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THE EFFECT OF SELECTED VARIABLES ON CARCASS TRAITS OF BEEF

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee

Jon Michael Baker

June 1976

1286534

ACKNOWLEDGMENTS

The author hereby expresses appreciation to the University of Tennessee, Virginia Polytechnic Institute and State University, County 4-H and Vocational Agriculture Agents and Advisors, who worked so diligently in providing the youth of upper East Tennessee and Southwest Virginia the opportunity to participate in the Bristol Junior Steer Show.

The University of Tennessee staff members for their excellence in compiling the data for this study.

Dr. Haley Jamison, Major Professor and thesis advisor, for his sound and sincere advice with statistical analysis, data interpretation and manuscript review.

Dr. William R. Backus and Dr. Cecil Carter for their suggestions and review of the manuscript.

Mr. A. Hayden Brown, Graduate Assistant in the Department of Animal Science, for his assistance in the preparation and experimental analysis of the data and preparation of this manuscript.

Mr. Leland Anderson and Mr. Joe Pearson, Graduate Assistants in the Department of Animal Science, for their assistance in preparation of these data.

Dr. Webster Pendergrass, Vice President, Institute of Agriculture, The University of Tennessee, Dr. William D. Bishop, Dean, Agricultural Extension Service, The University of Tennessee, Supervisors, Jesse E. Francis and John B. Brower, Jr., and Sullivan County Extension Agents

and staff, J. W. McClain, Claude Prince, Martha Childress, Pat Whitaker, Hubert Lambert, Helen Stocking, Joyce Gaines, Ronald Keck, Maxie Tittle, Charlotte Burnette and Catherine Roberts for their granting educational leave and their support while doing this study.

The Department of Animal Science Secretarial Staff for their help in preparation of this study.

To Sullivan County 4-H'ers for their youthful enthusiasm.

To his parents, Carl and Evelyn Baker, for their encouragement and support.

To his wife, Rose, for her love and understanding while completing this study.

ABSTRACT

Seven hundred and twenty-two carcasses from Shorthorn, Angus, Hereford, Charolais and Other Breeds (predominately Simmental X Hereford or Angus) were utilized in an eight year (1968-75) study of breed and year variation in beef carcass yield traits. These steers were entered in the Bristol Junior Steer Show by 4-H and FFA members of East Tennessee and Southwest Virginia. The calves consisted of 15 Shorthorn, 284 Angus, 316 Hereford, 75 Charolais and 32 Other Breeds steers ranging from 360 to 575 days of age.

Data collected relative to performance traits (live weight, carcass weight and weight per day of age) indicated a significant ($P < .05$) advantage of Other Breeds and Charolais carcasses when compared to Shorthorn carcasses. There was no significant difference when Other Breeds, Charolais, or Shorthorn were compared to Hereford and Angus. Shorthorn cattle performed lowest in these traits.

Angus cattle had the highest mean carcass grade of 12.50 or Low Choice. Other Breeds followed with a 12.10 or Low Choice. Hereford steer carcasses were significantly ($P < .05$) lower in quality grade than any other of the breed groups.

The mean carcass quality grade was 11.88 or High Good for all years and breeds. Carcasses of 1971 cattle were significantly ($P < .05$) higher with a score of 12.92 or approaching Average Choice.

Angus steer carcasses had an average marbling score of 57.10 (Modest Minus) which was significantly ($P < .05$) higher than the Other

Breed groups. Hereford and Charolais steer carcasses had the lowest marbling scores.

Although a correlation of 0.87 existed between carcass quality grade and USDA marbling score, the year 1970 had the highest significant ($P < .05$) marbling score.

Steers measured an average of 0.44 inches of external fat thickness over the twelfth rib. Charolais fat thickness was significantly ($P < .05$) smaller than the British Breed carcasses. Other Breeds were intermediate in measurements. Cattle slaughtered in 1971, 1972 and 1975 had significantly ($P < .05$) less external fat thickness.

A significant ($P < .05$) negative correlation of 0.87 existed between carcass fat thickness and percent retail cuts.

Ribeye area studies showed that Charolais and Other Breeds had a significant ($P < .05$) advantage. Shorthorn steers had significantly ($P < .05$) smaller ribeye area. Year had no significant ($P < .05$) effect.

The estimated overall mean for percent retail cuts was 50.35. Other Breeds and Charolais steers yielded the highest significant ($P < .05$) percent. Shorthorn steers were predicted ($P < .05$) to yield the lowest.

Live grade with respect to breed and year was not significant. The overall mean live grade was 12.67 compared to an overall mean carcass grade of 11.88 almost one-third higher than actual.

TABLE OF CONTENTS

CHAPTER		PAGE
I.	INTRODUCTION.	1
II.	REVIEW OF LITERATURE.	4
	Performance Traits.	4
	Factors relating to preweaning performance.	4
	Breed effects on preweaning performance	5
	Factors relating to postweaning performance	6
	Carcass Quality Traits.	8
	Conformation or type.	8
	Marbling.	9
	Composite USDA quality grade.	10
	Retail Yield Traits	11
	Fat thickness	11
	Carcass weight.	13
	Ribeye area	14
	Percent lean cuts	14
III.	EXPERIMENTAL PROCEDURE.	16
	Source of Information	16
	Packing Plant Data.	17
	Method of Analysis.	17
IV.	RESULTS AND DISCUSSION.	19
	Estimates of Performance.	19
	Hot carcass weight.	19

CHAPTER PAGE

IV. (continued)

Carcass weight per day of age 24

Carcass Quality Traits. 25

USDA quality grade. 25

USDA marbling score 28

Estimates of Carcass Retail Yield 28

Fat thickness 28

Ribeye area 30

Predicted percent retail cuts 32

Estimates of Live Performance Traits. 33

Live weight 33

Live grade. 33

V. SUMMARY 37

LITERATURE CITED. 39

VITA. 43

LIST OF TABLES

TABLE		PAGE
1.	Means and Standard Deviations of Variables Selected.	20
2.	Coefficients of Correlation (r) Between All Variables. . . .	21
3.	Least-Squares Means and Coefficients of Regression for the Effect of Breed, Year and Age-in-Days on Carcass Performance Traits	22
4.	Analysis of Variance of Carcass Weight and Carcass Weight Per Day of Age.	23
5.	Least-Squares Means and Coefficients of Regression for the Effect of Breed, Year and Age-in-Days on Carcass Quality Traits	26
6.	Analysis of Variance of Carcass Quality Traits	27
7.	Least-Squares Means and Coefficients of Regression for the Effect of Breed, Year and Age-in-Days on Carcass Retail Yield Traits.	29
8.	Analysis of Variance of Carcass Retail Yield Traits.	31
9.	Least-Squares Means and Coefficients of Regression for the Effect of Breed, Year and Age-in-Days on Live Performance Traits	34
10.	Analysis of Variance on Live Performance Traits.	35

CHAPTER I

INTRODUCTION

Beef cattle producers have to recognize the importance of beef cattle carcasses. These traits, since the early part of the twentieth century, are important tools in their industry from which progress can be made. Never in the history of the United States and the future of the cattle industry has this been so important.

One means that beef cattle producers have is to be able to evaluate the type of cattle they produce through various carcass shows. Many of these carcass shows have been associated with 4-H and FFA live steer shows from which these producers furnish youngsters steers to exhibit in area and state contests. The Bristol Junior Steer and Carcass Show is one such area show from which this study is made.

Carcass yield and quality are important to the United States beef cattleman as the quest for grain and grain based foodstuffs increases. It is essential that today's cattle maximizes the use of these feeds to compete in the current markets. If not, the reduction of grain-fed cattle seems inevitable.

The Bristol Junior Steer Show and Sale has just completed its thirtieth year. It has provided hundreds of 4-H and FFA members the opportunity for achievement and growth through a demanding project.

In 1944, Mr. O. L. Darter, President of the Bristol Chamber of Commerce, envisioned a great project in which youngsters in upper East Tennessee and Southwest Virginia could participate. He recognized

the importance youth in agriculture made to these two areas, as well as the resulting business area merchants received from these livestock areas.

In 1960, a carcass show was incorporated in the Roanoke Show by Arden Huff, Virginia 4-H Livestock Specialist, with the cooperation of Valley Dale Packers. The plans were to incorporate the carcass show with the Bristol Show the next year. Although the idea took some education of the sponsoring agencies on both sides, the show was held in 1960, but the carcasses were not allowed to be ribbed. However, in 1961, the carcass show idea was adopted in the Bristol Show making it one of the earliest of its kind in the United States.

The purpose was to understand more clearly the end results of the steer feeding project. Plus it was thought that the breeders, 4-H'ers, parents and extension agents could see the direction in which cattle must move to satisfy the customers' demands for high quality beef with little waste fat.

Results soon supported the carcass show. It was found that the live placings did not always correspond with carcass placings. Superior carcasses were many times found from cattle placing in the middle of the live placings and occasionally in the lower part of the live placings. The results were studied and evaluations took on a new light.

The type of consumer acceptable cattle have changed with more emphasis in larger, growthier cattle having less waste and fat. While the size of these cattle may be in doubt, the data received from these and other shows of this type have and will continue to have a direct

impact on the importance of high quality cattle with a minimum of waste and fat. Data supports that these cattle are much more efficient users of energy.

The figures that were compiled for each calf compared carcass weight, carcass grade, carcass weight per day of age, ribeye area, fat thickness, kidney and pelvic fat, percent boneless trimmed retail cuts, marbling score and carcass value index. This data corresponds with the qualities acceptable for both producers and consumer in supplying a quality carcass.

In 1969, the first of the exotic breed crosses participated in the Bristol Steer Show. Their numbers have been increasing rapidly since then until they reached a plateau in 1973 and 1974. These cattle now represent approximately one-third of this show yearly.

Therefore, the objectives of the study were:

1. To study breed differencies in carcass yield and quality traits
2. To summarize data from seven previous carcass shows and make this information available to interested individuals.

CHAPTER II

REVIEW OF LITERATURE

Numerous questions have been raised and answered through research of carcass data from studies including those of junior exhibits. Previously all data reflected findings of our British breeds and their crosses. Data substantiates that each of these breeds and their crosses has some positive merits (Fortune, 1973).

In recent years, the influx of crosses involving so-called exotics has given rise to a whole new realm of studies since according to Winfree (1973) performance and/or carcass characteristics of various crosses involving exotic breeds is limited.

Related literature will be reviewed under: performance traits, carcass quality traits, and carcass yield traits.

I. PERFORMANCE TRAITS

Factors Relating to Preweaning Performance

The age of dam affects the weaning weight of calves. Singh (1970) reported that cows from 8 to 11 years old tend to produce the heaviest calves while the lightest calves come from three-year-old cows. Similar findings were reported by Kress (1972).

Work reported by Austin (1968) showed that age of dam had a highly significant ($P < .01$) effect on weaning weight. He found that cow performance was lowest at 2, 3, 4 and 12 years of age and higher in other productive years.

In a different grouping of ages Dawson et al. (1947) found that bull and heifer calves were heavier from cows up to six years of age.

Burris and Blunn (1952), in a study of 502 calves found that birth weight of calves from two and three-year-olds averaged 4.7 pounds less for Angus, 4.9 pounds for Hereford, and 6.0 pounds for Shorthorn than from older cows of the same breed. The highest birth weights were from cows of nine and ten years of age.

In contrast, Marlow (1958) found that the birth weight of calves from Angus and Hereford cows was highest from two to seven years of age and decreased thereafter.

In relation to month and/or season of birth, Sellers (1970) found that bull and heifer calves born in the winter and spring seasons weaned heavier than those born in the summer months.

Barker (1964) states that calves born in January, February, and March performed better than those born in other months with April, May and December being the next best months.

Singh (1973) stated that month of birth had no significant ($P < .05$) influence on preweaning performance.

In regard to calves' sex, Brinks (1961) reported that bull calves weighed 7 percent more than heifer calves at birth. Koch (1973) stated that birth weight and preweaning daily gain was 7 to 8 percent higher in bulls than in heifers. Barker (1964) found that sex of calf had a significant ($P < .01$) effect on average daily gain.

Breed Effects on Preweaning Performance

In a study by Sellers (1970) involving Hereford and Angus calves,

it was found that Angus calves, due to the milking ability of the dams, produced heavier weaning weights than Hereford calves. However, Sellers further states while this may be so, Hereford calves if put on a proper plane of nutrition "have a greater growth potential than Angus calves."

Klosterman, Cahill, and Parker (1968) using Hereford, Charolais, and Hereford and Charolais crosses found that while the Charolais and Charolais crosses raised birth weight significantly, the Charolais cows tended to wean smaller percentages of calves than Herefords when bred straight, but higher percentages when crossed with Herefords. Cundiff (1970) stated that crossbreeding benefits fertility, maternal ability, as well as growth rate.

Chapman in 1971 conducting a study in Georgia with Hereford, Charolais, Simmental, and Santa Gertrudis X Hereford found that Hereford calves tended to be lighter than crossbred calves.

Jamison (1970) found that Angus, Hereford, and Shorthorn calves had an average weaning weight of 449, 420, 441 pounds, respectively; while Angus X Hereford, Shorthorn X Hereford, and Angus X Shorthorn calves weaned at 465, 470, and 465 pounds, respectively. Thus, exemplifying the statement Cundiff (1970) that hybrid vigor in cattle is a well established and usable tool in beef cattle performance traits.

Factors Relating to Postweaning Performance

Koch et al. (1973), in a 3,462 head study considering preweaning and postweaning growth of Hereford bulls and heifers found that heritability for postweaning daily gain was much larger for heifers

than bulls. He also found that heavier (fatter) heifers at weaning may have less stimulus to eat on pasture, using stored fat, than thinner heifers. Conversely, fatter bulls at weaning gained more in feedlot compared with thin bulls.

Christian et al. (1965) found that the average daily gain during the latter stages of postweaning feeding and the portion of trimmed valuable cuts in the carcass were found to increase significantly with ($P < .05$) increased weaning weight.

With relation to other carcass characteristics, Guenther (1965) found that lean deposition reached its maximum rate during the early part of the feedlot list and diminished as the animals approached maturity. At 10.8 months of age, calves had 83 percent of the total carcass lean at slaughter. Fat was deposited after lean subsided.

In a test using 51 Angus and 53 Hereford steers conducted by Butler et al. (1962), it was found that Hereford steers were more efficient on the same feed with 952 pounds of feed per 100 lbs. of gain.

While Butler et al. (1962) concluded feed efficiency reflected a better average daily gain for Herefords with a 2.37 gain compared to 2.25 for Angus, he also pointed out that while the chronological ages were very near the same, the physiological ages of the Hereford and Angus were not, with Herefords being less mature and having less marbling and fat thickness at slaughter.

While the deposition of fat appears to lower feed efficiency, Backus (1968) concluded that acceptable beef may be produced with little waste fat. But as fat deposition increased so did the desirable carcass traits of marbling score, carcass conformation, and carcass grade;

even though tenderness, juiciness, and flavor were not enhanced by increased fatness.

Crossbreeding, in a study conducted by the University of Tennessee at the Middle Tennessee Experiment Station indicated that Hereford X Charolais were more efficient in feed utilization than straightbred Hereford calves (Jamison, 1970).

II. CARCASS QUALITY TRAITS

Conformation or Type

Brown (1975) stated that conformation or type is the combination of characteristics that makes an animal useful for a specific purpose. He further states that type may be referred to as general appearance.

Bray (1963) defines this vague-visual term as the form or outline of a carcass relating primarily to its shape and volume of muscle excluding the fat.

Cole et al. (1963), Jeremiah et al. (1970), and Butler (1962) partially contradict themselves and the statements of Brown and Bray in studies of Angus cattle. Each stated that Angus cattle received higher type or conformation grades while each of these studies further reported that the percent of retail cuts was lower in Angus cattle due to more fat present and less red meat than their counterparts.

Backus (1968) states that carcass conformation was significantly ($P < .05$) affected by fat thickness with the fatter carcasses tending to receive higher carcass conformation grades ($r = 0.62$).

Pierce (1957) even went so far as to state that there was no better way to predict yields than the single objective measure of conformation.

Abraham (1968) reported that conformation was not significantly related to the yield of boneless steak and roast meat. He found that fat thickness was the most important variable in multiple regression equations predicting percent boneless steak and roast meat.

Marbling

Intramuscular fat, properly referred to as marbling (Fortune, 1973), as the major factor used to determine final carcass grade, may be over-emphasized in the current grading system (Winfree, 1973).

Bray (1963) states that if one assumes that marbling is an important quality characteristic, one must then consider the adequacy of the methods available for its measurements.

Marbling score based upon photographic standards has been used, yet those who use these standards find considerable variation in their interpretation. Studies relating the importance of marbling to meat quality require more precise evaluations than offered in these subjective scores.

A study conducted on 852 Hereford, 160 Shorthorn and 283 crossbred steers by Jeremiah et al. (1970) concluded that while there was very little difference in fat thickness between Hereford, Angus, and Shorthorn steers, marbling scores were highest for Angus, followed by Shorthorn and then Herefords. He found that the heavier the steers, the higher the marbling score. Carcasses from crossbreds were found to be intermediate in most carcass traits.

Any number of studies report that Angus cattle marble better than other breeds as pointed out by Cole et al. (1963), Scarth et al. (1973), Gaines et al. (1967), and Butler et al. (1962).

In a study involving 736 head of Angus, Hereford, Shorthorn, and primarily Charolais crossbreeds exhibited in the Knoxville finished calf show, Fortune (1973) found that Angus cattle had significantly higher ($P < .01$) USDA marbling scores than the other breeds. The Angus were followed by Shorthorn, Hereford, with primarily Charolais crosses having the lowest marbling score.

Cundiff (1970) in a study with Charolais crossed with British Breeds found that Charolais did grade two-thirds of a grade lower than Angus and Shorthorn and more than one-third lower than Hereford. However, when tests for tenderness were conducted, Charolais cross carcass lean was found to be as tender.

Cahill et al. (1962) concluded that straightbred Charolais had a lower marbling score, but the difference in tenderness was greater within breeds than the differences between breeds when put on a comparative basis.

Composite USDA Quality Grade

Scarth (1973) studying Angus, Hereford, and Shorthorn steers shown at the International Beef Show 1956 through 1967, found that Angus cattle graded the highest followed by Shorthorn and then Herefords. Scarth concluded that the two traits most responsible for this were ribeye area and marbling score with the least squares means for marbling being 8.0 for Angus, 7.4 for Shorthorn and 6.8 for Hereford.

Butler et al. (1962) found similar results in the British Breeds with marbling being the primary reason for the higher grade.

Backus (1968) found both fat thickness and marbling score to affect quality grade. He pointed out that conformation grade was

affected by fat thickness and that fatter cattle had a firmer, brighter colored muscle, thus concluding that marbling score, while having a great influence on carcass grade, was not the conclusive factor in its determination.

Cole et al. (1963) concluded that while Hereford carcasses had longer loins and legs with plumper rounds, the externally fatter Angus cattle graded higher due mainly to more marbling.

Jeremiah et al. (1970) found weight and fat covering to be an important consideration in steers grading choice. He states in his study that one can be confident that calves will grade choice if they are Angus weighing 340 kg and possess 2.5 mm of fat cover, or if they are Herefords weighing 453 kg and having 12.7 mm of fat or Crossbred or Shorthorns weighing 415 kg with 12.7 mm of fat.

Fortune (1973) in a study with 736 carcasses from Shorthorn, Angus, Hereford, and Charolais cross, found Angus carcasses graded an average of choice, followed by Shorthorn with a grade of Good+, followed by Hereford carcasses, with the lowest average carcass quality grade being those of crossbreds. However, there was no significant ($P < .05$) difference of the latter two compared to Shorthorn, with both the Herefords and Crossbreds grading Good+.

III. RETAIL YIELD TRAITS

Fat Thickness

Winfree (1973) stated that differences in estimates of carcass retail yield were associated with differences in carcass fatness. He states that fatter calves yielded smaller percentages of retail cuts,

thus supporting the statement of Murphy et al. (1960) of the negative correlation between fat thickness at the twelfth rib and percent boneless retail cuts.

Fortune (1973) found a significant ($P < .01$) negative correlation ($r = 0.87$) between fat thickness and percent retail cuts. Backus (1968) and Thackston (1966) also reported negative correlation between fat thickness and carcass yield.

Epley et al. (1970) summed up most studies stating that fat thickness with carcass weight was the single most valuable predictor of retail cuts.

Winfree (1973) also states that straightbred Hereford calves were fatter ($P < .01$) than F_1 calves of Main Anjou X Hereford, Simmental X Hereford, Limousin X Hereford, and Charolais X Hereford.

Scarth (1973) found on a study involving 1,419 Angus, 627 Herefords and 457 Shorthorns, over a twelve year period that Herefords had the smallest figure for fat thickness over the twelfth rib followed by Shorthorn and Angus, respectively.

Butler et al. (1962) in a test with Hereford and Angus steers found Herefords to exhibit less fat and have a higher percentage of retail cuts than the Angus cattle.

Cahill et al. (1962) concluded that carcasses from Charolais cattle with less fat over the ribeye cut more boneless trimmed retail cuts.

Abraham et al. (1968) contradicts other research stating that Charolais fat thickness seemed to have little effect on yield of boneless steak and roast. While the negative relationship existed for fat

thickness and percent of boneless retail cuts, there was a positive relationship between weight, marbling score, and fat thickness.

Jeremiah et al. (1970) concluded essentially the same, reporting that heavier steers when classed according to breed have higher marbling scores. However, he found that within categorized weights there was very little difference in fat thickness between Hereford, Angus, and Shorthorn, but retail cut percent was lowest in Shorthorn due to smallest ribeye area at the twelfth rib and the highest percent kidney, heart, and pelvic fat.

Carcass Weight

Allen et al. (1968) found that carcass weight had a significant ($P < .01$) effect upon yields of retail cuts and fat trim. He also stated that carcass weight showed a low negative relationship to percent measurements of muscling.

Jeremiah et al. (1970) stated that there was a direct positive relationship between heavier carcass weight and marbling score.

Abraham et al. (1968) in a study concerning the relationship of carcass weight, conformation, and carcass measurements in predicting beef carcass cutability found it was not weight but the fat thickness variable in a multiple regression equation that was most important in predicting cutability.

Thackston (1966) in comparing the overall means of predicting values of the USDA Cutability Formulae, Wisconsin Method, and the Tennessee Simplified Method, found positive ($P < .01$ to $P < .05$) relationship of carcass weight and actual percent retail yield in all formulae.

Ribeye Area

Fortune (1973), in a study of 736 junior steer calves, found that carcasses from crossbred steers averaged 12.57 square inches (REA) and were more desirable ($P < .05$) than the British Breeds with respect to (REA).

Cahill et al. (1962), in a study of Charolais X Hereford and Hereford, found that while the marbling score was higher for straightbred Herefords, Charolais carcasses possessed a larger ribeye area.

Cundiff (1970) found essentially the same results in a study involving Charolais cross carcasses with a comparative number of Angus, Shorthorns, and Herefords.

Cole et al. (1963), in comparing British, Zebu, and dairy cattle, found that Angus carcasses graded higher due to more marbling in the (REA), but Hereford carcasses had longer loins.

Butler et al. (1962) found in a comparison of Angus and Hereford steers that Angus graded two-thirds of a grade better in marbling and graded Average Choice compared to High Good for Herefords.

Scarth et al. (1973), in a study of the International Beef Show, found that Angus had the largest ribeye area and Shorthorn had the smallest. Angus had 75.5 cm^2, Hereford 74.3 cm^2, and Shorthorn 68.3 cm^2.

The least square means for marbling scores were 8.0, 7.4, and 6.8 for Angus, Shorthorn and Hereford, respectively.

Percent Lean Cuts

Butler et al. (1962) found when comparing percent lean cuts between Hereford and Angus steers on an 186 day feed test that Hereford

steers with a 46.29 percent yield had a decided advantage over Angus steers with 44.95 percent.

Fortune (1973) on a test with 736 Hereford, Angus, Shorthorn and crossbred steers reported that crossbred carcasses were estimated to yield a significantly ($P < .05$) higher percent retail cuts than Hereford or Shorthorn carcasses. The three British Breeds were not different with respect to predicted percent retail cuts. He did find that Angus carcasses were superior in retail cuts to carcasses from Shorthorn and Hereford steers, but the difference was not significant ($P < .05$).

Cundiff (1970) stated that Charolais crosses were superior in their portion of lean to fat when compared to cattle of the British Breed.

Cahill (1962) when comparing Hereford X Charolais and Hereford carcasses found that Charolais carcasses cut more boneless trimmed retail cuts.

CHAPTER III

EXPERIMENTAL PROCEDURE

I. SOURCE OF INFORMATION

Seven hundred twenty-two steers and their carcasses were included in the eight year study. The steers were entries in the Bristol Junior Steer Show and Sale during 1968-75. Five primary breed divisions were identified. These divisions were Shorthorn, Angus, Hereford, Charolais, and Other Breeds. During the eight year period, 15 Shorthorn, 284 Angus, 316 Hereford, 75 Charolais and 32 Other Breeds were evaluated. Steers entered in the show ranged from 360 to 575 days of age. All calves entered in the show were fitted and shown by 4-H and FFA members. Only those weighing at least 800 pounds and grading at least Average Good were eligible to be shown. The calves were entered, tagged, weighed, and graded on Wednesday and shown on Thursday. The calves were sold locally and slaughtered by Valleydale Packer, Incorporated, Bristol, Virginia. This enabled all of the carcasses to be evaluated at a central location by the University of Tennessee Extension Service and the Virginia Tech Extension Service.

The steers were slaughtered on Friday after the show. They were evaluated Monday following the show. Each steer was identified with a metal ear tag which remained with the carcass.

Animals involved in the study were representative of different types of management practices and were apparently representative of

each breed. Animals involved came from 4-H and FFA members in twelve southwest Virginia counties and six upper East Tennessee counties.

II. PACKING PLANT DATA

Individual hot carcass weights were recorded after dressing and before shrouding. The carcasses were chilled for about 24 hours at approximately 37°F. After chilling, the left side was ribbed by packing plant personnel between the twelfth and thirteenth ribs, exposing a cross-section of the l. dorsi muscle. The muscle and the surrounding tissue was measured to the nearest .1 square inch with a plastic overlay grid and recorded in square inches (REA). Fat thickness was measured over the l. dorsi muscle between the twelfth and thirteenth rib three-fourths distal to the chine. Carcass quality estimates and estimated kidney fat were obtained by a USDA grader.

Estimates of retail yield were made using the USDA beef carcass yield grade funds. Estimated Yield Grades were computed using BF thickness, Hot Carcass Weight, REA and Percent Kidney, Heart, and Pelvic Fat.

III. 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, year and age-in-days. If significant main effects were found, the means were subjected to Duncan's (1955) Multiple Range Test for separation. Simple correlation

coefficients were computed on live animal observations and measures of carcass composition.

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

$$y = u + Br_i + Yr_i + b_1 (A-\bar{A})$$

where

Y = dependent variables of hot carcass weight; carcass weight per day of age; USDA quality grade; USDA marbling score; carcass fat thickness; ribeye area; percent retail cuts and yield grade

u = mean of ith carcass trait

Br_i = effects of i breed

Yr_i = effects of i year

b_1 = coefficient of regression of the ith carcass trait on age

A = age in days at slaughter

CHAPTER IV

RESULTS AND DISCUSSION

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

Overall means and standard deviations of carcass data used in this study are reported in Table 1. Simple coefficients (r) of correlation between all carcass data were calculated and are reported in Table 2.

I. ESTIMATES OF PERFORMANCE

Hot Carcass Weight

Hot carcass weight and carcass weight per day of age are valid estimates of live performance of animals similar in age. In this study, they are reported on an age constant basis to remove those differences that occurred due to age.

Overall mean hot carcass weight was 550.61 pounds. Breed group means were 509.00, 534.64, 536.98, 588.52 and 583.89 pounds for Shorthorn, Angus, Hereford, Charolais and Other Breeds, respectively (Table 3). A least-square analysis of variance indicated that breed means, with respect to hot carcass weight, were significantly different ($P < .001$) (Table 4). A Duncan's Multiple Range Test revealed that Shorthorn steer carcasses were significantly lighter ($P < .05$) than

TABLE 1

MEANS AND STANDARD DEVIATIONS OF VARIABLES SELECTED

Variable	Mean	Standard Deviation
Number in sample	722	--
Hot carcass weight (lbs.)	550.61	75.47
Hot carcass weight per day of age	1.24	.16
USDA carcass quality grade[1]	11.53	1.53
USDA marbling score[2]	50.52	12.41
Carcass fat thickness (in.)	.44	.19
Area of l. dorsi (sq. in.)	11.21	1.40
Percent kidney fat	2.99	.67
Percent retail cuts	50.74	1.68
USDA yield grade[3]	2.69	.73
Live weight	918.98	108.50
Live grade	12.65	4.47
Age in days	447.38	44.21

[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.

TABLE 2

COEFFICIENTS OF CORRELATION (r) BETWEEN ALL VARIABLES

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Hot carcass weight	1.0000	.7345	.3256	.2657	.3516	.5600	.2639	-.2977	.3025	.9508	.0899	.4129
(2) Hot carcass wt./ day of age		1.0000	.1445	.0906	.2054	.4700	.2048	-.1676	.1734	.6608	.0975	-.2942
(3) USDA carcass quality grade			1.0000	.8508	.4465	.1444	.3205	-.3811	.3844	.2601	.0790	.2754
(4) USDA marbling score				1.0000	.4761	.1070	.3626	-.4053	.4067	.2125	.07313	.256174
(5) Carcass fat thickness (in.)					1.0000	-.0528	.3306	-.8677	.8697	.2961	.1162	.2360
(6) Area of l. dorsi (sq. in.)						1.0000	.1368	.3851	-.3836	.5553	.0060	.2033
(7) Percent kidney fat							1.0000	-.4105	.4067	.2173	.0105	.0994
(8) Percent retail cuts								1.0000	-.9963	-.2634	-.1085	-.2093
(9) USDA yield grade									1.0000	.2665	.1101	.2081
(10) Live weight										1.0000	.0830	.4459
(11) Live grade											1.0000	.0131
(12) Age in days												1.0000

TABLE 3

LEAST-SQUARES MEANS[1] AND COEFFICIENTS OF REGRESSION[b] FOR THE EFFECT OF BREED, YEAR AND AGE-IN-DAYS ON CARCASS PERFORMANCE TRAITS

Breed	Number in Sample	Hot Carcass Weight lb.	Carcass Wt./Day of Age lb.
Overall	722	550.61	1.24
Shorthorn	15	509.00[b]	1.14[b]
Angus	284	534.64[a,b]	1.20[a,b]
Hereford	316	536.98[a,b]	1.21[a,b]
Charolais	75	588.52[a]	1.33[a]
Other Breeds	32	583.89[a]	1.31[a]
1968	77	542.58[b]	1.23[a,b]
1969	73	531.78[b]	1.21[b]
1970	103	531.57[b]	1.20[b]
1971	102	537.19[b]	1.21[b]
1972	105	542.02[b]	1.26[a,b]
1973	95	564.22[a]	1.27[a]
1974	84	578.83[a]	1.30[a]
1975	83	559.50[a]	1.23[a,b]
Age-in-days[b][1]		.70	-.001

[1]Means in the same column bearing similar superscripts are not significantly different ($P < .05$).

TABLE 4

ANALYSIS OF VARIANCE OF CARCASS WEIGHT AND CARCASS WEIGHT PER DAY OF AGE

	d.f.	Mean Squares	
		Carcass Weight	Carcass Weight Per Day of Age
Breed	4	51,203.40***	.30***
Year	7	24,268.30***	.11***
Age-in-days	1	640,995.50***	1.48***
Residual	707	4,030.50	0.02

***P < .001.

carcasses from Charolais and Other Breeds. Angus and Hereford steer carcasses were intermediate in weight.

Carcasses from steers slaughtered in years 1973-1975 were significantly ($P < .05$) heavier than carcasses from steers slaughtered during any other years. Most weight increase could be attributed to a minimum weight to show increase from 750 to 800 pounds. Also, a greater proportion of the cattle were exotic crosses and a decline was seen in the Shorthorn breed, the lightest weight cattle in the study. Linear regression of age-in-days on hot carcass weight resulted in a significant ($P < .01$) regression coefficient of $b = 0.70$.

These findings paralleled the Fortune (1973) study with respect to weight increase due to the influence of exotic crossbreeds. However, Fortune found that carcasses from Shorthorn cattle were not significantly different when compared to Angus and Hereford in hot carcass weights. Fortune's data shows Angus steers had the lightest carcasses, however, they were not significantly different when compared to the Hereford and Shorthorn carcasses.

Carcass Weight Per Day of Age

Carcass weight per day of age ranged from 1.14 to 1.33 pounds for the Shorthorn and Charolais steers, respectively. A least-squares analysis of variance (Table 4) indicated a significant ($P < .001$) difference in carcass weight per day of age for both breed and year. These data indicated identical trends in hot carcass weight and carcass weight per day of age when breed and year effects were studied.

The Fortune (1973) study again parallels this data with respect to the crossbreeds weight per day of age, however, as expected the carcass weight per day of age was lowest for Angus rather than the Shorthorn.

II. CARCASS QUALITY TRAITS

USDA Quality Grade

Data reported in Table 5 illustrates that Angus carcasses had a mean carcass grade of 12.50, or Low Choice. This mean was the highest significant ($P < .05$) average carcass grade of the five breed groups. Other Breeds (predominately Simmental X Hereford or Angus) ranked next with an average carcass quality grade of 12.10 or Low Choice. A significant ($P < .05$) difference existed between these two breed groups. Next in descending order were Shorthorn, Charolais and Herefords. Hereford steer carcasses were significantly ($P < .05$) lower in quality grade than any of the other breed groups.

Jeremiah (1970), Cole et al. (1963), Scarth et al. (1960), Gaines et al. (1967), Butler et al. (1962), and Fortune (1973) all found that Angus cattle had a higher carcass grade when compared to the other breeds and their crosses. This difference is associated with the ability of Angus cattle to possess a higher degree of marbling.

Least squares analysis of variance (Table 6) shows that the year differences for carcass quality traits were significant ($P < .05$). These data also show that cattle slaughtered in 1971 had a higher significant ($P < .05$) average carcass quality grade with a score of 12.92 or approaching Average Choice. However, the same cattle did not

TABLE 5

LEAST-SQUARES MEANS[1] AND COEFFICIENTS OF REGRESSION[b] FOR THE EFFECT OF BREED, YEAR AND AGE-IN-DAYS ON CARCASS QUALITY TRAITS

Breed	Number in Sample	USDA[2] Carcass Quality Grade	USDA[3] Marbling Score
Overall	722	11.88	50.56
Shorthorn	15	$11.82^{b,c}$	51.30^{a}
Angus	284	12.50^{a}	57.10^{b}
Hereford	316	11.39^{d}	47.74^{b}
Charolais	75	$11.59^{c,d}$	46.01^{c}
Other Breeds[4]	32	12.10^{b}	50.65^{c}
1968	77	12.12^{b}	52.47^{b}
1969	73	$11.87^{b,c}$	$50.24^{b,c}$
1970	103	12.13^{b}	55.80^{a}
1971	102	12.92^{a}	$50.05^{b,c}$
1972	105	12.05^{b}	$50.36^{b,c}$
1973	95	$11.78^{b,c}$	47.28^{c}
1974	84	11.52^{c}	48.81^{c}
1975	83	11.64^{c}	$49.46^{b,c}$
Age-in-days[b1]		.009	.065

[1]Means in the same column with similar superscripts are not significantly different ($P < .05$).

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

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

[4]Primarily Simmental cross on Angus and Hereford.

TABLE 6

ANALYSIS OF VARIANCE OF CARCASS QUALITY TRAITS

Source	d.f.	Mean Squares	
		USDA Quality Grade	USDA Marbling Score
Breed	4	46.30***	3632.40***
Year	7	3.80*	612.10***
Age-in-Days	1	104.04***	5569.90***
Residual	705	1.90	114.60

***P < .001.

*P < .05.

have the highest average marbling score of the years studied, which indicates that they were superior in conformation or younger than their counterparts. Mean carcass quality grade was the lowest in 1971 with 11.52 or High Good.

USDA Marbling Score

Angus steer carcasses had an average marbling score of 57.10 (Modest Minus) which was significantly ($P < .05$) higher than those of the other breed groups. Hereford and Charolais steer carcasses had the lowest mean marbling score. A significantly ($P < .05$) positive correlation of 0.87 existed between carcass quality grade and USDA marbling score.

The higher significant ($P < .05$) mean for USDA marbling score existed for the year 1970 with a 55.80 or Small (+). The average USDA marbling score was lowest ($P < .05$) in 1973 with 47.28 or Small (-).

III. ESTIMATES OF CARCASS RETAIL YIELD

Fat Thickness

A least-square analysis of variance indicates that breed and year were both significant sources of variation in external fat thickness. Overall fat thickness was 0.44 inches as measured over the l. dorsi muscle at the 12th rib. These data indicate that Charolais steers exhibited the smallest significant ($P < .05$) external fat thickness. There was no significant difference between the fat thickness in Shorthorn, Angus, and Hereford steers (Table 7). Other Breed steers had external fat thickness significantly ($P < .05$) greater than the Charolais but significantly ($P < .05$) smaller than the three aforementioned

TABLE 7

LEAST-SQUARES MEANS[1] AND COEFFICIENTS OF REGRESSION[b] FOR THE EFFECT OF BREED, YEAR AND AGE-IN-DAYS ON CARCASS RETAIL YIELD TRAITS

Breed	Number in Sample	Fat Thickness (in.)	REA (sq. in.)	Percent Retail Cuts	Yield Grade
Overall	722	.44	10.73	50.74	2.69
Shorthorn	15	.45[a]	10.59[c]	49.95[c]	3.04[a]
Angus	284	.49[a]	10.73[b]	50.59[a,b]	2.76[a,b]
Hereford	316	.48[a]	10.69[b]	50.40[b]	2.83[a]
Charolais	75	.34[c]	10.87[a]	51.91[a]	2.45[b]
Other Breeds	32	.43[b]	10.85[a]	50.85[a]	2.64[b]
1968	77	.49[a]	10.71	50.19[c]	2.91[a]
1969	73	.51[a]	10.68	50.27[c]	2.89[a]
1970	103	.46[a]	10.71	50.52[c]	2.76[a]
1971	102	.40[b]	10.75	51.07[b]	2.55[b]
1972	105	.41[b]	10.77	51.34[a]	2.43[c]
1973	95	.46[a]	10.69	50.45[c]	2.83[a]
1974	85	.48[a]	10.79	51.04[b]	2.57[b]
1975	83	.39[b]	10.74	51.04[b]	2.57[b]
Age-in-days[b][1]		.0009	.0006	.008	.034

[1]Means in the same column with common superscripts are not significantly different ($P < .05$).

British Breeds. One possibility is the fact that the Charolais cattle are much later maturing or physiologically younger.

Those cattle slaughtered during the years 1971, 1972, and 1975 had significantly ($P < .05$) less external fat thickness than cattle in any of the other years studied.

The research data (Table 8), reported on an age constant basis, shows regression of age on carcass fat thickness to be significant ($P < .001$) ($b = 0.0009$). A significant ($P < .05$) correlation $r = -0.87$ existed between carcass fat thickness and percent retail cuts.

Research findings reported by Backus (1968), Thackston (1966), Winfree (1973), Murphy et al. (1960) and Fortune (1973) seem to substantiate the negative correlation between fat thickness and the percent retail cuts.

Cahill et al. (1962) found Charolais cattle to have less external fat and a larger percentage of retail cuts.

Jeremiah et al. (1970) stated that there was no significant difference between Hereford, Angus and Shorthorn steers with respect to fat thickness.

Fortune (1973) found no variation in external fat thickness due to the effect of year.

Ribeye Area

These data show that Charolais and Other Breed groups had significantly ($P < .05$) larger (REA) when compared to other breed groups. Fortune (1973) stated that Charolais crossbreed steers were more desirable with respect to (REA). Observations by Cahill et al. (1962) and Cundiff (1970) support these findings.

TABLE 8

ANALYSIS OF VARIANCE OF CARCASS RETAIL YIELD TRAITS

Source	d.f.	Mean Squares			
		Fat Thickness	REA	Percent Retail Cuts	Yield Grade
Breed	4	.34***	414.26***	334.58***	62.68***
Year	7	.17***	12.01	151.69***	26.96***
Age-in-Days	1	1.30***	504.73***	839.02***	153.02***
Residual	707	.02	14.46	22.99	4.39

***P < .001.

The Shorthorn steer carcasses in this study had a significantly ($P < .05$) smaller (REA). Scarth (1973) found Shorthorn cattle to have the least desirable carcass with respect to (REA).

Year had no significant ($P < .05$) effect on mean ribeye area. However, the steers in 1969 possessed the smallest (REA) but the difference was non-significant.

Predicted Percent Retail Cuts

Other Breeds and Charolais steers yielded the highest significant ($P < .05$) percent retail cuts with a predicted yield of 50.85 and 51.91 percent, respectively. Shorthorn steers had the lowest significant ($P < .05$) predicted yield of retail cuts with 49.95 percent.

With respect to year, 1972 ranked the highest, with a mean predicted yield with 51.34 percent. The lowest year was in 1968 with a predicted percent retail cuts of 50.19. This was significantly ($P < .05$) different with respect to 1972 but not significantly different when compared to the other years in the study.

The estimated overall mean for percent retail cuts was 50.34. This 50.34 percent in terms of yield grade is equal to 2.8.

A regression of percent retail cuts on age in days resulted in a significant ($P < .01$) negative coefficient of $b = 0.008$. This illustrates the effect of carcass external fatness on percent retail cuts.

Variations in USDA yield grade are identical to those reported for percent retail cuts since both variables are calculated from identical data and are based on identical functions (Tables 7 and 8, pages 29 and 31).

The studies of Fortune (1973), Cundiff (1970) and Cahill (1962) exemplify these findings. They found Charolais crosses to be significantly ($P < .05$) superior to British Breeds with respect to percent lean cuts.

IV. ESTIMATES OF LIVE PERFORMANCE TRAITS

Live Weight

The overall mean live weight for the eight year period was 919 pounds (Table 9). A least-squares analysis of variance revealed that both breed and year were significant ($P < .001$) sources of variation in live weight. When compared on an age constant basis, a Duncan's Multiple Range Test showed that Charolais and Other Breeds had significantly ($P < .05$) higher mean live weights when compared to Shorthorn steers. There was no significant difference when compared to Hereford and Angus steers. However, Hereford and Angus steers had heavier live weights. In addition, the lighter Shorthorn steers showed no significant ($P < .05$) difference when compared to Angus and Hereford steers.

Steers in 1974 had a significantly ($P < .05$) higher average weight than steers in other years. The years 1972, 1973, and 1975 showed intermediate weights of 926, 933, and 937 pounds, respectively. The highest significant ($P < .05$) weights were 1968, 1969, 1970 and 1971. However, lower minimum show weights existed during these years.

Live Grade

Breed and year in this study showed no significant variation in live grade in a least-squares analysis of variance (Table 10).

TABLE 9

LEAST-SQUARES MEANS[1] AND COEFFICIENTS OF REGRESSION[b] FOR THE EFFECT OF BREED, YEAR AND AGE-IN-DAYS ON LIVE PERFORMANCE TRAITS

Breed	Number in Sample	Live Weight	Live Grade
Overall	722	919.00	12.67
Shorthorn	15	860.00[b]	11.44
Angus	284	892.20[a,b]	13.09
Hereford	316	909.10[a,b]	12.64
Charolais	75	966.60[a]	13.26
Other Breeds	32	967.10[a]	12.92
1968	77	907.70[c]	12.99
1969	73	892.10[c]	12.83
1970	103	899.50[c]	12.00
1971	102	894.70[c]	12.66
1972	105	926.20[b]	13.17
1973	95	933.50[b]	12.41
1974	84	960.00[a]	12.41
1975	83	937.70[b]	12.89
Age-in-Days[b][1]		1.089	0.0002

[1]Means in the same column with common superscripts are not significantly different ($P < .05$).

TABLE 10

ANALYSIS OF VARIANCE ON LIVE PERFORMANCE TRAITS

Source	d.f.	Mean Squares	
		Live Weight	Live Grade
Breed	4	92,491.47***	16.34
Year	7	45,738.65***	13.31
Age-in-Days	1	1,562,630.02***	.06
Residual	707	8,091.80	12.35

***P < .001.

Charolais and Angus means were the highest with 13.26 and 13.09 (Average Choice) grade scores, respectively. However, due to the small variation in the grades assigned by official graders, the difference was non-significant.

CHAPTER V

SUMMARY

Seven hundred and twenty-two carcasses from Shorthorn, Angus, Hereford, Charolais and Other Breeds (predominately Simmental X Hereford or Angus) were utilized in an eight year (1968-75) study of breed and year variation in beef carcass yield traits. These steers were entered in the Bristol Junior Steer Show by 4-H and FFA members of East Tennessee and Southwest Virginia. The calves consisted of 15 Shorthorn, 284 Angus, 316 Hereford, 75 Charolais and 32 Other Breeds steers ranging from 360 to 575 days of age.

Data collected relative to performance traits (live weight, carcass weight and weight per day of age) indicated a significant ($P < .05$) advantage of Other Breeds and Charolais carcasses when compared to Shorthorn carcasses. There was no significant difference when Other Breeds, Charolais, or Shorthorn were compared to Hereford and Angus. Shorthorn cattle performed lowest in these traits.

Angus cattle had the highest mean carcass grade of 12.50 or Low Choice. Other Breeds followed with a 12.10 or Low Choice. Hereford steer carcasses were significantly ($P < .05$) lower in quality grade than any other of the breed groups.

The mean carcass quality grade was 11.88 or High Good for all years and breeds. Carcasses of 1971 cattle were significantly ($P < .05$) higher with a score of 12.92 or approaching Average Choice.

Angus steer carcasses had an average marbling score of 57.10 (Modest Minus) which was significantly ($P < .05$) higher than the Other Breed groups. Hereford and Charolais steer carcasses had the lowest marbling scores.

Although a correlation of 0.87 existed between carcass quality grade and USDA marbling score, the year 1970 had the highest significant ($P < .05$) marbling score.

Steers measured an average of 0.44 inches of external fat thickness over the twelfth rib. Charolais fat thickness was significantly ($P < .05$) smaller than the British Breed carcasses. Other Breeds were intermediate in measurements. Cattle slaughtered in 1971, 1972 and 1975 had significantly ($P < .05$) less external fat thickness.

A significant ($P < .05$) negative correlation of 0.87 existed between carcass fat thickness and percent retail cuts.

Ribeye area studies showed that Charolais and Other Breeds had a significant ($P < .05$) advantage. Shorthorn steers had significantly ($P < .05$) smaller ribeye area. Year had no significant ($P < .05$) effect.

The estimated overall mean for percent retail cuts was 50.35. Other Breeds and Charolais steers yielded the highest significant ($P < .05$) percent. Shorthorn steers were predicted ($P < .05$) to yield the lowest.

Live grade with respect to breed and year was not significant. The overall mean live grade was 12.67 compared to an overall mean carcass grade of 11.88 almost one-third higher than actual.

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LITERATURE CITED

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VITA

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He attended The University of Tennessee at Knoxville and graduated in December 1968, with a Bachelor of Science degree in Animal Husbandry. While attending The University of Tennessee he was a member of the Block and Bridle Club, U.T. Livestock, Meats and Poultry Teams and a member of the Alpha Gamma Rho fraternity.

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