ($P<.05$) with increased weaning weight.

Backus (1968) determined that, while the deposition of fat appears to make feed utilization less efficient, acceptable beef may be produced with little waste fat. However, as fat deposition increased, so did the improvement in carcass traits, marbling score, carcass conformation, and carcass grade, even though tenderness, juiciness and flavor were not enhanced by increased fatness.

Jamison (1970) reported that indications from a study conducted by the Middle Tennessee Experiment Station of The University of Tennessee were that Hereford X Charolais crosses were more efficient in feed utilization than were straightbred Hereford calves.

Carcass Quality Traits

Conformation. Conformation, as defined by Bray (1963), is the form or outline of a carcass, relating to its shape and volume of muscle and excluding the fat. Brown (1975) stated that type may be referred to as general appearance.

Carcass conformation was affected ($P<.05$) by fat thickness with the fatter carcasses tending to receive higher carcass conformation grades in data studied by Backus (1968).

LeVan et al. (1979), in a study of Angus and Charolais steers, reported that neither breed nor slaughter weight had a marked effect on relative distribution of retail lean, fat or bone throughout the animal's body. In addition, although a significant breed difference was noted in fat and bone content, differences in growth rate and retail lean were relatively minor when cattle were slaughtered at similar percentages of their breed's average mature weight.

Butts et al. (1980) reported that body depth of calves was negatively related ($P<.05$) to carcass weight, and Pierce (1957) found that no single objective measure of conformation was consistently better than conformation grade for predicting yields.

Kirkpatrick (1967) reported carcass conformation score in a Hereford steer study to be significantly correlated with carcass grade, pounds of retail trimmed high-priced cuts, total pounds of fat trim and carcass weight.

Fortin et al. (1980) studied the growth and distribution of muscle in the trunk and thoracic and pelvic limbs of 141 cattle ranging

in slaughter weight from 121 to 706 kg. Holstein and Angus bulls, steers and heifers were fed two levels of energy -- ad libitum (ad lib.) and 65-70% ad lib. In both breeds, irrespective of the level of energy intake, sex did not influence growth rate of muscle in the thoracic and pelvic limbs relative to the carcass side or to total muscle. However, sex was found to affect growth rate of muscle in the trunk relative to the carcass side. Generally, level of energy or breed altered ($P<.05$) growth rate of muscle in the three joints. Breed influenced ($P<.05$) the distribution of muscle in the trunk and pelvic limbs.

Marbling. According to USDA grading standards, marbling (intramuscular fat) is a major factor used to determine final carcass grade. Photographic standards have been used as a basis for marbling scores. Considerable variation in the interpretation of these standards has been found between individuals using them.

Baker (1976), in a study of 722 carcasses from the Bristol Junior Steer Show, found that Angus steer carcasses had an average marbling score of 57.10 (modest minus) which was higher ($P<.05$) than the scores of the other breed groups. Hereford and Charolais steer caracasses had the lowest marbling scores. In this study there was a correlation of .87 between carcass quality grade and USDA Marbling Score.

O'Mary et al. (1979) reported, from a study of carcasses of Angus and Charolais X Angus steers, that the heavier crossbred carcasses

had less external fat, less fat in the 9-10-11th rib cut and less marbling than did the lighter Angus carcasses but had higher USDA cutability percent and more water and protein in the 9-10-11th rib cut. In the same study, when the steers were slaughtered at lighter weights and younger ages, the heavier crossbred carcasses had larger longissimus muscles, a higher cutability and more water and protein in the 9-10-11th rib cut than did Angus carcasses. The Angus had more marbling and higher carcass grade than did the crossbreds.

Jeremiah et al. (1970) found that, while there was very little variation in fat thickness among Hereford, Angus and Shorthorn steers, marbling scores were highest in Angus carcasses, followed by Shorthorn carcasses and then Hereford carcasses. He found marbling to be highly correlated with carcass weight.

Fortune (1973) found in a study of 736 steers from the Knoxville Finished Calf Show that Angus steer carcasses had higher ($P<0.1$) USDA Marbling scores than did carcasses of other breeds. Following the Angus were Shorthorn and Hereford, in that order, and the Charolais cross carcasses had the lowest marbling scores.

Tatum et al. (1980) found that the palatability of steaks generally increased as marbling score increased; however, the difference in palatability associated with each successive increase in marbling score was not always directionally consistent, nor were they always statistically significant.

Composite USDA quality grade. Tatum et al. (1982) found that marbling had a small positive relationship to all of the palatability

traits of beef; more than 90% of the steaks with "slight" or higher degrees of marbling were "desirable" in overall tenderness, flavor desirability and overall palatability.

Baker (1976) found that, in the 722 steers entered in the Bristol Junior Show during an eight-year period (1968-75), Angus had the highest mean carcass grade of 12.5 (low choice). The other-breeds group followed with 12.1 (low choice). Hereford steer carcasses were lower ($P<.05$) in quality grade than any of the other breed groups.

Fortune (1973), in a study of 736 steer carcasses (Shorthorn, Angus, Hereford and Charolais Crosses), from the Knoxville Junior Show found that Angus carcasses had the highest mean carcass grade (low choice) of the four breeds. Shorthorn carcasses ranked next with a mean carcass grade of high good. A difference ($P<.01$) existed between carcass grades of these two breeds. The Hereford carcasses were not significantly different from Shorthorn carcasses; however, the crossbred carcasses had the lowest average carcass quality grade of the four breed groups. In this study it was concluded also that age of steers had a positive ($P<.01$) effect on carcass quality grade and marbling score.

Urick et al. (1974), in a study of beef X beef and beef X Brown Swiss crosses (beef breeds being Angus, Hereford and Charolais), found that comparisons of crossbreds of the three breeds with straightbreds showed heterosis not to be an important source of variation in carcass quantity and quality traits. Breed group differences in carcass grade were not significant.

Peacock et al. (1979), in a study of breed and heterosis effect on carcass characteristics of Angus, Brahman and crossbred steers, found that the direct effects of Angus breeding were positive on quality grade, thickness of fat over the longissimus muscle and rib eye. The effects of Charolais breeding were negative on fat over the eye and quality grade. The effects of Brahman breeding were negative on rib-eye area (REA) and quality grade.

Davis et al. (1979), in a study of a sample of 80 beef loins from a group of 1005 steaks, found that the independent variables that contributed most in accounting for the observed variation in tenderness were fragmentation index, sarcomere length, intramuscular moisture percentage and soluble collagen percentage.

Tatus et al. (1980) found that steaks from the higher grading (by 1/3 grade) carcasses (high choice and average choice) were more ($P<.05$) juicy, flavorful and desirable in overall palatability than were steaks from the lower grading (by 1/3 grade) carcasses (low good and high standard); however, steaks from low choice, high good and average good carcasses did not differ in juiciness, tenderness or overall palatability. When steaks from carcasses differing by full grades were compared, grade was not associated with differences in palatability.

Increased time on feed was associated wtih increased carcass maturity, increased fat deposition, decreased (higher numerical) yield grade and increased percentage of carcasses grading choice. Increasing time on feed from 100 days to 160 days had a beneficial effect on flavor

desirability but did not significantly affect juiciness, tenderness or overall palatability.

Retail Yield Traits

Fat thickness. Marshall et al. (1985) found external fat thickness in calves from Hereford X Angus and Angus X Hereford cows (average 1.51 cm) was 0.24 cm greater than in calves from Simmental cross and Jersey X Angus cows and 0.34 cm greater than in calves from Brown Swiss X Hereford and Jersey X Hereford cows. Baker (1976) found a correlation ($P<.05$) of -.87 between carcass fat thickness and percent retail cuts. Charolais fat thickness was less ($P<.05$) than that of British breed carcasses. Fortune (1973), Backus (1968) and Thackston (1966) also reported negative correlations between fat thickness and carcass yield. Cross and Dinius (1978) reported that the form of feed fed (ground or pelleted) did not affect fatness or marbling traits.

Jeremiah et al. (1970) reported that heavier steer carcasses, when classified according to breed, have higher marbling scores. However, he found that, within categorized weight groups, there was very little difference in fat thickness between Hereford, Angus and Shorthorn, but retail cut percent was lowest in Shorthorn due to their smallest REA at the twelfth rib and the highest percent kidney, heart and pelvic fat.

It was advocated by Ramsey et al. (1962) that a single carcass fat thickness measurement taken at the twelfth rib be used to estimate

fat trim. Backus (1968) reported that live fat thickness measurements from the twelfth rib anatomical region are useful in predicting carcass fatness.

Carcass weight. Cross and Dinius (1978), in a study of beef steers finished on forage diets, reported that the form of the diets (ground or pelleted) affected chilled carcass weight and marbling score.

Butts et al. (1980) reported wither height to be positively correlated ($P<.001$) with carcass weight and with days on feed ($P<.001$) among calves on a high-energy diet. Wither height was less highly related ($P>.05$) to carcass weight and unrelated ($P>.10$) to days on feed among calves on a medium-energy diet. The association between initial fat and carcass weight was negative ($P<.001$) and differed ($P<.01$) between the Charolais-cross and British-breed groups. Thackston (1966) found a positive ($P<.01$ to $P<.05$) relationship of carcass weight and actual percent retail yield, and Jeremiah et al. (1970) found a positive relationship between carcass weight and marbling score.

Nour et al. (1983) reported marbling score, quality grade and REA increased ($P<.005$) .028 units, .027 units and .1 cm^2, respectively, for each kg increase in chilled carcass weight.

Rib-eye area (REA). Baker (1976) and Fortune (1973) found that crossbred steers had a significant advantage over straightbred British-breed steers with respect to REA. Peacock et al. (1979) reported that

Brahman dams had a positive effect on REA, while Charolais dams had a negative effect. Scarth (1973) found that Angus carcasses had the largest REA and Shorthorn carcasses the smallest in his study. Skelley et al. (1980), studying crossbred steers finished on high-silage diets, found Holstein X Angus crosses and Polled Hereford X Angus crosses had a smaller ($P<.05$) longissimus muscle area and higher yield grade than did carcasses of Charolais and Simmental crosses.

Matthews and Bennett (1962) found REA to be negatively related to fat thickness. REA was negatively related also to quality traits. Slanger et al. (1985) found that REA increased with percent breed heterosis. This increase was greater with heifers than with steers. Heifers had more marbling and higher quality grades than did steers.

Martin et al. (1980) reported the longissimus muscle area to be significantly affected by pre-weaning creep, 81.8 cm on creep vs 75.7 cm on non-creep.

Percent lean cuts. Urick et al. (1974) reported that steers from Brown Swiss dams sired by Hereford and Angus bulls excelled the straightbred beef steers in carcass growth traits and percent cutability.

Martin et al. (1980) reported that Chianina-sired steers had estimated cutability of 51.3%; Holstein, 46.9%; Angus, 49.3%; and Simmetal, 49.6%.

Abraham et al. (1980), in a study of 280 carcasses, found that, on the average, carcasses they studied had higher actual yields than

were predicted by the yield grade. The value obtained from a regression equation developed from this study and based on the same factors was only slightly more highly correlated with cutability than was the value calculated from the equation currently used to predict yield grade. There was little evidence that the present equation discriminates more against certain types of cattle than does the equation developed in their study. Therefore, there would be little advantage from revising the present USDA yield grade standards for the purpose of improving the cutability predictions of the present standards.

Baker (1976) found, in a study of 722 carcasses from Shorthorn, Angus, Hereford, Carolais and other breeds (predominantly Simmental X Hereford or Angus), that the estimated overall mean percent retail cuts was 50.35. Other breeds and Charolais steers yielded the highest ($P<.05$) percent. Shorthorn steers were predicted to yield the lowest percent retail cuts.

Fortune (1973) estimated crossbred carcasses to yield higher ($P<.05$) percent retail cuts than Angus, Hereford or Shorthorn carcasses.

General Brief Overview of Published Findings

To give a gneral overall view of the breed effect on the variables used in this study the following statements can be made.

Carcass weight. Charolais and other-breed groups have had generally heavier carcasses than British breeds on an age-constant basis.

Marbling and quality grade. British breeds have generally been superior to Charolais and crossbreds in marbling and quality grade, and Angus have scored higher than Herefords and Shorthorns.

Rib-eye area (REA). Charolais and other-breed groups have had a larger REA than have British breeds.

Fat thickness and percent retail cuts. Charolais and other-breed groups have had less fat and a higher percent retail cuts than have Angus, Herefords and Shorthorns.

In general, year differences have not been a major source of variation in overall carcass quality traits.

CHAPTER III

EXPERIMENTAL PROCEDURE

Source of Information

Four hundred twenty-five steers and their carcasses were included in this six-year study. The steers were entries in the Obion County Junior Livestock Show and Sale during 1973-1978. Four primary breed divisions were identified. These divisions were Angus, Hereford, Charolais and other-breeds. During the six-year period, 154 Angus, 104 Hereford, 38 Charolais and 129 other-breeds were evaluated. The crossbred steers were shown in the other-breeds class. When the feeding period was started, each steer was weighed and freeze branded. The steers were entered and weighed on Monday and shown and graded on Tuesday morning. The steers were sold locally at auction on the night of the show. All of the steer carcasses that were evaluated were slaughtered at Reelfoot Packing Company, Union City, Tennessee. This permitted evaluation of all of the carcasses at a central location by the University of Tennessee Extension Service and USDA graders.

The steers were slaughtered on Wednesday after the show. The carcasses were evaluated on Friday. Each steer was identified with a metal ear tag or hip tag in addition to the freeze brand.

Animals involved in the study were representative of different types of management practices and were apparently representative of each breed. Animals involved had been fed by 4-H and FFA members in Obion County only.

The overall means and standard deviations of carcass data used in this study are presented in Table 1. Breed differences were of primary interest in this study. Therefore, attention is focused on breed differences rather than on year differences.

Table 1. Means and Standard Deviations of Selected Variables in a Sample of 425 Steer Carcasses

Variable	Mean	Standard Deviation
Hot carcass weight (lb.)	635.22	76.91
USDA carcass quality grade[1]	11.43	1.88
USDA marbling score[2]	52.4	14.03
Carcass fat thickness (in.)	.54	.23
Area of longissimus muscle (sq. in.)	11.65	1.32
Percent retail cuts	49.89	1.90
USDA yield grade[3]	3.07	.83

[1] 11 = Good (+), 12 = Choice (-).

[2] 37 = "Slight (-)," 40 = "Slight," 43 = "Slight (+)," 47 = "Small (-)," 50 = "Small," 53 = "Small (+)," 57 = "Modest (-)," 60 = "Modest," 63 = "Modest (+)."

[3] 1.9 = 52.6, 2.0 = 52.3, 2.1 = 52.1, 2.2 = 51.9, 2.3 = 51.6, 2.4 = 51.4, 2.5 = 51.2, 2.6 = 51.0, 2.7 = 50.7, 2.8 = 50.5, 2.9 = 50.3, 3.0 = 50.0, 3.1 = 49.8, 3.2 = 49.6, 3.3 = 49.3, 3.4 = 49.1, and 3.5 = 48.6 percent retail cuts.

Packing Plant Data

Individual hot carcass weights were recorded after dressing of the carcasses and before they were shrouded. The carcasses were chilled for about 48 hours at approximately 37°F. After chilling, the left side of each carcass was ribbed by packing plant personnel between the twelfth and thirteenth ribs, exposing a cross-section of the longissimus muscle. The area of the muscle and surrounding tissue was measured to the nearest .1 square inch with a plastic overlay grid and recorded in square inches as rib-eye area (REA). Fat thickness was measured over the longissimus muscle between the twelfth and thirteenth ribs approximately three-fourths of the distance from the edge of the muscle to the chine. Carcass quality estimates and estimated percent kidney, heart, and pelvic fat were recorded by a USDA grader.

Estimates of retail yield were made using the USDA beef carcass yield grade formula. Estimated yield grades were computed using fat thickness, hot carcass weight, REA and percent kidney, heart and pelvic fat.

Method of Analysis

The data were analyzed statistically using the method of least-squares analysis as described by Harvey (1960). Constants were fitted for the independent variables, breed and year. The manner in which the analysis was conducted insured that year and breed effects were not confounded. If significant main effects were found, the means were subjected to Duncan's (1955) Multiple Range Test to separate them into groups different ($P<.05$) from one another.

The data were subjected to least-squares analysis of variance, using computer programs developed by the SAS Institute (SAS, 1982).

The primary model used in the least-squares analysis was:

$$Y_{ijk} = \mu + b_i + y_j + e_{ij}$$

where

μ = general mean

b_i = effect of i^{th} breed

y_j = effect of j^{th} year

e_{ij} = random error.

CHAPTER IV

RESULTS AND DISCUSSION

Objective and subjective measures for evaluating carcass merit have been used extensively. These criteria are useful to producers, feeders and packers for improving the marketability of carcass beef.

Estimates of Performance

Hot carcass weight. Hot carcass weight is a valid estimate of live performance of animals that are similar in age. In this study, these weights are reported on an age-constant basis.

Overall mean hot carcass weight is presented in Table 2. A least-squares analysis of variance indicated that breed means, with respect to hot carcass weight, were different ($P<.001$) (Table 3). A Duncan's Multiple Range Test delineated these differences ($P<.05$) in mean hot carcass weight of the four breeds. Herefords produced the lightest carcasses, while Charolais produced the heaviest carcasses. Other-breeds group and Angus were intermediate in weight, with Angus being lighter than other-breeds.

Carcasses from steers slaughtered during the years 1976-1978 were heavier ($P<.01$) than carcasses from steers slaughtered during the years 1973-1975. Most weight increase could be attributed to the increased number of exotic crosses in the show. A minimum eligibility weight of 850 lbs. was established.

Table 2. Year and Breed Least-Squares Means[1] of Carcass Performance Traits

	Number in Sample	Hot Carcass Weight (lb.)
Breed:		
Overall	425	635.22
Angus	154	629.85[a]
Hereford	104	602.35[b]
Charolais	38	703.46[c]
Other-Breeds	129	646.34[a]
Year:		
1973	62	608.14[a]
1974	74	631.39[a]
1975	75	626.49[a]
1976	65	666.02[b]
1977	80	665.71[b]
1978	69	675.26[b]

[1]Means in the same column with different superscripts are different ($P<.01$).

Table 3. Analysis of Variance of Carcass Weight

Source	d.f.	Mean Squares Carcass Weight
Breed	5	101690.53[a]
Year	3	48922.67[a]
Error	416	5915.68

[a]P<.001.

These findings are similar to those of Fortune (1973) and Baker (1976) with respect to weight increase due to the influence of exotic crossbreds. However, Baker (1976) found a difference in Angus and other-breeds. In the Obion County show the other-breeds group undoubtedly was influenced by Angus breeding used in these crosses.

Carcass Quality Traits

USDA marbling score. Data shown in Table 4 illustrate that Angus steer carcasses had a higher (P<.05) average marbling score than did those of Herefords, Charolais and the other-breeds group. There was no difference in marbling scores of Charolais and Hereford carcasses.

USDA quality grade. The Angus steer carcasses had the highest mean quality grade. Charolais produced the lowest carcass grade, but

Table 4. Breed and Year Least-Squares Means[1] of Carcass Quality Traits

	Number in Sample	USDA[2] Carcass Quality Grade	USDA[3] Marbling Score
Breed:			
Overall	425	11.43	52.4
Angus	154	12.28[a]	58.29[a]
Hereford	104	10.78[b]	47.05[b]
Charolais	38	10.31[b]	45.47[b]
Other-Breeds	129	11.39[c]	52.02[c]
Year:			
1973	62	11.21[a]	47.56[a]
1974	74	10.57[b]	52.35[b]
1975	75	11.33[a,c]	52.93[b]
1976	65	11.83[a,c,d]	53.83[b]
1977	80	10.33[b]	44.43[a]
1978	69	11.86[c,d,e]	53.14[b]

[1]Means in the same column with different superscripts are different ($P<.05$).

[2]11 = Good (+), 12 = Choice (-).

[3]43 = "Slight (+)," 47 = "Small (-)," 50 = Typical "Small," 53 = "Small (+)," 57 = "Modest (-)."

they were not different from the Herefords. There are several studies in which Angus cattle have been found to have a higher carcass grade when compared to other-breeds and their crosses. Angus carcasses have had a higher degree of marbling.

Least-squares analysis of variance (Table 5) showed difference ($P<.001$) in carcass quality traits.

Table 5. Analysis of Variance of Carcass Quality Traits

Source	d.f.	Mean Squares: USDA Quality Grade	Mean Squares: USDA Marbling Score
Breed	3	66.92*	3361.76*
Year	5	30.66*	1122.55*
Error	416	3.52	196.94

*P<.001.

Retail Yield Traits

Fat thickness. Data in Table 6 indicate that Charolais had the least ($P<.05$) fat thickness measured over the longissimus muscle at the twelfth rib. There was a difference between Angus and the other-breeds group but not between Herefords and the other-breeds group.

Table 6. Breed and Year Least-Squares Means[1] of Carcass Retail Yield Traits

	Number in Sample	Fat Thickness in.)	REA (sq. in.)	Percent Retail Cuts	Yield Grade
Breed:					
Overall	425	.51	11.87	50.22	2.92
Angus	154	.59^{a}	11.54^{a}	49.40^{a}	3.28^{c}
Hereford	104	.56^{a,b}	11.03^{b}	49.69^{a,b}	3.15^{a,c}
Charolais	38	.34^{c}	13.14^{c}	51.70^{c}	2.28^{b}
Other-breed	129	.53^{b}	11.80^{a}	50.08^{b}	2.98^{a}
Year:					
1973	62	.52^{a,b}	11.44^{a}	49.86^{b,c}	3.08^{b,c}
1974	74	.55^{a}	12.18^{b,c}	50.28^{a,b,c}	2.89^{a,b,c}
1975	75	.46^{b}	11.94^{b,d}	50.78^{a}	2.67^{a,d}
1976	65	.49^{a,b}	11.52^{a,d}	50.00^{a,b,c}	3.02^{a,b,c}
1977	80	.50^{a,b}	11.75^{a,d}	49.85^{b}	3.08^{b}
1978	69	.53^{a,b}	12.44^{c}	50.53^{a}	2.79^{a}

[1]Means in the same column with different superscripts are different ($P<.05$).

This can be attributed to the fact that the Charolais cattle, being late maturing, were physiologically younger.

Baker (1976) found Charolais to have less ($P<.05$) external fat thickness but found no differences among Shorthorn, Angus and Hereford steers.

A least-squares analysis of variance indicates that breed and year both were sources of variation ($P<.001$) (Table 7) in external fat thickness. Baker (1976) found that cattle slaughtered during the years 1971, 1972 and 1975 had less ($P<.05$) external fat than did cattle slaughtered during the years 1968, 1969, 1970, 1973 and 1974. Fortune (1973) found no variation in external fat thickness due to the effect of year (1970-1972). Without more detailed information concerning variation in environment from year to year, no complete explanation for observed year differences in carcass variables can be provided. Year differences in percentages of the various breeds included would contribute to differences in year means.

Rib-eye area (REA). These data show that Charolais had larger ($P<.05$) REA when compared to the other groups. This parallels the information from studies by Baker (1976), Fortune (1973), Cundiff (1970) and Cahill et al. (1962).

Angus and the other-breeds groups had similar REA. Hereford REA was the smallest.

Fortune (1973) reported a year effect on REA while Baker (1976) found no year effect.

Table 7. Analysis of Variance of Carcass Retail Yield Traits

Source	d.f.	Mean Squares			
		Fat Thickness	REA	Percent Retail Cuts	Yield Grade
Breed	3	.62*	42*	55.38*	10.64*
Year	5	.06	7.65*	9.81*	1.92*
Error	416	.05	1.74	3.62	.69

*P<.001.

Predicted percent retail cuts. The percent of carcass weight in boneless, closely trimmed retail cuts from round, loin, rib and chuck is of economic importance in the beef industry. Charolais steers yielded the highest (P<.05) percent retail cuts. Angus had the lowest yield. This agrees with the findings of Baker (1976) and Fortune (1973) that Charolais crosses were superior to British breeds with respect to percent lean cuts.

CHAPTER V

SUMMARY

Four hundred twenty-five carcasses, from Angus, Hereford, Charolais and other breeds (predominantly crossbreds from Angus and Hereford dams) were utilized in a six-year (1973-1978) study of breed and year variation in beef carcass yield traits. These steers were entered in the Obion County Junior Livestock Show and Sale by 4-H and FFA members in the county. The steers consisted of 154 Angus, 104 Herefords, 38 Charolais and 129 steers of other breeds.

Data on performance traits (carcass weight) indicated a superiority ($P<.01$) of Charolais as compared to the other-breed group. Herefords had the lowest carcass weight. There was no difference between Angus and the other-breeds group.

Angus steer carcasses had the highest ($P<.05$) marbling score and carcass grade of all breed groups. Charolais and Hereford were the lowest, with no difference between them.

External fat thickness (measured over the twelfth rib) studies showed Charolais to have the least ($P<.05$) fat. Angus had more ($P<.05$) fat than did the other-breeds group. There was no difference between Herefords and the other-breeds group or between Angus and Herefords.

Charolais steers had the largest ($P<.05$) rib-eye area (REA). Herefords had the smallest REA. Angus and the other-breeds group were similar in REA.

The highest ($P<.05$) percent retail cuts was yielded by the Charolais carcasses. Angus and Hereford had the lowest ($P<.05$) yield. There was no difference between Herefords and the other-breeds group in percent retail cuts yield.

LITERATURE CITED

LITERATURE CITED

Abraham, H. C., C. E. Murphey, H. R. Cross, G. C. Smith and W. J. Franks, Jr. 1980. Factors affecting beef carcass cutability: An evaluation of the USDA yield grades for beef. J. Anim. Sci. 50:841.

Anderson, D. C., C. C. O'Mary and E. L. Martin. 1978. Birth, preweaning and postweaning traits of Angus, Holstein, Simmental and Chianina Sired calves. J. Anim. Sci. 46:362.

Backus, W. R. 1968. The effects of subcutaneous fat thickness on production efficiency and organoleptic properties of beef. Unpublished doctoral dissertation, The University of Tennessee, Knoxville.

Bailey, C. M. and J. D. Moore. 1980. Reproductive performance and birth characters of divergent breeds and crosses of beef cattle. J. Anim. Sci. 50:645.

Baker, J. E. 1964. Factors influencing performance of beef calves in commercial and purebred herds in Tennessee. Unpublished master's thesis. The University of Tennessee, Knoxville.

Baker, J. M. 1976. The effect of selected variables on carcass traits of beef. Unpublished master's thesis, The University of Tennessee, Knoxville.

Beef Improvement Federation (BIF) 1972. Guidelines for uniform beef improvement programs. USDA Extension Service. Program Aid 1020.

Boggs, D. L., E. F. Smith, R. R. Schalles, B. E. Brent, L. R. Corah and R. J. Pruitt. 1980. Effect of milk and forage intake on calf performance. J. Anim. Sci. 51:550.

Bray, R. W. 1963. Symposium on feed and terminology: IV. Quantitative measures of carcass composition and qualitative evaluation. J. Anim. Sci. 22:548.

Brown, W. G. 1975. 4-H Beef Cattle Handbook. University of Tennessee. Agricultural Extension Publication No. 568.

Butts, W. T., W. R. Backus, E. R. Lidvall, J. A. Corrick and R. F. Montgomery. 1980. Relationships among definable characteristics of feeder calves, subsequent performance and carcass traits and objective measurements. J. Anim. Sci. 51:1297.

Cahill, V. R., E. W. Klosterman and H. W. Ockerman. 1962. Composition of Charolais beef. J. Anim. Sci. 21:979.

Chapman, H. D., P. R. Utley and W. C. McCormick. 1971. Performance of Hereford, Simmental X Hereford, Charolais X Hereford and Santa Gertrudis X Hereford steers. Reprint. Tifton, Georgia.

Christian, L. L., E. R. Hauser and A. B. Chapman. 1965. Association of preweaning and postweaning traits with weaning weights in cattle. J. Anim. Sci. 24:652.

Cross, H. R. and D. A. Dinius. 1978. Carcass and palatability characteristics of beef steers finished on forage diets. J. Anim. Sci. 47:1265.

Cundiff, L. V. 1970. Experimental results on crossbreeding cattle for beef production. J. Anim. Sci. 30:694.

Danner, M. L., D. G. Fox and J. R. Black. 1980. Effect of feeding system on performance and carcass characteristics of yearling steers, steer calves and heifer calves. J. Anim. Sci. 50:394.

Davis, G. W., G. C. Smith, Z. L. Carpenter, T. R. Duston and H. R. Cross. 1979. Tenderness variations among beef steaks from carcass of the same USDA Quality Grade. J. Anim. Sci. 49:103.

Dillard, E. V., O. Rodriquez and O. W. Robinson. 1980. Estimation of additive and nonadditive direct and maternal genetic effects from crossbreeding beef cattle. J. Anim. Sci. 50:653.

Duncan, D. B. 1955. Multiple range and multiple F. tests. Biometrics 11:1.

Fortin, A., J. T. Reid, A. M. Maiga, D. W. Sim and G. H. Wellington. 1980. Effect of level of energy intake and influence of breed and sex on muscle growth and distribution in the bovine carcass. J. Anim. Sci. 51:1288.

Fortune, T. E. 1973. Factors affecting carcass traits of beef. Unpublished master's thesis, The University of Tennessee, Knoxville.

Gortsema, S. R., J. A. Jacobs, R. G. Sasser, T. L. Gregory and R. C. Bull. 1974. Effects of endogenous testosterone on production and carcass traits in beef cattle. J. Anim. Sci. 39:680.

Gregory, K. E., G. M. Smith, L. V. Cundiff, R. M. Koch and Laster. 1979. Characterization of biological types of cattle - Cycle III: 1. Birth and weaning traits. J. Anim. Sci. 48:271.

Hammack, S. P. and R. R. Shrode. 1986. Calfhood weights, body measurements and measures of fatness versus criteria of overall size and shape for predicting yearling performance in beef cattle. J. Anim. Sci. 63:447.

Harvey, W. R. 1960. Least-squares analysis of data with unequal subclass numbers. USDA. ARS-20-8.

Jamison, H. M. 1970. Crossbreeding in beef cattle. Mimeograph. The University of Tennessee, Knoxville.

Jeremiah, L. E., G. C. Smith and J. K. Hillers. 1970. Utilization of breed and traits determined from the live beef steer for prediction of marbling score. J. Anim. Sci. 31:1089.

Kirkpatrick, F. D. 1967. The use of certain traits in predicting retail trimmed high-priced cuts in beef carcasses. Unpublished master's thesis, New Mexico State University, Las Cruces.

LeVan, P. J., L. L. Wilson, J. L. Watkins, C. K. Grico, J. H. Ziegler and K. A. Barber. 1979. Retail lean, bone and fat distribution of Angus and Charolais steers slaughtered at similar stages of physiological maturity. J. Anim. Sci. 49:683.

Marlowe, T. J. and J. A. Gaines. 1958. The influence of age, sex and season of birth of calf and age of dam on preweaning growth rate and type score of beef calves. J. Anim. Sci. 17:706.

Marshall, D. M., R. R. Frahm and L. E. Walters. 1985. Comparisons among two-breed cross cow groups II. Feedlot and carcass performance of three-breed cross calves. J. Anim. Sci. 61:856.

Martin, E. L., D. C. Anderson and C. C. O'Mary. 1980. Carcass traits of and preweaning creep feeding effects on steers sired by Angus, Holstein, Simmental and Chianina bulls. J. Anim. Sci. 50:62.

Matthews, J. and James Bennett. 1962. Effect of preslaughter rate of gain upon tenderness and other carcass characteristics of beef. J. Anim. Sci. 27:738.

Nour, A. Y. M., M. L. Thonney, J. R. Stouffer and W. R. C. White, Jr. 1983. Changes in carcass weight and characteristics with increasing weight of large and small cattle. J. Anim. Sci. 57:1154.

O'Mary, C. C., E. L. Martin and D. C. Anderson. 1979. Production and carcass characteristics of Angus and Charolais X Angus steers. J. Anim. Sci. 48:239.

Peacock, F. M., A. Z. Palmer, J. W. Carpenter and M. Kogee. 1979. Breed and heterosis effect on carcass characteristics of Angus, Brahman and crossbred steers. J. Anim. Sci. 49:391.

Pierce, J. C., Jr. 1957. The influence of confirmation, finish and carcass weight on the percentage yield of wholesale and retail weight of beef. Tenth Annual Reciprocal Meat Conference. 10:119.

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.

SAS 1982. SAS User's Guide. Statistical Analysis System Institute, Inc., Cary, NC.

Scarth, R. D. 1973. Effects of breed and age classification of live weight and carcass traits of steers shown at International Quality Beef Show. J. Anim. Sci. 36:653.

Singh, H. I., R. L. Willham and R. C. DeBaca. 1970. Effect of certain factors on weaning weight of beef calves. J. Anim. Sci. 31:5.

Skelley, G. C., C. E. Thompson, D. L. Cross and L. W. Grimes. 1980. Carcass characteristics of Polled Hereford X Angus, Charolais X Angus, Simmental X Angus and Holstein X Angus steers finished on high silage diets. J. Anim. Sci. 51:822.

Slanger, W. D., M. J. Marchello, R. B. Danielson, C. N. Haugse, V. K. Johnson, A. S. Vidal, W. E. Dinusson and P. T. Berg. 1985. Muscle tenderness, other carcass traits and the effects of crossbreeding on these traits in beef cattle. J. Anim. Sci. 61:1402.

Tatum, J. D., G. C. Smith, B. W. Berry, C. E. Murphey, F. L. Williams and A. L. Carpenter. 1980. Carcass characteristics, time on feed and cooked beef palatability attributes. J. Anim. Sci. 50:833.

Tatum, J. D., G. C. Smith and Z. L. Carpenter. 1982. Interrelationship between marbling, subcutaneous fat thickness and cook beef palatability. J. Anim. Sci. 54:777.

Thackston, G. R. 1966. Comparison of three methods of evaluating carcasses of bulls, steers and heifers. Unpublished master's thesis, The University of Tennessee, Knoxville.

Thrift, F. A., S. R. Gallion and C. W. Allner. 1978. Breed of sire and dam comparisons for preweaning traits under commercial beef cattle conditions. J. Anim. Sci. 46:977.

Urick, J. J., B. W. Knapp, R. L. Hiner, O. F. Pahnish, J. S. Brinks and R. L. Blackwell. 1974. Results from crossing beef X beef and beef X Brown Swiss: Carcass quantity and quality traits. J. Anim. Sci. 39:292.

VITA

Charles William Grooms was born in Trenton, Tennessee, on June 9, 1938. He received his primary and secondary education in Gibson County, Tennessee. In 1957 he was graduated from Peabody High School in Trenton, Tennessee.

He attended The University of Tennessee at Martin and was graduated in 1962, with a Bachelor of Science degree in General Agriculture. While attending The University of Tennessee at Martin he was a member of the Alpha Gamma Rho fraternity.

In October of 1962 he accepted a position in the service department of The John Deere Company. While working for Deere, he lived in Memphis, Tennessee, Springfield, Missouri and Fairfield, Illinois.

On December 1, 1966, he accepted a position as Assistant County Agent in Obion County with the Tennessee Agricultural Extension Service. He is now Extension Agent in Obion County.

He entered Graduate School at The University of Tennessee, Knoxville on a part-time basis. He received the Master of Science degree with a major in Animal Science in 1987.

In June 1963, he married Judy Ray of Union City, Tennessee. They have one son, Christopher, born January 1970.