EVALUATION OF PERFORMANCE TESTED SIRES

by

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INTRODUCTION

More emphasis is currently being placed on efficient production of beef cattle than at any previous period and producers and ranchers are trying to determine adequate measures of production. Three general procedures used to measure production are: (1) visual appraisal, (2) objective measurement, and (3) determining genetic potential.

Visual appraisal is a subjective evaluation of an individual compared to a standard which is accepted as ideal. Such a standard should involve all economically important traits in live and carcass evaluation. To evaluate animals subjectively one must have the ability to compare the economic traits against the standard and the standard must change when necessary. Visual appraisal is the most widely used form of breeding animal selection and as such should be carefully studied as to its effectiveness.

Although many objective measures are easily obtained their application is often complicated. Measures such as weaning weight, yearling weight, ribeye area, and fat thickness can be expressed as simple measurements or ratios with age, live weight, carcass weight, etc. Using these ratios in a selection program many times reflect an entirely different meaning than did the original simple measurements. Thus one must be careful as to the system used in evaluating objective measures.

Genetic potential refers to the ability of the parent to transmit traits to their offspring. Measuring these traits involves both visual and objective appraisal. Heritability coefficients have been estimated for most economic traits. However, environmental conditions such as management, season and ration can alter the expression of genetic potential so these factors must be considered in a selection program.

Any one of all of the above measures can be helpful in a successful beef production program and they warrant the attention of researchers.

As these selection methods are used, it must be remembered that all segments of the beef industry from the calf producer to the meat retailer must have a profitable product to merchandise.

With these factors in mind, this study was designed to investigate: (1) the value of performance tested sires of different breeds and types, (2) the use of visual appraisal and objective measurements in evaluating offspring and carcass performance.

LITERATURE REVIEW

Live Animal Evaluation

Many objective measures have been used by animal scientists and researchers throughout the world to improve the effectiveness of existing methods of evaluating superior live animal phenotype and genotype.

Birth Weight

Koch and Clark (1955b) studied records of 4,553 Hereford calves and reported heritability estimates for birth weight as 0.35 for both sexes. Marlowe (1962) using records on 2,392 Hereford bulls and 2,383 heifers found the average birth weights to be 70 and 66.2 pounds respectively. Brinks *et al*. (1962) and Dawson, Phillips and Black (1947) reported age of dam had a highly significant (P<.01) effect on birth weight.

Hawkins (1937) using range calves reported a correlation coefficient of 0.60 between birth weight and average daily gain (ADG) from birth to weaning. Flock, Carter and Priode (1962) reported correlations between birth weight and preweaning gain may justify selection for heavy birth weights in Angus and possibly Herefords, but not in Shorthorns. Singh (1969) found that birth weight had a highly significant effect (P<.01) on preweaning ADG. Singh (1969) and Ray *et al*. (1970) reported a highly significant (P<.01) sire effect on birth weight. Brinks *et al*. (1964) found high correlations between birth weight, post weaning gain, eight and twelve month weights, and gain from twelve to eighteen months in Hereford females.

Pre-Weaning Gain

Marlowe, Mast and Schalles (1965) observed that as calves increased in age their ADG from birth to weaning decreased significantly (P<.05). They also reported that sex of calf and month of birth had highly significant effects on the ADG of calves from birth to weaning. Steers that did or did not receive creep feed gained six percent faster than heifers receiving the same treatment. March and April born calves had the highest preweaning average daily gain. May calves showed a gradual decline then a gradual increase was noted through March and April. A significant (P<.05) year effect was found on the ADG and highly significant (P<.01) age of dam effect. These findings were substantiated by the finding of McKee (1967), Singh (1969) and Ray et al (1970). Singh (1969) in his second study reported age of dam showed a non-significant effect on preweaning ADG.

McKee (1967) and Thrift et al. (1970) reported sire had a highly significant (P<.01) effect and sex had a significant (P<.05) effect on preweaning ADG. Marlowe and Gains (1958) found that creep fed calves reduced season of birth and age of dam effects on ADG but did not alter the sex effect. Singh (1969) found that creep feeding had no significant management advantage over no creep. Brinks et al. (1961) found a highly significant (P<.01) sex effect with heifers gaining five percent less than steers from birth to weaning.

Weaning Weight

Burgess, Landblom and Stonaker (1954) found a highly significant age of calf (P<.01) effect on weaning weight. Similar results were reported by Hamann, Wearden and Smith (1963), Minyard and Dinkel (1965), and Singh (1969). Cundiff, Willham and Pratt (1966) found a highly significant (P<.01) effect on weaning weight due to sex of calf, age of dam, type of management, location of herd, and month of birth. Sex was responsible for highly significant (p<.01) differences in weaning weight with steer calves averaging five kilograms more than heifers. They also found a definite advantage for classifying cows under four years of age into three to five month increments for weaning weight adjustments while cows six to nine years old showed maximum productivity. Marlowe, Mast and Schalles (1965) reported that calves from cows under seven years of age and over eleven years grew slower and graded lower than calves from seven through eleven year old cows. McKee (1967) reported a significant (P<.05) effect by age of dam on weaning weight, while Ray et al. (1970) reported dam had significant (P<.05) effect on weaning weight.

Hogan (1968), Singh (1969) and McKee (1967) reported that sire had highly significant (P<.01) effect on weaning weight. Hogan (1968) reported heritability estimates for weaning weight of 0.31. Rollins and Wagnon (1956) maintained two similarly bred Hereford cow herds on differing levels of nutritions and found no difference for heritability estimates for weaning weights from either herds.

Weaning Grade

Hultz (1927) reported that shape and pattern in cattle changed during a feeding period and that weaning grade was not highly correlated to slaughter grade. Lush (1932) found little correlation of type and their relation to subsequent performance. He concluded, "The data indicates that no score card or standard grades on conformation could ever be predicted from it with but few mistakes."

Koch and Clark (1955a) reported that age of dam had a marked influence on weaning grade while McKee (1967) reported a significant (P<.05) effect. Marlowe et al. (1965) collected information on 17,294 Angus records and 11,663 Hereford records and found age of calf and sex had a highly significant influence on grade (type score). Heifer and bull calves graded significantly higher than steer calves. McKee (1967), Teagarden (1968), Thrift et al. (1970) reported sex had a significant (P<.05) effect on weaning grade, while McKee (1967) found no effect on weaning grade by sex, but a significant correlation 0.58 between live animal grade and muscling scores indicate that traits are recognizable as animals undergo changes in age and weight. Waugh and Marlowe (1969) reported grade was effected by age of calf. Hogan (1968) reported heritability estimates for feeder grade and weaning bone score of 0.19 and 0.23 respectively.

Post Weaning Gain

Koger and Knox (1951) reported that if environment was standarized, the faster growing calves at weaning would gain better in subsequent periods. Brinks *et al*. (1964) reported high correlations between weaning weight, post weaning gain, twelve month weight, gain from twelve to eighteen months and eighteen month weight. Thrift *et al*. (1970) reported sex of calf had a significant ($P<.01$) effect for all performance traits.

Feedlot Gain

Heritability estimates of measurable traits of feedlot performance have relatively high values. Warwick and Cartwright (1955) reported heritability of feedlot gain is high and rate of gain can very effectively be selected for. Swiger (1961) using Hereford bulls and heifers reported that lighter calves at weaning made more rapid gains during the first part of a 140 day feeding period and lower gains the latter part of the trial, having lower total gains. The author suggests that gains late in the nursing period are highly correlated with subsequent feedlot gains and consequently rapid gainers could be identified early. Shelby *et al*. (1963) in Montana, working with 614 Hereford steers, concluded that the correlation values for feedlot ADG with slaughter weight was 0.81; slaughter grade, 0.37; and carcass grade 0.06. Correlation of slaughter weight with slaughter grade was 0.50 and with carcass grade 0.30;

slaughter grade with carcass grade 0.42. Meiske (1969) worked with offspring by the same sire and from similar bred dams. The bull's calves had heavier weaning weights than the steers or heifers. Bulls and steers were similar in feedlot performance and both gained more efficiently and rapidly than heifers. In his literature review Warwick (1958) reported polled heritability estimates of 0.45 for feedlot gain and 0.39 for slaughter grade. Shelby et al. (1963) using 614 Hereford steers found correlation values for feedlot ADG with slaughter weight, 0.81; slaughter grade, 0.37; and carcass grade, 0.06.

Schalles and Marlowe (1967) using bull records reported breed had a significant (P<.05) effect on lifetime ADG, record performance test ADG and 365 day weight. Shorthorns and Herefords excelled in all these traits. Breed showed no significant effect in end-of-test type score. Pahnish et al. (1964) reported age of dam had a significant (P<.05) effect on bull yearling weight and female yearling weight. Teagarden (1968) reported sires had a non-significant effect on total gain on feed.

Slaughter Grade

Knapp, Black and Phillips (1939) analyzed scores by seven experienced judges using twelve traits in a studt of visual scoring as a technique of evaluating animal differences. They concluded that evaluation of animal differences is subject to considerable error and is probably of very doubtful value when differences between animals are small. However, they stated that when population differences are large, scoring techniques are undoubtedly the simplest way to evaluate conformation differences. Gregory et al. (1962b) recorded evaluations by three graders immediately prior to slaughter on 204 steers. The study indicated that group means for carcass weight, fat thickness at the 12th rib, percent kidney fat, ribeye area at 12th rib, cutability, and carcass grade in live cattle can be estimated with reasonable accuracy by trained personnel. Also, it showed that cutability can be visually appraised more accurately than carcass quality grade. Subjective live scores and estimates accounted for only about twenty to twenty-five percent of the variation on carcass traits. Wilson et al. (1964) and Wheat and Holland (1960) agreed that live appraisers can not accurately predict carcass quality traits. Lewis, Suess, and Kauffman (1969) reported that trained personnel could account for more than half of the variation in carcass traits and three-fourths of the variation in fat thickness.

Performance Testing

In Genesis, Jacob was reported to have used the strongest animals of his flock to further his breeding program. The Simmental Breeders of Switzerland have used performance records in selecting outstanding individuals since 1806. Many researchers have studied performance testing and have proposed different testing programs.

Black and Knapp (1936) outlined a program for measuring performance in beef cattle in which certain conditions should be held constant among animals for record-of-performance tests. They proposed that weaning weight (500 pounds, regardless of age), slaughter weight (slaughter at 900 pounds), feed and methods of feeding all should be held constant in an attempt to reduce environmental influences. They also suggested that the period of development from the feeder animal to the time of slaughter should be studied most extensively. Studies by Winters and McMahon (1933) revealed that differences in economy of gain are inherited and that it is possible to develop lines which are superior in this regard. Daily gain had long been recognized as a good criteria of feed efficiency and they concluded that selling price and daily gain are two of the most important factors effecting net profit. They proposed a relatively simple and accurate record of performance test considering daily rate of gain from birth to 365 days of age and a final body score.

Knapp and Black (1942) found a rapid increase in information gained for each animal added up to five when progeny testing beef bulls. Information gained for each successive animal added was relatively unimportant. They concluded that six to ten progeny would be satisfactory to conduct a progeny test with reliable results. A 168 day feeding period was felt adequate to measure the total performance of a steer, if corrected to a standard weight and gain.

Woodward and Clark (1950) studying steer performance used eleven sires bred the first year to randomly selected "herds" of cows at the U.S. Range Station, Miles City and the second year to "herds" at the North Montana Branch Station, Havre. Steer progenies were fed out at Miles City the first year with the Havre produced calves being fed at the Montana Experiment Station at Bozeman. A non-significant sire X station interaction indicated that sires producing fast gaining calves at one station did likewise at the other station. Kincaid and Carter (1958) used nineteen high gaining bulls and nineteen low gaining bulls over a six year period to study progeny tests. On feedlot performance tests progeny of high gaining bulls averaged 2.24 pounds per day while progeny by the low gaining bulls averaged 1.65 pounds per day.

Kieffer et al. (1958) using 60 Angus steers and heifers by seven sires, studied sire influence upon carcass characteristics. Sire had a significant ($P<.05$) effect on carcass grade, slaughter grade, marbling score and percent bone of the 9-10-11th ribs. A non-significant effect was found for fat and lean percentage of the 9-10 and 11th ribs.

Gregory _et al_. (1961) stated that record-of-performance will have its greatest impact through application by purebred breeders on seedstock herds to which the range bull producers and commercial cattlemen can come for replacements animals. Marlowe (1969) found that performance tested bull buyers were placing their major emphasis on conformation and growth. Hereford buyers were more interested in pedigree than Angus buyers, while Angus buyers were more interested in life ADG and age. Brown and Absher (1971) reported that conformation is becoming less important as compared with growth traits in determining the selling price of bulls.

Ultrasonics

Temple _et al_. (1956) using an ultrasonic instrument, known as a "somascope", in live cattle found it provided a reliable indication of fat thickness. Price _et al_. (1958) intorduced the Sperry Reflectoscope to measure depth of subculaneous fat and lean muscle of hogs and cattle. Muscle depth in swine was reliably estimated with less accuracy in cattle. Stouffer, Wallentine and Wellington (1959) using a Sperry Reflectoscope with a 1.0 mc. transducer produced favorable results for estimating loineye area in hogs and cattle with greater accuracy in hogs. Stouffer _et al_. (1961) found a significant but low correlation coefficient between ribeye areas measured by ultrasonics and carcass ribeye area. He reported probable factors accounting for the low relationship as being due to changes of shape and size of the ribeye in the slaughtering and hanging procedures and variability in pressure of the transducer against the hide during probing.

Hedrick _et al_. (1962) using ultrasonics reported correlation coefficients between live estimated ribeye area and fat thickness to actual carcass data varied from 0.58 (P<.01) to 0.89 (P<.01), and 0.11 (P<.05) to 0.63 (P<.01) respectively. Also, ultrasonic measurements of ribeye area measured five months prior to slaughter had a significant relationship to actual area in the carcass. Davis et al. (1964) using the Branson Sonoray reported correlations of ultrasonics estimates and corresponding carcass measurements for loin eye area and fat thickness of 0.87 and 0.90, respectively.

Davis, Temple and McCormick (1966) measuring operator differences found ultrasonics reasonably repeatable. Temple, Ramsey and Patterson (1965) identified several errors which cause less reliable readings than desired. These were: (1) animal, (2) tissue change during slaughter, (3) interpretations and (4) machine manipulation. They also stated that very firm or very fat animals possibly cause difficulty in making accurate readings. Watkins, Sherrit, and Ziegler (1967) using Methylene Blue injected under the hide for post-mortem identification of scanning position reported correlations of 0.90 and 0.56 between estimated and actual fat thickness and ribeye area, respectively.

McReynolds and Arthaud (1970a) reported use of a "B" scan in which a Polaroid Photograph was taken of the oscilloscope as the animal was scanned gave greater accuracy than the "A" scan where readings were taken at stationary positions. They used 132 cattle and the correlations between estimated fat and carcass fat were 0.25 when using the "A" scan and 0.59 for the "B" scan. McReynolds and Arthaud (1970b) ultrasonicaly scanned six bulls and four steers, starting at approximately 230 days old, at four subsequent six week intervals. They suggested that a curvilinear relationship existed between live weight and fat deposition. A correlation of 0.95 was found between the estimated ribeye area and the actual corcass ribeye area.

Research with ultrasonics (high-frequency sound) used for measuring fat thickness and ribeye area (longissimus dorsi muscle) in cattle, indicate that ultrasonics can be used as a tool for selective breeding programs.

Carcass Evaluation

Fat Thickness

The distribution of fat plays an important role in the composition of the meat animal and the subsequent carcass. As the percent of fat increases, lean content decreases. Haecker (1920) and Moulton, Trowbridge, and Haigh (1922) reported an increase in percent of body fat and a decrease in percent of lean as beef animals fattened. Hankins and Titus (1939) stated that fat is deposited at varying rates in different parts of the body, which results in a marked difference in the proportions of fat found in different areas. Callow (1947, 1948, 1949, 1950) found that the major change in composition of the animal body depends on the level of fatness. Berg and Butterfield (1968) reported that in normal slaughter ranges, as weight increases muscle and bone percentage decreases while fat increases.

In beef carcass evaluation, the most common fat measurement is at the 12th rib. Naumann (1952) proposed that an average of three measurements be taken at the 12th rib. However, Ramsey, Cole and Hobbs (1962) found that one measurement taken over the ribeye three-fourths of the distance from the medial to the lateral edges of the ribeye is just as reliable. Allen (1963) reported that there is a rather low correlation of 0.20 between fat thickness at the 12th rib and marbling score. Briedenstein (1965) also agreed that fat thickness over the 12th rib is more valuable in predicting retail yield of a steer carcass than measurements taken at other locations. Hedrick *et al*. (1965) found that subcutaneous fat thickness measurements were more highly associated with percent than with weight of retail cuts. Allen (1966) found that the fat measurements with the highest correlation to percent separable components and retail yield were a single fat measurement over the 12th rib three-fourths of the distance from the medial to the lateral edge of the ribeye, average of three measurements over the ribeye (Naumann, 1952) and a fat probe measurement four inches off the dorsal midline at the fifth thoracic vertebra. Allen et al. (1968) reported that the average 12th rib fat thickness had a highly significant (P<.01) effect on weight and percent separable components, retail cuts and fat trim. Brackelsberg et al. (1968) found correlations for fat depth at the 12th rib when using one and an average of three measurements of 0.62 and 0.82, respectively, with percent of carcass separable fat. The latter is similar to the value of 0.80 found by Ramsey, Cole and Hobbs (1962). Eply et al. (1970) stated that fat thickness was equally as valuable as hot carcass weight in predicting percent retail cuts.

Longissimus Dorsi Muscle Area

Cahill et al. (1956) reported a correlation of 0.85 between ribeye area at the 12th rib and percent edible portion of the carcass. Cole, Orme and Kincaid (1960) reported ribeye area was associated with only eighteen percent of the variation in separable carcass lean. Goll, Kline and Hazel (1961) reported a zero correlation between ribeye area and percent thick cuts. Brungardt and Bray (1963) found a correlation of 0.45 between ribeye area and percent retail cuts and retail yield (muscle trimmed .3 inch fat depth) of 0.40 to 0.60. Since ribeye area is at least partially a function of weight they found that on a carcass weight and fat constant basis, the correlation coefficient were significantly reduced. Brackelsberg and Willham (1968) found a simple correlation of 0.42 between ribeye area and percent muscle.

Hedrick et al. (1965) found the differences which occur between right and left longissimus dorsi muscle area and subcutaneous fat thickness measurements are due principally to errors in ribbing. Also, ribeye area measurements were more highly associated with weight than with percent ratial cuts. Henderson, Goll and Kline (1966) reported the following correlation coefficients between ribeye area at the 12th rib and percent total separable muscle of round, loin, rib, and chuck (0.31); and percent total retail yield of round, loin, rib and chuck, (0.46). Abraham (1968) reported that ribeye was highly significantly (P<.01) correlated with weight of retail cuts but lowly (although significant and negatively) correlated with percent retail cuts. Similar results were found by Birkett, Good and MacKintosh (1965) and Miller _et al_. (1965). Brackelsberg _et al_. (1968) found the correlation between ribeye area with carcass muscle/kg was o.60. Kauffman _et al_ (1968) indicated that ribeye measurements were similar for breeds. Epley _et al_. (1970) found the ribeye area measurement was the least valuable measurement of all carcass measurements in predicting retail cuts. Briskey and Bray (1964) concluded that emphasis upon size of the ribeye muscle may be justified because it comprises a large proportion of two of the high priced wholesale cuts of b-ef, although the influence of ribeye area upon retail yield is small compared to that of fat.

Other Carcass Traits

Cundiff _et al_. (1963) worked with 47 sire progeny groups containing 265 Hereford and Angus steers. They reported the following heritability extimates; carcass weight per day of age, 0.39; ribeye area, 0.73; ribeye area per 100 pounds carcass weight, 0.29; fat thickness, 0.43; carcass grade, 0.62; carcass yield grade, 0.36; and percent retail cuts, 0.40. They also indicated that as carcass grade increased due to increasing degrees of marbling, there is a corresponding increase in deposition of eternal fat which lowers cutability. Christians et al. (1962) worked with 176 Angus calves by 24 sires and found the following heritability estimates: Slaughter weight, 100.0; ADG, 0.88; dressing percent, 0.96; carcass grade, 0.78; carcass conformation, 0.29; fat thickness, 0.38; ribeye area, 0.76. Zinn (1964) in his summary of heritabilities gave the following pooled estimates: Carcass grade, 0.44; ribeye area, 0.63; fat thickness, 0.35; and marbling, 0.29.

Suess et al. (1966) working with 88 Angus steers and heifers from sires that represented four herds reported significant sire effects on differences in percent retail cuts ($P<.05$), weight of the retail cuts ($P<.01$), ribeye area ($P<.05$), and carcass grade ($P<.01$). McKee (1967) reported that sire had a significant ($P<.01$) effect on slaughter weight, carcass weight, carcass grade, and marbling. Teagarden (1968) reported sires had a non-significant effect on carcass grade and fat thickness in one year but the next year a significant ($P<.05$) effect was found on marbling score, ribeye area, ribeye area/cwt. of chilled carcass and primal cwt. weight. Hogan (1968) reported a highly significant ($P<.01$) sire effect on chilled carcass weight and dressing percentage. Wilson et al. (1969) using eleven different polled Hereford bulls found a significant ($P<.05$) sire effect for lean tenderness, loineye area, cutability and weights and percentages of untrimmed and trimmed round and loin. Thrift et al. (1970) reported that sire had a significant effect on cold carcass weight, carcass weight per day of age, ribeye area per 100 kg carcass, fat thickness, trimmed retail cuts and estimated percent kidney and pelvic fat.

Sex Differences

Arthaud et al. (1969) working with 157 calves from 17 sires found that at the same age, bull carcasses weighed 24.5 kg more than steers and yielded

26.8 kg more boneless trimmed meat. Steers had a finer texture, more desirable red color, and more marbling in their loin eye than bulls. Meiske (1969) worked with offspring by one sire and similar bred dams. Bulls had carcasses with significantly less (P<.01) fat thickness, less (P<.01) percent kidney, pelvic, and heart fat; lower (P<.01) marbling scores; lower (P<.01) carcass quality grades; but significantly (P<.01) higher yield grades or percentage retail yield than either the steer or heifer carcasses. Bull and steer carcasses had larger loineye area than heifer carcasses. Hedrick, Thompson, and Krause (1969) reported that bulls were more efficient in converting feed to live weight gain. Bulls had superior carcass conformation grades compared to steers and heifers. Marbling scores and carcass quality grades were lower in bulls. Champagne _et al_. (1969) found that bulls gained faster and more efficiently than steers and had higher dressing percent, lower marbling scores, and hielded approximately four percentage points more trimmed, boneless retail cuts. He also found the U.S.D.A. formula for trimmed, boneless retail cuts underestimated true yield of bull carcasses by approximately two percentage points.

Experimental Procedure

Performance Data

Seven sires tested in the Flint Hills Bull Test Station, Eureka, Kansas, were used in this study. A summary of sire performance and sonoray data is presented in Table 1. All sires were used on one commercial cow herd for a 45 day breeding period starting in early May, 1969.

Four sires representing the Hereford (sire 38), Angus (sire 92), Shorthorn (sire 39), and Galloway (sire 11) breeds were randomly mated to 100 grade Hereford cows in one large pasture. In addition, a Shorthorn bull (sire 36) was mated to 30 Shorthorn cows and another Shorthorn (sire 37) was mated to 25 second calf heifers which were predominately of Hereford breeding. The other bull was a Hereford (sire 40) and was mated to 25 first calf heifers of mixed but predominately Hereford breeding.

All calves were ear tagged at birth and birth dates recorded. None of the calves were creep fed. Male calves and dams were kept separately from heifer calves and dams in the pre-weaning period. From sire 38 all male calves were castrated at approximately three months of age except for six randomly selected bull calves. All calves were vaccinated for blackleg and malignant edma. All calves were weaned, weighed, and graded at approximately 6 months of age. Five steer calves were randomly picked from each sire for post-weaning and feedlot gain tests and carcass comparison. Post-weaning and feedlot gain tests were conducted at the Agricultural Experiment Station, Manhattan, Kansas, and individual pictures were taken at the beginning and end of this 168 day period.

A committee of four judges scored the calves at the beginning and ending of 168 day test using three methods of live grading. The first method was the standard 17 point system of U.S.D.A. feeder and slaughter grades (table 2). The second was the system developed by Ankony Farms which involves scoring frame, muscle, structure, and predeposition of fat separately (table 3). The third was a scoring system developed by Dr. Harlan Ritchie, Michigan State University, and Dr. Gary Minish, Virginia Polytechnic Institute, for scoring frame and muscle (table 4).

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Table 1 Sire Performance

Sire	Adj. Weaning Weight[a]	Adj. Yearling Weight[b]	WDA[c]	Age Starting Test	Weight Starting Test[d]	140 Day Gain	Fat	REA[e]	Adj. LEA[f]	Yield Grade[g]
G 11[h]	528	912	2.30	254	636	2.47	.19	12.95	13.36	1.71
S 36[i]	487	1037	2.69	249	575	3.89	.79	12.57	11.76	3.67
S 37	479	939	2.45	295	656	3.45	.54	12.55	11.57	3.10
H 38[j]	368	763	2.05	371	606	3.69	.49	13.87	12.86	2.54
S 39	342	712	1.92	387	579	3.62	.54	12.76	12.11	2.91
H 40	371	794	2.11	319	534	3.62	.30	12.72	12.36	2.25
A 93[k]	385	940	2.37	218	403	3.71	.36	11.33	12.28	2.48

[a] Adjusted weaning weight = $\frac{\text{(starting 140 day weight - 75)}}{\text{Age}} \times 205 + 75$.

[b] Adjusted yearling weight = $\frac{\text{(140 day weight - 75)}}{\text{Age}} \times 365 + 75$.

[c] Adjusted yearling weight/day of age.
[d] Weight starting 140 day test.
[e] Rib eye area.
[f] Rib eye area adjusted to 1000 pounds.
[g] With 60% dress, 3.5% kidney knob.
[h] Galloway.
[i] Shorthorn.
[j] Hereford.
[k] Angus.

Table 2 U.S.D.A. Feeder and Slaughter Steer Grades

Feeder or Slaughter Grade	High	Average	Low
Prime	17	16	15
Choice	14	13	12
Good	11	10	9
Standard	8	7	6
Utility	5	4	3

Table 3 Ankony Farms Feeder and Slaughter Scoring System

Trait scored	Score for[a] Desirable	Score for[a] Undesirable
Predeposited to fat	10	1
Muscling	10	1
Size of frame	10	1
Soundness of structure	10	1

[a] Scoring systam ranged from 1 to 10 on all traits scored with 10 being most desirable and the least desirable.

Table 4 Grading System Method III[a]

Trait scored	Extremely[b] Small	Extremely[b] Large
Frame	1	5
	Heavy Muscle[c]	Light Muscle[c]
Muscling	A	E

[a] This grading system was developed by Dr. Harlan Ritchie of Michigan State University and Dr. Gary Minish of Virginia Polytechnic Institute.

[b] Frame was scored on a scale of 1 to 5 with 1 representing an extremely small early maturing type steer and 5 representing a large framed, long growthy type steer.

[c] Muscling was scored on a scale of A to E with A representing extremely heavily muscled steers and E representing extremely light muscled steers.

Feeding

All calves were fed a growing ration in one large pen for 38 days after which they were individually weighed and penned by sire groups. A ration of 60% alfalfa haylage and 40% flaked milo (as fed basis) with prairie hay *ad libitum* was fed for 94 days. The ration was then changed and fed according to the schedule given in table 5.

Table 5 Rations Fed During Feedlot Gain Test

No. of days fed	% Alfalfa haylage	% Milo	% Supplement
56	26	68	6[a]
28	16	78	6[a]
84	10	86	4[b]

[a] (50% protein).
[b] (40% protein).

AnScan Data

All calves were sonorayed by the same technician, at three times 112 days apart during the feeding phase. The Anscan model 421, King KC 79-29 transducer and swine guide were used the first two times. The third time, 24 hours pre-slaughter, the same machine was used but with a cattle guide. Fat thickness and ribeye area on the right side, taken between the 12th and 13th rib, was estimated each of these three times. Interpretation of the polaroid pictures was done by the technician.

Carcass Data

All animals were slaughtered immediately after the 168 day test. The right side of each carcass ribbed between the 12th and 13th ribs with fat thickness (Ramsey, Cole and Hobbs, 1962) and ribeye area (Nauman, 1952) being measured. The following carcass data were collected: Carcass conformation; maturity; marbling; final quality grade; hot carcass weight; estimated percent kidney, pelvic and heart fat; carcass yield grade; color and texture of lean (table 6). Round length was measured from the forward edge of the aitch bone to the epiphyseal plate. Carcass length was measured from the forward edge of the aitch bone.

Statistical Analysis

Analysis of variance by the least squares analysis of data with unequal subclass numbers by Harvey (1960) was used on all data collected. The models that were used are as follows:

weaning weight, weaning grades

sex + sire + age

post weaning gain

sex + sire + weaning weight

Anscan data, slaughter grades

sex + sire + weight + age

140, 168 day gain/day

sex + sire + weaning weight + starting 140 day weight + starting 140 day age

yearling weight

sex + sire + weaning weight + yearling age + starting 140 day weight + 140 day gain/day

Hot carcass weight

sex + sire + age + fat thickness + slaughter weight

Dressing percent

sex + sire + slaughter weight + fat thickness

Carcass ribeye, round and carcass length

sex + sire + carcass weight

Fat thickness

sex + sire + carcass weight + 168 day gain/day

Percent Kidney knob

sex + sire + marbling + fat thickness + slaughter weight

Carcass maturity, final quality grade, yield grade

sex + sire + slaughter weight

Carcass conformation, marbling

sex + sire + 168 day gain/day + slaughter weight + fat thickness

For the within-sire, sex comparison, sex was substituted for sire in the above models.

Correlation coefficients were determined according to Snedecor (1956).

Table 6 Characteristics and Scores Used in the Subjective Carcass Evaluation

Characteristic	Score
Conformation score	______[a]
Maturity score	______[b]
Marbling score	______[c]
Final grade	______[a]
Estimated % kidney knob	______[d]
Color of lean	______[e]
Texture of lean	______[f]

[a] Conformation and/or grade

Conformation and/or grade	Low	Average	High
U.S. Standard	6	7	8
U.S. Good	9	10	11
U.S. Choice	12	13	14
U.S. Prime	15	16	17

[b] Maturity

Maturity	-	Average	+
A	15	14	13
B	12	11	10
C	9	8	7
D	6	5	4
E	3	2	1

[c] Marbling

Marbling			
Devoid	1	2	3
Practical devoid	4	5	6
Traces	7	8	9
Slight	10	11	12
Small	13	14	15
Modest	16	17	18
Moderate	19	20	21
Slightly abundant	22	23	24
Moderately abundant	25	26	27
Abundant	28	29	30

[d] Percent of hot carcass weight

[e] Color of lean

Color of lean	Score
Very light cherry red	7
Cherry red	6
Slightly dark red	5
Moderately dark red	4
Dark red	3
Very dark red	2
Black	1

Table 6 (cont.)

f Texture of lean	Score
Very fine	7
Fine	6
Moderately fine	5
Slightly fine	4
Slightly coarse	3
Coarse	2
Very coarse	1

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CHAPTER 1

Performance Traits

Many objective measures have been used by animal scientists and researchers throughout the world to improve the effectiveness of existing methods of evaluating superior live animal phenotype and genotype. However, the measuring and recording of the economically important traits has been the most widely used.

Cundiff, et al. (1966) found a highly significant ($P < .01$) effect on weaning weight due all the following factors: sex of calf, age of dam, management, herd location and birth month. Sex was responsible for steer calves averaging five Kilograms more than heifers. Hogan (1968), Singh (1969) and McKee (1967) reported that sire also had a highly significant ($P < .01$) effect on weaning weight.

Swiger (1961) using Hereford bulls and heifers reported that lighter calves at weaning made more rapid gains during the first part of a 140 day feeding period and lower gains the latter part of the trial, having lower total gains. Meiske (1969) working with offspring by the same sire and from similar bred dams, found that bull calves had heavier weaning weights than steers or heifers. Bulls and steers were similar in feedlot performance and both gained more efficiently and rapidly than heifers.

Gregory et al. (1961) stated that record-of-performance will have its greatest impact through application by purebred breeders on seedstock herds to which the range bull producers and commercial cattlemen can come for replacement animals.

This study was designed to investigate: (1) the value of performance tested sires of different breeds and types, and (2), the use of objective measurements in evaluating offspring performance.

Experimental Procedure. Sevan performance tested sires were used in this study. A summary of sire performance data is presented in Table 1. All sires were used on ome commercial cow herd for a 45 day breeding period starting in early May, 1969.

All calves were ear tagged at birth and birth dates recorded. Calves were not creep fed and prior to weaning, male calves and dams were kept separate from heifer calves and dams. All calves were vaccinated for blackleg and malignant edma and were weaned, weighed and graded at approximately six months of age. Five steer calves were randomly picked, whenever possible, from each sire for progeny testing. Six bull calves by sire 38 were also selected for testing. Post-weaning and feedlot gain tests were conducted at the Agricultural Experiment Station at Manhattan, Kansas.

Calves were fed a growing ration in one large pen for 38 days after which they were individually weighed and penned by sire groups. A ration of 60% alfalfa haylage and 40% flaked milo (on as-fed basis) with prairie hay *ad libitum* was fed for 94 days. The ration was then changed and fed according to the schedule given in Table 2.

All animals were slaughtered immediately after 168 day test at Wilson Certified Foods packing plant in Kansas City, Kansas. Carcasses were chilled for 24 hours and carcass data collected.

The statistical procedures followed were described by Harvey (1960) and Snedecor (1956).

Results and Discussion

Weaning Weight. Sire and sire by sex interaction had a highly significant ($P<.01$) effect on adjusted weaning weight of both steers and hiefers (table 7). These findings point out that some sires produced male calves that weaned heavier than females and vise versa. Heifer calves from sire 93 (Angus) had a 62.6 pound weaning weight advantage over the steer calves from the same sire (table 7). Also heifer calves from sire 37 (Shorthorn) weaned 24.7 pounds heavier than their half-sib steer calves. Steer calves from all other sires weaned heavier than heifers calves with an average 11.0 pound advantage. Comparing overall average weaning weights (table 7), sires 38 and 40 (Herefords) and sire 39 (Shorthorn) produced calves with the lightest weaning weights. The other sire groups in the study were not significantly different (table 7).

Sex had no significant effect on adjusted weaning weights of steers and heifers (table 7). However, when comparing bulls and steers, at 190 days of age, bulls had a twelve pound advantage over steers, (table 8).

Correlation coefficients between weaning weight and other performance traits are presented in table 9. Weaning weight had a highly significant (P<.01) correlation with adjusted yearling weight, starting test weight and slaughter weight of 0.49, 0.76 and 0.61, respectively. Heavier weaning calves started and finished the 94 day growing period at heavier weights than did the lighter weaning weight calves. These findings agree with those of Swiger (1961).

Highly significant (P .01) correlations presented in table 9 between weaning weight and carcass data, again indicate that heavier weaning calves would have heavier hot carcass weights (0.60), larger carcasses (0.52), with longer rounds (0.66).

Average age at weaning was 190 days with a range of 161 to 225 days. Age had a highly significant (P<.01) effect on adjusted weaning weight with older calves having heavier weaning weight (table 10). These findings agree with those of Burgess et al. (1954), Koger and Knox (1945) and Minyard and Dinkel (1965) and indicate that weight changes rapidly as age increases.

Yearling weight. The lightest calves at the starting of the test were the fastest growing. This pen consisted of calves from first calf heifers and much of their gain during the test could have been compensatory. When comparing bulls and steers, starting test weight had a highly significant ($P<.01$) effect on yearling weight with bulls averaging 20 pounds heavier than steers (table 8).

Adjusted yearling weight had a highly significant ($P<.01$) correlation (0.43) with test ADG. Also, starting test weight, slaughter weight and slaughter weight per day of age, had highly significant ($P<.01$) correlations with adjusted yearling weight (table 9). Correlations in the same table between adjusted yearling weight and carcass measurements are similar to those between weaning weight and these same traits.

Sire had no significant effect on yearling weight, although there was a 26 pound difference between the high and low pen.

Comparing bull and steer yearling weights, sex had no significant effect even though bulls had a 24.7 pound advantage over steers (table 8).

Slaughter weight. As was expected, weaning weight and test ADG had a significant (P .05) and highly significant ($P<.01$) effect on slaughter weight (table 10).

There were no significant sire effect on slaughter weight (table 10) even though there were 96 pounds difference between mean weights of the high and low progeny groups. These results contrast with those of Kieffer et al. (1958).

When comparing sexes, bulls had an 11 pound slaughter weight advantage over steers, but this difference was not significant (table 8).

As shown in table 9, slaughter weight was highly significantly ($P<.01$) correlated with carcass measurements. These results are as was expected since size and weight of animal directly influences most objective carcass measures taken.

Post-Weaning ADG. Age had a highly significant ($P<.01$) effect on post-weaning ADG in steers (table 11). Although there was 0.4 pound per day difference between the high and low progeny groups, this difference was not large enough to cause a significant sire effect (table 11). The younger pens of calves had highest post-weaning gains with the exception of sire 36 (Shorthorn) whose progeny were among the oldest and most rapid gaining. No significant difference was noted due to sex when comparing bulls and steers (table 12).

Post-weaning gain was highly significantly (P<.01) correlated with starting test weight, 0.51; slaughter weight 0.45; and loin eye area/cwt, -0.43 (table 9). These correlations indicate steers with higher ADG will have heavier weights going on and off test and will have less loin eye area/cwt of carcass than lighter weight steers.

<u>140 Day Test</u>. Weaning weight had a significant (P<.05) effect on 140 day ADG with the lightest pen of calves at the beginning of the test having the highest 140 day ADG (table 11). This pen of calves were from first calf heifers and apparently had the genetic potential to gain but did not have the opportunity to express it until the 140 day test.

Sire had a highly significant (P<.01) effect on 140 day ADG with a difference of 0.7 pounds per day between the high and low pens as is shown in table 11.

Sex had a highly significant (P<.01) effect on 140 day ADG when comparing bulls and steers, with bulls averaging 0.44 pounds/day more than steers (table 12). Bulls also had a more efficient feed conversion (6.46 pound feed/pound of gain) compared to steers (7.55 pound feed/pound of gain). These results are similar to those reported by Champagne <u>et al</u>. (1969) and Hedrick <u>et al</u>. (1969).

Slaughter weight was highly significantly (P<.01) correlated (0.57) with 140 day ADG indicating the faster gaining individual had heavier slaughter weights as obviously would be expected.

A very high correlation (0.94) was found between 140 and 168 day ADG.

This indicates that calves on 140 day test will perform similarly on a 168 day test and that the 140 day test period should be sufficient to determine ADG.

Ribeye area was highly significantly (P<.01) correlated with 140 day ADG (0.48), as was maturity (-.48), hot carcass weight (0.52) and carcass length (0.47).

Table 7 Sire Effects on Adjusted Weaning Weights of Steers and Heifers

Sire	Avg. steer weaning weight	Avg. heifer weaning weight	Overall avg. weaning weight
11 (Galloway)	459.4[ab]	453.0[ab]	457.6[a]
36 (Shorthorn)	477.4[a]	446.8[ab]	460.7[a]
37 (Shorthorn)	430.0[bc]	454.7[a]	434.9[a]
38 (Hereford)	410.3[c]	402.2[bc]	405.7[b]
39 (Shorthorn)	402.2[c]	399.1[bc]	400.3[b]
40 (Hereford)	394.7[c]	375.5[c]	383.7[b]
93 (Angus)	394.7[c]	457.3[a]	426.0[ab]

[A,B,C] Means in the same column bearing a different superscript differ significantly (P<.01).

Table 8 Effect of Sex and Other Factors on Average Weaning, Yearling and Slaughter Weights

Trait	Average weaning weight	Average yearling weight	Average slaughter weight
Sex[a]			
Steers	392.3	724.2	961.5
Bulls	404.2	744.9	971.9
Age[b]	1.879	-.5	---
Weaning weight[b]	---	-.098	0.89**
Post-weaning gain[b]	---	---	93.18*
Start. test weight[b]	---	1.159**	---
140 day gain[b]	---	33.41	---
168 day gain[b]	---	---	174.6**

a Least square means

b Regression coefficients

* ($P < .05$)

** ($P < .01$)

Table 9 Correlation Coefficients Between Performance Traits

Trait		2	3	4	5	6	7	8	9	10
Weaning weight	1	0.80**	0.91**	0.62**	0.49**	0.49**	0.76**	0.34*	0.06	0.03
Weaning age	2		0.69**	0.69**	0.07	0.07	0.37*	0.43**	0.14	-.01
Adj.weaning wt.[a]	3			0.60**	0.56**	0.56**	0.56**	-.05	0.08	0.04
Post wn. gain[b]	4				0.40*	0.40*	0.51**	0.10	0.12	0.09
Adj. yrlg. wt.[c]	5					1.00	0.70**	-.07	0.42**	0.43**
Adg. yr. WDA[d]	6						0.70**	-.06	0.43**	0.43**
Start. test wt.[e]	7							0.51**	0.11	0.13
Start test age[f]	8								-.08	-.03
140 day gain	9									0.94**
168 day gain	10									

a Adjusted weaning weight
b Post-weaning gain/day
c Adjusted yearling weight
d Adjusted yearling weight/day of age
e Starting test weight
f Starting test age
* (P <.05)
** (P <.01)

Table 10 Sire Effects on Average Weaning, Yearling and Slaughter Weights

Trait	Average weaning weight	Average yearling weight	Average slaughter weight
Sire[d]			
11 (Galloway)	430.8[ab]	732.8	965.8
36 (Shorthorn)	452.5[a]	720.0	1004.0
37 (Shorthorn)	368.5[bc]	730.4	920.7
38 (Hereford)	392.3[ab]	724.2	961.5
39 (Shorthorn)	380.1[bc]	717.4	956.8
40 (Hereford)	326.1[c]	741.4	918.6
93 (Angus)	375.8[bc]	705.1	908.9
Age[e]	1.698**	-.196	---
Weaning weight[ef]	---	0.062	0.898*
Start. test wt.[eg]	---	0.954	---
Post wn. gain[eh]	---	---	4.338
168 day gain	---	---	203.2**
140 day gain	---	73.69**	---

a,b,c Means in the same column bearing a different superscript differ significantly (P<.05).
d Least square means.
e Regression coefficients.
f Weaning weight.
g Starting test weight.
h Post weaning gain.
* (P<.05).
** (P<.01).

Table 11 Sire Weaning Weight and Age Effects on Test Gains

Trait	Post weaning gain/day, lb.	140 day gain/day, lb.	168 day gain/day, lb.
Sire[d]			
11 (Galloway)	1.71	2.54[bc]	2.48[c]
36 (Shorthorn)	1.57	2.37[c]	2.33[c]
37 (Shorthorn)	1.44	2.30[c]	2.41[c]
38 (Hereford)	1.49	2.36[c]	2.32[c]
39 (Shorthorn)	1.31	2.40[c]	2.39[c]
40 (Hereford)	1.50	3.06[a]	3.07[a]
93 (Angus)	1.66	2.82[ab]	2.83[ab]
Weaning wt.[ef]	--	0.002*	0.001
Age[e]	0.008**	0.002	0.003

a,b,c Means in the same column bearing a different superscript differ significantly ($P<.01$).

d Least square means.

e Regression coefficients.

f Weaning weight.

Table 12 Sex Weaning Weight and Age Effects on test Gains

Trait	Post weaning gain/day, lb.	140 day gain/day, lb.	168 day gain/day, lb.
Sex[c]			
Steers	1.49	2.36[b]	2.32[b]
Bulls	1.58	2.80[a]	2.69[a]
Age	0.001	-.011	-.004
Weaning wt.[de]	0.003	0.005	0.004

a,b Means in the same column bearing a different superscript differ significantly ($P<.05$).

c Least square means.

d Regression coefficients.

e Weaning weight.

Summary

The results of this test indicate that sire had a highly significant ($P<.01$) effect on adjusted weaning weight and test ADG. Since these traits are of great economic importance they should be strongly considered when selecting a herd sire. This is in contrast with finding of Teagarden (1968).

Age also had a significant ($P<.05$) effect on weaning weight and post-weaning ADG. Older calves had heavier weaning weights and younger calves had higher post-weaning ADG. The high gaining progeny group during the 168 test was the youngest progeny group on test. Since, this pen of calves were from first calf heifers, this gain could well have been compensatory.

When comparing bulls to steers, sex had a highly significant ($P<.01$) effect on test ADG. The bulls averaged 0.44 pound/day more than steers and were more efficient than steers. Bulls required 6.46 pounds feed/pound gain and steers 7.55. Bulls averaged 12 pounds heavier than steers at weaning but this difference was not significant.

There was a sex by sire interaction which indicated that some sires produced heavier weaning weights for male calves than females and vice versa.

Most correlation coefficients between performance traits and carcass traits were highly significant ($P<.01$) and indicate that these traits are positively related and can be selected for in a selection program with expectations of improving most of these traits through selection for one or two of them.

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CHAPTER II

Effectiveness of Grading Steers as Feeders and Slaughter Steers Using Three Methods of Grading

Subjective measures have been used by animal scientists and researchers throughout the world to improve the effectiveness of existing methods of evaluating superior live animal phenotypes.

Hultz (1927) reported that shape and pattern in cattle changed during a feeding period and that weaning grade was not highly correlated to slaughter grade. Lush (1932) found little relationship between type of animal and subsequent performance. McKee (1967) found sex had no effect on weaning grade, but he reported a significant correlation (0.58) between live animal grade and muscling scores which he felt indicated that traits are recognizable as animals undergo changes in age and weight.

Gregory _et al_. (1962) recorded evaluations by three graders immediately prior to slaughter on 204 steers. This study indicated that mean group estimates of carcass weight, fat thickness at the 12th rib, percent kidney fat, ribeye area at the 12th rib, cutability and carcass quality grade in live cattle were reasonably accurate when done by trained personnel. Also, these workers reported that cutability (Yield grade) can be visually appraised more accurately than carcass quality grade. Lewis, Suess and Kauffman (1969) reported that trained personnel could account for more than half of the variation in carcass traits, with greatest accuracy in estimating fat thickness where three-fourths of the variation was accounted for by subjective estimates.

Experimental Procedure

Thirty-one steers and six bulls by 7 performance tested sires were used in this study. Post weaning and feedlot gain tests were conducted at the

Agricultural Experiment Station, Manhattan, Kansas. All cattle were slaughtered at Wilson Certified Foods Packing Plant, Kansas City, Kansas.

A committee of four judges scored the calves at the beginning and ending of the feeding test using three methods of live grading. The first method (Method I) was the standard system of U.S.D.A. feeder and slaughter grades (table 2). The second (Method II) was the system developed by Ankony Farms (table 3). The third (Method III) was a scoring system developed by Dr. Harlan Ritchie, Michigan State University and Dr. Gary Minish, Virginia Polytechnic Institute (table 4).

The statistical procedures followed were described by Harvey (1960) and Snedecor (1956).

Results and Discussion

Feeder Grades. No significant sire or sex effect was found for all feeder traits scored (tables 13 and 14).

Weaning weight had a significant ($P<.01$) effect on all traits scored except predeposition of fat (Method II) (table 13). Because predeposition of fat was not effected by weaning weight, this indicates animal weight did not influence this score. However, in general it should be pointed out that heavier calves at weaning had the higher feeder scores.

Age had a significant effect on feeder traits graded (table 13). Age significantly lowered except predeposition of fat score (Method II) (table 13). Similar results were found by Waugh and Marlowe (1969).

In both bulls and steers, weaning weight had a significant effect on most traits scored under Method II and III, with heavier weaning weights increasing scores, except in Method II predeposition of fat where no effect was noted (table 14).

Correlation coefficients between feeder and slaughter grades are shown in table 15. Most of the correlations were highly significant ($P<.01$) and indicate that traits are recognizable as animals undergo changes in weight. This is shown by the significant ($P<.05$) correlations of muscle scores for Method II and III with carcass conformation of 0.40 and -.38, respectively. Similar results were reported by McKee (1967).

A correlation coefficient of 0.45 between feeder frame score (Method II) and carcass yield grade indicates the larger framed steers have higher yield grades (closed to 5.0). These results are probably due to the narrow range in size of the steers in this study as this contrasts with findings of Allen (1963) who reported that longer larger-framed cattle were trimmer.

Method I feeder score and Method II and III frame score were highly significantly ($P<.01$) correlated with carcass and round length (table 16). These results indicate that cattle which produce longer carcasses and rounds could be selected for as feeders.

Slaughter grades. Slaughter grade (Method I) and structure score (Method II) at slaughter time were significantly ($P<.01$) effected by sire (table 7). Sire also had a significant ($P<.05$) effect on muscle score (Method II). Sire 38 (Hereford) produced significantly lower slaughter grades than any other sire except sire 11 (Galloway). Sire 11 (Galloway), sire 36 and 37 (Shorthorn), and sire 40 (Hereford) produced steers with no significant difference in slaughter grade. Sire 93 (Angus) and sire 39 (Shorthorn) produced steers with significantly higher slaughter grades than sire 11 (Galloway) and sire 38 (Hereford) but not not significantly different than the other sires.

Muscle score (Method II) showed that sire 11 (Galloway) produced steers with significantly lower scores than all other sires except sires 36 and 37 (Shorthorns). However, there was no significant difference between these two sires and all others except sire 39 (Shorthorn) (table 17). The fact that there was a significant difference in Method II muscle score and not Method III muscle score indicates that scoring systems definitely influence results and that further study of methods of scoring is needed.

Sire 11 (Galloway) produced calves that were significantly ($P<.05$) poorer in structure Method II, than calves from any of the other sires.

Slaughter weight significantly ($P<.01$) increased slaughter grade (Method I) and Methods II and III frame scores (table 18) in both bulls and steers. Method II structure score also significantly ($P<.05$) increased due to slaughter weight in both bulls and steers.

When scoring U.S.D.A. slaughter grade (Method I) the committee scored bulls significantly ($P<.01$) lower than steers. Arthaud _et al._ (1969), Meiske (1969), Hedrick, Thompson and Krause (1969), and Champagne _et al._ (1969), agree that bulls have lower marbling scores and grade lower than steers. Steers were scored as being significantly larger framed than bulls (table 18) using Method II frame score.

The correlation coefficints between slaughter grade and objective carcass measurements are presented in table 19. Slaughter grade as scored by Method I had a highly significant ($P<.01$) relationship with marbling (0.43), carcass quality grade (0.41), and yield grade (0.51). This indicates that the committee estimates of U.S.D.A. slaughter grade was related to carcass grade but only accounted for approximately 16 percent of the variation. It should be remembered that this is an attempt by the scoring committee to estimate to the nearest one-third of a grade and the correlation would probably be higher if correlated to the nearest full grade. The predeposition of fat score (Method II), showed a highly significant ($P<.01$) negative correlation (-.50) with carcass yield grade indicating the committee was successful in predicting which animals would be more highly finished at slaughter time using this scoring system. Carcass conformation was significantly (P<.01) related to Method II muscle score (0.51). This was a higher relationship than was found between Method III muscle score and carcass conformation (-.38). This indicates that when scoring muscle or conformation score, a scoring system with a wider scoring range should be used. Also, these relationships indicate that something other than what the committee was scoring as muscling was influencing carcass conformation.

The committee evaluation of size was reasonably accurate as shown in table 19. The committee estimates of slaughter grade (Method I) was influenced by size of the animal as is evident by the highly significant (P<.01) relationships to other size estimates and objective carcass measurements (table 19). High positive correlations were found particularly between Method II and III frame scores and round length of 0.84 and 0.81, respectively. This indicates that frame score as estimated by the committee was obviously greatly influenced by the height of the animal. Highly significant (P<.01) but slightly lower correlations are noted between these same two variables and carcass length (table 19).

Summary

Sire and age had highly significant (P<.01) effects on U.S.D.A. slaughter grade while age also significantly effected (P<.01) the committee's scoring of frame under both Methods II and III. There was no major difference between scoring bulls and steers for traits except when scoring U.S.D.A. slaughter grades where bulls were scored significantly (P<.01) lower.

Age had significant (P<.05) or highly significant (P<.01) effects on all traits scored as feeders except the predeposition of fat score (Method II).

Correlations between traits scored at slaughter with themselves and carcass traits were very similar to correlations found between feeder scores and these same traits. This would indicate that scoring feeder steers has similar value in a selection program to the scoring of these steers at slaughter.

These results indicate that all three systems of grading have merit but that in a selection program possibly a grading system where several traits are scored would bo of more value than one where a single score is placed on the animal.

Table 13 Sire Weaning Weight and Age Effects on Feeder Traits Scored

Trait	Method I[d]	Method II[e]				Method III[f]	
	conformation	fat	muscle	frame	structure	frame	muscle
Sire[a]							
11 (Galloway)	11.6	4.8	4.3	5.1	6.3	3.0	3.4
36 (Shorthorn)	11.5	4.2	4.5	5.5	6.3	3.0	3.2
37 (Shorthorn)	11.9	4.5	5.1	5.2	6.5	2.9	2.9
38 (Hereford)	11.6	4.7	5.0	4.8	5.9	2.8	3.0
39 (Shorthorn)	12.4	4.6	5.4	5.5	7.3	3.3	2.8
40 (Hereford)	11.9	5.3	5.7	5.4	7.4	3.3	2.6
93 (Angus)	12.0	5.4	4.8	5.0	6.7	3.1	3.1
Wn. wt.[bc]	0.014**	0.005	0.012**	0.017**	0.008**	0.013**	-.006**
Age[c]	-.028**	-.006	-.018**	-.028**	-.012*	-.022**	0.009*

a Least square means.
b Weaning weight.
c regression coefficient.
d scoring system, table 2.
e scoring system, table 3.
f scoring system, table 4.

Table 14 Sex, Weaning Weight and Age Effects on Feeder Traits Scored

Trait	Method I[d]	Method II[e]				Method III[f]	
	conformation	fat	muscle	frame	structure	frame	muscle
Sex[a]							
Steers	11.6	4.7	5.0	4.8	5.9	2.9	3.0
Bulls	11.9	4.6	5.3	5.3	6.1	3.2	2.9
Wn. wt.[bc]	0.023**	0.011	0.013*	0.029*	0.018*	0.015*	-.013*
Age[c]	-.009	-.026	0.024	-.020	-.014	-.010	0.002

a Least square means.

b Weaning weight.

c Regression coefficient.

d Scoring system, table 2.

e Scoring system, table 3.

f Scoring system, table 4.

* $(P<.05)$.

** $(P<.01)$.

Table 15 Correlation Coefficients Between Weaning and Slaughter Grades

		2	3	4	5	6	7	8	9	10	11	12	13	14
I[a]	1	0.40*	0.72**	0.77**	0.69**	0.76**	-.73**	0.52**	0.03	0.38*	0.63**	0.24	0.54**	-.10
II Fat	2		0.10	0.48**	0.46**	0.53**	-.15	0.16	0.45**	0.22	0.55**	0.08	0.44**	-.02
II Muscle	3			0.63**	0.64**	0.61**	-.91**	0.63**	-.43**	0.56**	0.51**	0.36*	0.48**	-.29
II Frame	4				0.67**	0.95**	-.65**	0.62**	-.16	0.33*	0.82**	0.21	0.74**	-.18
II Structure	5					0.64**	-.62**	0.72**	0.04	0.37*	0.59**	0.26	0.52**	-.17
III Frame	6						-.58**	0.57**	-.08	0.41*	0.83**	0.21	0.78**	-.15
III Muscle	7							-.62**	0.34*	-.60**	-.57**	-.40*	-.44**	0.47**
I[b]	8								-.38*	0.45**	0.60**	0.40*	0.53**	-.22
II Fat	9									-.08	0.02	-.10	0.02	0.15
II Muscle	10										0.50**	0.67**	0.46**	-.35*
II Frame	11											0.28	0.88**	-.22
II Structure	12												0.24	-.13
III Frame	13													-.03
III Muscle	14													

[a] Weaning grades.
[b] Slaughter grades.
* (P<.05).
** (P<.01).

Table 17 Sire Slaughter Weight and Age Effects on Slaughter Traits Scored

Trait	Method I[g]	Method II[h]				Method III[i]	
	conformation	fat	muscle	frame	structure	frame	muscle
Sire							
11 (Galloway)	12.1^{bc}	4.7	4.4^{f}	5.6	4.2^{b}	3.1	3.1
36 (Shorthorn)	12.5^{ab}	3.7	4.9^{ef}	5.4	5.5^{a}	3.1	3.0
37 (Shorthorn)	12.5^{ab}	3.6	4.9^{ef}	4.9	5.6^{a}	2.8	2.9
38 (Hereford)	11.9^{c}	4.4	5.4^{de}	5.7	5.7^{a}	3.3	2.9
39 (Shorthorn)	12.7^{a}	4.5	5.7^{d}	5.7	5.6^{a}	3.2	2.8
40 (Hereford)	12.6^{ab}	3.9	5.5^{de}	5.1	5.7^{a}	3.0	2.9
93 (Angus)	12.9^{a}	3.9	5.5^{de}	5.4	6.0^{a}	3.1	3.0
Sl. wt.	0.009^{**}	$-.021^{*}$	$-.004^{*}$	$-.008^{**}$	0.013	$-.010^{**}$	0.001

a,b,c Means in the same column bearing a different superscript differ significantly ($P < .01$).
d,e,f Means in the same column bearing a different superscript differ significantly ($P < .05$).
g Slaughter weight-regression coefficients.
f Age-regression coefficients.
g Scoring system, table 2.
h Scoring system, table 3.
i Scoring system, table 4.

Table 16 Correlation Coefficients Between Weaning Grade (Method I) and Methods II and III Frame Score with Carcass Measurements

Trait		2	3	4	5	6
Method I (weaning grade)	1	0.78**	0.76**	0.54**	0.58**	0.60**
Method II (frame score)	2		0.95**	0.74**	0.75**	0.79**
Method III (frame score)	3			0.72**	0.78**	0.85**
Hot Carcass Weight	4				0.82**	0.79**
Carcass length	5					0.84**
Round length	6					

** Significant at ($P < .01$).

Table 18 Sex, Slaughter Weight and Age Effects on Slaughter Traits Scored

Trait	Method I[h]	Method II[i]				Method III[j]	
	conformation	fat	muscle	frame	structure	frame	muscle
Sex[e]							
Steers	11.9[a]	4.4	5.4	5.7[c]	5.7	3.3	2.9
Bulls	10.9[b]	4.0	5.2	4.1[d]	4.8	2.5	3.0
Sl. wt.[fg]	0.008**	0.002	0.007**	0.014**	0.007*	0.006**	-.002

a,b Means in the same column bearing a different syperscript differ significantly ($P < .01$).

c,d Means in the same column bearing a different superscript differ significantly ($P < .05$).

e Least square means.

f Regression coefficients.

g Slaughter weight.

h Scoring system, table 2.

i Scoring system, table 3.

j Scoring system, table 4.

Table 19 Correlation Coefficients Between Slaughter Grade (Method I) and Methods II and III Frame Score with Carcass Measurements

Trait		2	3	4	5	6
Method I (slaughter grade)	1	0.60**	0.53**	0.67**	0.55**	0.50**
Method II (frame score)	2		0.88**	0.73**	0.77**	0.84**
Method III (frame score)	3			0.65**	0.74**	0.81**
Hot carcass weight	4				0.82**	0.79**
Carcass length	5					0.84**
Round length	6					

** Significant at ($P<.01$).

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CHAPTER III

Ultrasonics

Ultrasonics have been used in recent years in an attempt to more accurately estimate the body composition of animals. Several workers have reported varying degrees of success and ultrasonics are now routinely used by many breeders in their selection programs.

Temple et al. (1956), using an ultrasonic instrument known as a "somascope," found it provided a reliable indication of fat thickness in live cattle. Davis et al. (1964) using the Branson Sonoray reported correlations between ultrasonics estimates and corresponding carcass measurements for loin eye area and fat thickness of 0.87 and 0.90, respectively.

McReynolds and Arthaud (1970a) reported use of a "B" scan instrument, in which a Polaroid Photograph was taken of the oscilloscope as the animal was scanned, gave greater accuracy than the "A" scan where readings were taken at stationary positions. With 132 cattle they obtained a correlation between estimated fat and carcass fat of 0.25 when using the "A" scan and 0.59 with the "B" scan. McReynolds and Arthaud (1970b) ultrasonically scanned six bulls and four steers at four six week intervals starting at approximately 230 days old. Their findings suggested that a curvilinear relationship existed between live weight and fat deposition. A correlation of 0.95 was found between the estimated ribeye area and the actual carcass ribeye area.

Research using ultrasonics for measuring fat thickness and ribeye area (longissimus dorsi muscle) in cattle, indicate that ultrasonics can be used as a tool for selective breeding programs.

This study was designed to investigate the use of ultrasonics in selecting calves at weaning as yearlings or as slaughter steers.

Experimental Procedure

Thirty one steers and six bulls by seven performance tested sires representing four breeds were used in this study. All calves were fed a growing ration for 94 days post weaning followed by a high concentrate ration for 168 days pre-slaughter.

All calves were sonorayed by the same technician, three different times, 112 days apart during the feeding phase. The Anscan model 421, King KC 79-29 transducer and swine guide were used the first two periods. The third period, 24 hours preslaughter, the same machine was used with a cattle guide. The third time ribeye area could be estimated only on 13 of the 37 animals. Ribeye area analysis and regression equations for Anscan at slaughter was based on only these 13 animals. Fat thickness and ribeye area at the 12th rib was estimated on the right side of each animal each of the three measuring periods. Interpretation of the polaroid pictures was done by the technician.

All animals were slaughtered immediately after the 168 day test. After a 24 hour chill, the right side of each carcass was ribbed between the 12th and 13th ribs and fat thickness (Ramsey et al. 1962) and ribeye area (Nauman, 1952) were measured.

The statistical procedures followed were described by Harvey (1960) and Snedecor (1956).

Results and Discussion

<u>Anscan at Weaning</u>. Weight, fat thickness and ribeye area means with standard deviations are presented in table 20. Estimated and actual fat thickness and ribeye areas are presented in tables 21 and 22. In comparing bulls with steers, fat thickness was significantly ($P<.05$) effected by age with calves having 0.003 more fat thickness for each day increase in age. Steers were significantly fatter than bulls (table 22). When using only steer data, significant age differences were not found (table 21). This would agree with the findings of Meiske (1969) who reported significantly ($P<.01$) less fat thickness on bulls carcasses than on steer carcasses. Ribeye area was significantly ($P<.05$) effected by weight (table 21).

Estimated fat thickness at weaning was highly significantly ($P<.01$) correlated (0.50) with actual carcass fat thickness (table 23). This indicates that fatter calves at weaning tend to have fatter carcasses and fat thickness could be selected against in a selection program where replacement animals are selected at weaning.

Correlations between estimated ribeye area at weaning and actual ribeye area at slaughter was 0.37. This correlation indicates that this carcass trait can not be predicted with great accuracy using anscan at weaning.

Multiple regression equations were derived and are shown in table 24. Equation one accounts for 25 percent of the variation in actual fat thickness using anscan estimates at weaning. Equation two accounting for 42 percent of the variation gives greater accuracy in estimating ribeye area.

<u>Anscan at One Year of Age</u>. Sex had a highly significant ($P<.01$) effect

on fat thickness with steers being fatter than bulls (table 22). Ribeye area was significantly ($P<.05$) effected by age in both bulls and steers (table 22). Meiske (1969) reported that bulls had larger ribeye areas than steers.

The correlation between estimated and actual fat thickness was 0.22. This would indicate selection at this point for fat thickness would have very little merit. A highly significant ($P<.01$) correlation (0.42) was found between estimated ribeye area of yearlings with actual ribeye area when slaughtered. This indicates that ribeye area can possibly be selected for as yearlings.

Multiple regression equation number three (table 24) accounted for 16% of the variation in fat thickness. Equation four increases the variation accounted for by the prediction equation to 23%.

Anscan at Slaughter. Sex had a highly significant ($P<.01$) effect on fat thickness with steers being the fatter (table 22). These findings agree with those of Meiske (1969). No significant sire effect was found on fat thickness and ribeye area. Due to mechanical difficulty, only 13 observations could be used in the analysis for ribeye area (tables 21 and 22).

Highly significant ($P<.01$) correlations were found between estimated and actual fat thickness and ribeye area of 0.76 and 0.65, respectively.

Using multiple equations five and six (table 24), 69 and 72 percent of the variation in fat thickness and ribeye area, respectively, was accounted for. These could be used with reasonable accuracy in predicting fat thickness and ribeye area of slaughter animals.

Table 20 Ultrasonic Estimates of Fat Thickness and Ribeye Area by Periods

No. of Animal	Period	Liveweight, lbs.		Fat thickness, in.		Loineye area, sq.in.	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
37	weaning	436	66.0	0.21	0.05	4.75	.63
	Yearling	677	85.0	0.40	0.07	7.28	1.03
	Slaughter	967	94.2	0.50	0.09	----	----
13	Slaughter	986	130.0	----	----	11.40	1.43

Table 21 Sire, Age and Weight Effects on Estimated and Actual Fat thickness and Ribeye Area

Trait	Anscan at Weaning		Anscan at one year		Anscan at Slaughter		Actual	
	Fat[a]	REA[b]	Fat[a]	REA[b]	Fat[a]	REA[b]	Fat[a]	REA[b]
Sire[c]								
11 (Galloway)	0.21	5.06	0.40	7.22	0.56	----	0.44	10.39
36 (Shorthorn)	0.23	4.22	0.42	6.93	0.58	----	0.67	9.86
37 (Shorthorn)	0.21	5.05	0.38	7.56	0.41	----	0.45	10.00
38 (Hereford)	0.23	4.76	0.44	6.77	0.54	----	0.54	10.28
39 (Shorthorn)	0.20	4.15	0.37	6.45	0.48	----	0.49	10.39
40 (Hereford)	0.21	4.86	0.37	7.55	0.45	----	0.40	10.48
93 (Angus)	0.22	5.36	0.41	7.86	0.51	----	0.41	10.34
Age[d]	0.000	0.080*	0.000	0.030	0.001	----	----	-----
Weight[d]	-.004	0.005	0.001	0.005	0.000	----	----	-----

a Fat thickness, in.
b Ribeye area, sq. in.
c Least square means.
d Regression coefficients
* (P<.05).

Table 22 Sex, Age and Weight Effects on Estimated and Actual Fat Thickness and Ribeye Area

Traits	Anscan at Weaning		Anscan at one year		Anscan at slaughter		Actual	
	Fat[f]	REA[g]	Fat[f]	REA[g]	Fat[f]	REA[g]	Fat[f]	REA[g]
Sex[h]								
Steer	0.23	4.76	0.44[a]	6.77	0.54[c]	12.09[e]	0.52	10.39
Bulls	0.20	4.70	0.38[b]	7.91	0.30[d]	12.10[e]	0.42	12.18
Age[hi]	0.003*	0.019	0.000	0.066*	0.001	-----	----	----
Weight[i]	0.000	0.004	0.001	0.001	0.000	-----	----	----

a,b Means in same column with different superscript differ significantly (P<.05).

c,d Means in same column with different superscript differ significantly (P<.01).

e Reading on three steers and six bulls only.

f Fat thickness, in.

g Ribeye area, sq. in.

h Least square means.

i Regression coefficients.

* (P<.05).

Table 23 Correlation Coefficients Between Estimated and Actual Fat Thickness and Ribeye Area

Trait		2	3	4	5	6	7	8	9	10	11
Wn. fat[a]	1	0.18	0.57**	0.50**	0.20	----	0.56**	----	----	-.24	0.50**
Wn. REA[b]	2		0.45**	0.26	0.53**	----	0.15	----	----	0.28	0.08
Wn. wt.[c]	3			----	----	----	----	----	----	0.36*	0.45**
Yr. fat[d]	4				0.11	0.40*	0.41*	----	----	-.03	0.42**
Yr. REA[e]	5					0.51**	0.21	----	----	0.22	0.34*
Yr. wt.[f]	6						----	----	----	0.48**	0.40*
Sl. fat[g]	7							0.37*	0.28	-.14	0.76**
Sl. REA[hi]	8								0.65*	0.65*	0.43
Sl. wt.[j]	9									0.56**	0.44**
Car. REA[k]	10										-.10
Car. fat[l]	11										

a Weaning fat thickness
b Weaning ribeye area
c Weaning weight
d Yearling fat thickness
e Yearling ribeye area
f Yearling weight
g Slaughter fat thickness
hi Slaughter ribeye area, on three steers and six bulls
j Slaughter weight
k Carcass ribeye area
l Carcass fat thickness
* (P<.05)
** (P<.01)

Table 24 Multiple Regression Equations for Estimating Carcass Fat Thickness and Ribeye Area

Period	Equation number	Equation
Weaning	1	$Yi = 0.11323 + 1.7216(X_1)$
	2	$Yj = 8.4544 - 17.7015(X_1) = 0.0136(X_2)$
Yearling	3	$Yi = -.01207 + 0.0007(X_3)$
	4	$Yj = 5.98792 + 0.0068(X_3)$
Slaughter	5	$Yi = -.50999 + 1.0213(X_4) - .0071(X_5) + 0.0005(X_6)$
	6	$Yj = 3.63274 - 9.5904(X_4) + 0.4558(X_5) + 0.0071(X_6)$

(X_1) = weaning fat thickness

(X_2) = weaning weight

(X_3) = yearling weight

(X_4) = slaughter fat thickness

(X_5) = slaughter ribeye area

(X_6) = slaughter weight

Yi = estimated fat thickness

Yj = estimated ribeye area

Summary

The relationship between estimated fat thickness and ribeye area with actual fat thickness and ribeye area was studied using 37 animals (only 13 animals were used in estimating anscan for ribeye area at slaughter).

Correlation coefficients between estimated and actual fat thickness (0.76) and ribeye area (0.65) were found using anscan at slaughter.

Equations were developed which could be used for evaluating fat thickness and ribeye area in a selection program. Multiple regression equations at weaning and yearling accounted for 22 and 16 percent, respectively, of the variation in fat thickness. While 42 and 23 percent, respectively, were accounted for in ribeye area. Equation using anscan at slaughter accounted for 69 and 72 percent of the variation in fat thickness and ribeye area, respectively, which could be used more accurately than equations developed from weaning and yearling anscan readings.

More work is needed in relating anscan pictures with actual carcass measurements of these two traits before accurate selection of breeding animals using the anscan method can be realized.

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CHAPTER IV

Carcass Evaluation

The distribution of fat plays an important role in the composition of the meat animal and the subsequent carcass. As percent of fat increases, lean content decreases. Berg and Butterfield (1968) reported that in normal slaughter weight ranges, as weight increases muscle and bone percentage decreases while fat increases.

Allen (1963) reported that there is a rather low correlation 0.20 between fat thickness at the 12th rib and marbling score.

Cahill et al. (1956) reported a correlation of 0.85 between ribeye area at the 12th rib and percent edible portion of the carcass. Kauffman et al. (1968) reported that ribeye measurements were similar for breeds. Briskey and Bray (1964) concluded that emphasis upon size of the ribeye muscle may be justified because it comprises a large proportion of two of the high priced wholesale cuts of beef, although the influence of ribeye area upon retail yield is small compared to that of fat.

Wilson et al (1969) using 11 different polled Hereford bulls, found a significant ($P<.05$) sire effect for lean tenderness, ribeye area, percent cut-out and weights and percentages of untrimmed and trimmed round and loin.

Meiske (1969) worked with bulls, heifers and steers by one sire and similarly bred dams. Bull carcasses had significantly less ($P<.01$) fat thickness; less ($P<.01$) kidney, pelvic, and heart fat; lower ($P<.01$) marbling scores; and lower ($P<.01$) carcass quality grades; but significantly ($P<.01$) higher yield grades or percentage retail yield than either the steer or heifer carcasses. Bull and steer carcasses had larger ribeyes than heifer carcasses. Champagne et al. (1969) found the U.S.D.A. formula for trimmed, boneless retail cuts underestimated true yield of bull carcasses by approximately two percentage points. With these factors in mind, this study was designed to investigate sire and sex influences on carcass grade factors.

Experimental Procedure

Thirty-one steers and six bulls by four breeds (Hereford, Angus, Galloway, and Shorthorn) were used in this study. These sires were mated to commercial cows from one herd. All calves were fed a growing ration for 94 days and a finishing ration for 168 days from weaning to slaughter.

All animals were slaughtered immediately after the 168 day test at Wilson Certified Foods Packing Plant, Kansas City, Kansas. The right side of each carcass was broken between the 12th and 13th rib with fat thickness (Ramsey, Cole and Hobbs, 1962) and ribeye area (Naumann, 1952) being measured. Carcass quality grade factors and yield grade factors were measured or estimated with color and texture of lean being scored (table 6). Round length was measured from the anterior edge of the aitch bone to the epiphyseal plate and carcass length from the anterior edge of the first rib to the anterior edge of the aitch bone.

Statistical analysis was done using analysis of variance by the least squares method described by Harvey (1960) and Snedecor (1956).

Results and Discussion

Conformation. Slaughter weight had significant ($P<.05$) effect on conformation as shown in table 25. Bull carcasses had higher conformation scores than steer carcasses but the difference was not significant (table 26).

Correlation coefficients between conformation and performance and carcass traits are presented in table 27. These correlations indicate that the larger more growthy cattle had a decided advantage in carcass conformation score and as was expected, they also had larger ribeyes.

Marbling. Sire had a significant ($P<.05$) effect on marbling (table 25). Sire 93 (Angus) produced progeny with significantly higher marbling scores (table 25) than either of the Hereford sires, but these progeny were not significantly different than those sired by the Shorthorn or the Galloway. Sire 40 (Hereford) produced progeny with the lowest marbling scores being significantly lower than all progeny groups except sire 38 (Hereford) and sire 36 (Shorthorn). These findings support those of Butler *et al.* (1962) who reported that Angus steers had significantly higher marbling scores than Herefords. These results indicate that marbling can be selected for in a selection program and that carcass evaluation for this trait should be a part of a selection program.

Correlation coefficients between marbling with performance and other carcass traits are shown in table 27. One highly significant ($P<.01$) negative correlation (-.52) between marbling and adjusted yearling weight/day of age indicates the faster growing animals had lower marbling score. The correlation of 0.36 between fat thickness and marbling is slightly higher than the value of 0.20 reported by Allen (1963). This infers that the relationship between outside fat cover and marbling is very low as fat thickness only accounts for 14 percent of the variation in marbling in this study.

Table 25 Sire, Slaughter Weight and Fat Thickness Effects on Carcass Measurements

Trait	Conformation[d]	Maturity[d]	Marbling[d]	Final Grade[d]
Sire[e]				
11 (Galloway)	12.1	14.5	17.2[ab]	12.7[a]
36 (Shorthorn)	13.0	15.1	15.9[abc]	12.6[a]
37 (Shorthorn)	13.8	14.7	17.1[ab]	13.0[a]
38 (Hereford)	13.4	14.8	13.7[bc]	12.0[ab]
39 (Shorthorn)	12.9	15.0	16.3[ab]	12.8[a]
40 (Hereford)	12.9	15.0	13.1[c]	11.1[b]
93 (Angus)	13.1	15.0	18.8[a]	13.0[a]
Sl. weight[f]	0.006*	-.001	0.004	0.002
Fat th.[f]	-.080	-----	6.090	-----

a,b Means in same column with different superscript differ significantly ($P<.05$).
d For scoring procedure, refer to table 6.
e Least square means.
f Regression coefficients.
* ($P<.05$).

Table 26 Sex, Slaughter Weight and Fat Thickness Effects on carcass Measurements

Trait	Conformation[c]	Maturity[c]	Marbling[d]	Final Grade[c]
Sex[d]				
Steer	13.4	14.8	13.7	12.0[a]
Bull	14.5	14.5	12.0	10.1[b]
Sl. weight[e]	0.004	-.003*	-.006	0.002
Fat th.[e]	-2.828	-----	9.993*	-----

a,b Means in same column with different superscript differ significantly ($P<.05$).

c For scoring procedure, refer to table 6.

d Least square means.

e Regression coefficients.

* ($P<.05$).

Table 27 Correlation Coefficients Between Performance and Carcass Traits[a]

		2	3	4	5	6	7	8	9	10	11	12
Weaning wt.	1	0.80	0.91	0.49	0.49	0.76	0.34	0.06	0.03	0.61	0.17	-.16
Age weaning	2		0.69	0.14	0.23	0.38	0.43	0.01	-.01	0.29	0.01	-.18
Adj. wn. wt.	3			0.56	0.56	0.56	-.05	0.08	0.04	0.47	0.04	-.24
Adj. yr. wt.	4				1.00	0.70	-.07	0.42	0.43	0.78	0.37	0.04
Adj. yr. wt/day of age	5					0.70	-.06	0.43	0.43	0.78	0.38	-.03
Beginning 140 day wt.	6						0.51	0.11	0.13	0.86	0.40	-.04
Beginning 140 day age	7							-.08	-.03	0.39	0.27	0.10
140 day gain/day	8								0.94	0.57	0.48	0.20
168 day gain/day	9									0.62	0.47	0.16
Slaughter weight	10										0.56	0.06
Loin eye area	11											0.84

Table 27 continued

		13	14	15	16	17	18	19	20	21	22	23	24	25
Weaning weight	1	0.38	0.23	-.22	0.29	0.30	0.04	0.34	-.20	-.08	0.23	0.60	0.52	0.66
Age weaning	2	0.28	0.15	-.12	0.30	0.34	0.02	0.22	-.19	-.19	0.08	0.28	0.12	0.21
Adj. wn. wt.	3	0.26	0.16	-.19	0.23	0.26	0.05	0.31	-.11	-.04	0.12	0.44	0.47	0.61
Adj. yr. wt.	4	0.28	0.36	-.37	-.08	-.14	0.00	0.27	-.11	-.06	0.24	0.74	0.77	0.78
Adj. yr.wt/day/age	5	0.28	0.36	-.38	-.09	-.15	-.01	+.27	-.12	+.05	+.24	0.74	0.79	0.78
Beginn. 140 day wt.	6	0.45	0.35	-.28	0.14	0.10	0.09	0.38	-.20	-.03	0.42	0.86	0.74	0.79
Beginn. 140 day age	7	0.32	0.22	-.07	0.19	0.17	-.01	0.12	-.10	-.02	0.37	0.43	0.12	0.11
140 day gain/day	8	0.16	1.33	-.48	-.35	-.36	-.12	0.00	-.35	-.09	0.06	0.52	0.47	0.39
168 day gain/day	9	0.17	0.42	-.37	-.30	-.31	-.10	0.04	-.23	0.07	0.12	0.57	0.48	0.39
Slaugh. wt.	10	0.44	0.49	-.42	-.04	-.08	0.02	0.32	-.28	0.01	0.40	0.98	0.84	0.83
Loin eye area	11	-.10	0.58	-.58	-.35	-.46	-.33	-.45	-.59	-.27	0.06	0.51	0.40	0.40
Adj. loin eye area	12	-.38	0.38	-.41	-.38	-.49	-.42	-.73	-.49	-.30	-.19	0.01	-.04	-.04
Fat thickness	13		0.07	0.03	0.36	0.38	0.42	0.81	0.16	0.14	0.61	0.53	0.30	0.28
Conformation	14			-.27	-.21	-.24	-.24	-.14	-.28	0.16	0.25	0.50	0.19	0.31
Maturity	15				0.29	0.30	0.13	0.20	0.60	0.48	0.10	-.34	-.33	-.35
Marbling	16					0.95	0.48	0.43	0.43	0.18	0.33	0.04	-.04	-.05
Final grade	17						0.47	0.50	0.43	0.17	0.34	0.01	-.13	-.10
% kidney knob	18							0.66	0.27	0.08	0.51	0.13	0.17	-.01
Yield grade	19								0.42	0.28	0.61	0.43	0.33	0.26
Color of lean	20									0.58	0.31	-.17	-.12	-.27
Texture of lean	21										0.37	0.09	-.05	-.13
Dressing percent	22											0.59	0.32	0.26
Hot carcass wt.	23												0.82	0.79
Carcass length	24													0.84
Round length														

[a] Levels of significance
(P<.01) 0.325
(P<.05) 0.418

Maturity. In both bull and steer carcasses, slaughter weight had a significant ($P<.05$) effect on maturity (table 26) with heavier animals being older.

Correlation coefficients between maturity with performance and carcass traits are found in table 27. As was expected, the correlations observed in the same table between maturity scores increase as measures of animal and carcass weight increase. Carcasses with younger maturity scores also had lighter, more youthful colored lean and finer texture scores than did carcasses that had older maturity scores.

Carcass Quality Grade. Bull carcasses graded significant points lower than steers where a score of 1.0 equals 1/3 of a quality grade.

Carcass quality grade correlation coefficients with performance and carcass traits are shown in table 27.

Ribeye Area. Sire had no significant effect on ribeye area (table 28); which agrees with Wilson *et al.* (1969). Bulls averaging a significant 1.9 square inches more ribeye area than steers (table 29). This is in agreement with Meiske (1969).

Correlation coefficients are shown in table 27 between ribeye area with performance and carcass measures. A highly significant ($P<.01$) correlation between ribeye area and carcass conformation (0.58) indicated that ribeye area has an effect on conformation accounting for approximately 34 percent of the variation in this trait.

Fat Thickness. Bull carcasses averaged a non-significant 0.1 inches less fat than steer carcasses. Correlations coefficients between fat thickness with performance and carcass traits are shown in table 27. The highly significant ($P<.01$) correlation (0.61) between fat thickness and dressing percent indicates that higher finished animals also have higher dressing percent; which is in agreement with results reported by Hankins and Ellis (1939).

Percent Kidney Fat. Fatter bulls and steers have significantly more kidney fat. Correlation coefficients between percent kidney fat with performance and carcass measures are shown in table 27. A highly significant ($P<.01$) correlation between percent kidney fat, with dressing percent (0.51) and marbling (0.48), indicates that carcasses with greater amounts of internal fat are apt to be higher dressing and higher grading carcasses. There was a higher relationship between percent kidney fat and marbling than between outside fat and marbling.

Hot Carcass Weight. Sire and slaughter weight had a highly significant ($P<.01$) effect on hot carcass weight with 31 pounds difference between the high and low progeny group averages. Sire 36 (Shorthorn) produced progeny whose carcasses had significantly heavier weights than all other sires except sire 37 (Shorthorn) (table 28). Sire 11 (Galloway) produced progeny whose carcasses were significantly lighter than all sires except sire 93 (Angus) and sire 38 (Hereford). Carcasses from progeny by these last two sires were not significantly lighter than the carcasses from progeny of any of the other sires except sire 36 (Shorthorn) (table 28).

Correlation coefficients between hot carcass weight with performance and carcass traits are presented in table 27. Results of this section indicate that a large share of the variation in hot carcass weight can be accounted for using performance traits and could be selected for in a selection program.

Yield Grade. Slaughter weight had a significant ($P<.05$) effect on yield grade in both bulls and steers (table 29). Since the correlation between slaughter weight and hot carcass weight was 0.98; and hot carcass weight is a function of yield grade, this effect should be expected.

Sire had no significant effect on yield grade although there was a difference of 0.85 of a hield grade between the high and low progeny groups (table 28). Sex had a significant (P<.05) effect on yield grade with bulls having 1.22 lower yield grades than steers (table 29). This is in agreement with Meiske (1969).

Highly significant (P<.01) positive correlations between yield grade and marbling (0.43) and quality grade (0.50) indicate that fatter carcasses with higher yield grades are also higher grading carcasses with more marbling.

Dressing Percent. Sire had a highly significant (P<.01) effect on dressing percent (table 28). Sire 11 (Galloway) produced progeny which had significantly lower dressing percent values than all other sires except sire 93 (Angus) and sire 38 (Hereford). The progeny by sire 36 (Shorthorn) had the highest dressing carcasses with the highest mean dressing percent of any of the sire groups and being significantly higher than sires 11 (Galloway), 38 (Hereford), and 93 (Angus) (table 28). In studying this same table, it should be noted that the progeny from sire 36 (Shorthorn) also had the greatest mean fat thickness (0.67) which could account for a part of their high dressing percent. However, all of the differences in dressing percent cannot be attributed to fat thickness, since the progeny from sire 40 (Hereford) had the least fat thickness and were not significantly different from the progeny from sire 36 (Shorthorn).

Slaughter weight also had a significant (P<.05) effect on dressing percent. This indicates the fatter, heavier weighing steers (table 28) yielded heavier carcasses. Steers had 1.0 percent higher mean dressing percent values than did bulls but this difference was not significant (table 29).

Highly significant correlation coefficients between dressing percent and performance and carcass measures indicates that greater fat thickness and internal fat increase dressing percent.

Color of Lean. Sire had a highly significant ($P<.01$) effect on color of lean (table 30). Sire 40 (Hereford) produced steers with significantly lighter colored lean scores than any of the other sires except sires 36 and 37 (Shorthorn) and sire 93 (Angus). Progeny by sire 38 (Hereford) had the darkest mean color of lean score but this was not significantly different from the mean color scores of the progeny from sires 11 (Galloway), 39 (Shorthorn) and sire 93 (Angus).

Correlation coefficients are presented in table 27 for color of lean with performance and carcass traits.

Carcass Length. Sire and hot carcass weight had a highly significant ($P<.01$) effects on carcass length (table 30). Progeny from sire 38 (Hereford) had the shortest carcasses, from all other progeny groups except those by sires 37 and 39 (Shorthorn). The progeny groups from these two sires were different significantly from only the progeny group of sire 11 (Galloway).

When comparing bull and steer carcasses, hot carcass weight had a highly significant ($P<.01$) effect on carcass length (table 31). Although bulls averaged 1.3 inches longer than steers, sex had no significant effect.

Correlation coefficients (table 27) for carcass length with 140 day gain/day (0.47), and slaughter weight (0.84), indicate that heavier, faster growing animals have longer carcasses.

Table 28 Sire, slaughter Weight and Fat Thickness Effects on Carcass Traits

Trait	REA, sq. in.	Fat thickness, in.	Percent kidney fat	Hot carcass weight, lb.	Yield grade	Dressing percent
Sire[d]						
11 (Galloway)	10.39	0.44	2.74	561.1[c]	2.94	59.0[c]
36 (Shorthorn)	9.86	0.67	3.01	592.6[a]	3.79	62.1[a]
37 (Shorthorn)	10.00	0.45	3.38	583.6[ab]	3.44	6.13[ab]
38 (Hereford)	10.28	0.52	2.08	572.7[bc]	3.15	60.3[bc]
39 (Shorthorn)	10.39	0.49	2.81	580.6[b]	2.98	61.2[ab]
40 (Hereford)	10.48	0.40	2.20	578.3[b]	3.00	60.8[ab]
93 (Angus)	10.34	0.41	3.12	573.3[bc]	3.14	60.1[bc]
Sl. weight[ef]	----	----	----	0.644**	0.004*	0.082*
Fat thickness[e]	----	----	2.026	14.89	----	0.005

a,b,c Means in same column with different superscript differ significantly (P<.01).
d Least square means.
e Regression coefficients for slaughter weight and fat thickness.
f Slaughter weight.
* (P<.05).
** (P<.01).

Table 29 Sex, Slaughter Weight and Fat Thickness Effects on Carcass Traits

Trait	REA, sq. in.	Fat thickness, in.	Percent kidney fat	Hot carcass weight, lb.	Yield grade	Dressing percent
Sex[f]						
Steers	10.28[b]	0.52	2.08	572.7	3.15[c]	60.8
Bulls	12.18[a]	0.42	1.90	558.0	1.93[d]	58.9
Sl. wt.[e]	----	----	----	0.7145**	0.005*	0.010
Fat thickness[e]	----	----	2.830*	23.16	-----	2.433

a,b Means in same column with different superscript differ significantly (P<.05).

c,d Means in same column with different superscript differ significantly (P<.01).

f Least square means.

e Regression coefficients for slaughter weight and fat thickness.

* (P<.05).

** (P<.01).

Table 30 Sire and Hot Carcass Weight Effects on Carcass Traits

Trait	Color of lean[d]	Texture of lean[d]	Carcass length, in.	Round length, in.
Sire[e]				
11 (Galloway)	6.3^{bc}	6.1	46.6^{a}	24.6
36 (Shorthorn)	7.0^{a}	6.8	46.3^{ab}	24.1
37 (Shorthorn)	6.8^{ab}	6.4	45.3^{bc}	24.0
38 (Hereford)	6.0^{c}	6.4	44.7^{c}	24.2
39 (Shorthorn)	6.4^{bc}	6.2	45.3^{bc}	23.9
40 (Hereford)	7.0^{a}	6.7	46.1^{ab}	23.8
93 (Angus)	6.6^{abc}	6.3	46.1^{ab}	24.3
Hot car. wt.[ef]	----	----	0.017**	0.009**

a,b,c Means in same column with different superscript differ significantly ($P<.01$).

d For scoring precedure, refer to table 6.

e Least square means.

f Regression coefficients.

* ($P<.01$).

Table 31 Sex and Hot Carcass Weight Effects on Carcass Traits

Trait	Color of lean[a]	Texture of lean[a]	Carcass length, in.	Round length, in.
Sex[b]				
Steers	6.0	6.4	44.7	24.2
Bulls	5.7	5.5	46.0	24.1
Hot car. wt.[c]	---	---	0.017**	0.009**

[a] For scoring procedure, refer to table 6.

[b] Least square means.

[c] Regression coefficients.

** ($P < .01$).

Summary

The results of this study indicate that carcass evaluation should be a part of a sire selection program. This is especially true since sire had a highly significant ($P<.01$) effect on marbling, hot carcass weight, dressing percent, color of lean, and carcass length, which all have an economical effect when selling slaughter calves on grade and yield. Highly significant ($P<.01$) correlations between performance traits and carcass traits indicate that carcass traits can be selected for in a beef selection program.

Color and texture of lean correlation with maturity of 0.48 and 0.60, respectively, show that as an animal ages chronologically, color of lean tends to become darker and texture of lean becomes more coarse.

Carcass and round length are highly significantly ($P<.01$) related to many performance traits (table 27). This indicates that by selecting for these performance traits should also result in selecting for taller and longer bodied animals.

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Appendix Table I Performance Data

Sire	Calf no.	Sex	Birth date	Age	Weaning Weight	Adj. weaning weight	Conformation score
G11	21	M	3-4	219	468	443	11.7
	26	M	3-22	201	425	432	10.7
	53	M	4-5	187	465	503	11.7
	64	M	4-8	184	380	415	11.0
	78	M	4-22	170	430	504	11.7
	30	F	3-10	213	460	445	12.0
	57	F	4-6	186	425	461	11.3
S36	33	M	3-20	203	440	444	12.7
	35	M	3-20	203	510	514	13.3
	37	M	3-18	205	470	470	12.0
	38	M	3-19	204	475	477	12.0
	50	M	4-1	191	480	510	11.3
	G36	M	3-1	222	520	486	11.7
	16	F	2-28	223	460	429	12.3
	17	F	2-27	224	470	436	11.7
	18	F	2-26	225	515	475	11.0
	34	F	3-22	201	440	447	11.7
	32	F	3-21	202	475	481	11.3
	36	F	3-20	203	410	413	11.3
S37	R61	M	4-5	187	350	415	11.3
	63	M	5-9	153	350	490	13.0
	65	M	4-4	died			
	66	M	4-4	178	325	400	10.0
	68	M	4-4	178	320	394	10.0
	69	M	4-6	176	330	410	11.7
	70	M	4-8	174	420	531	12.0
	73	M	4-23	169	360	464	11.7
	75	M	3-19	204	322	356	10.7
	76	M	3-23	200	440	494	12.3

Appendix Table I continued

Sire	Calf no.	Sex	Birth Date	Age	Weaning weight	Adj. weaning weight	Conformation score
S37	77	M	3-23	200	350	393	11.3
	78	M	3-23	200	350	393	11.3
	80	M	3-29	194	365	420	12.0
	64	F	4-8	Lost Tag			
	67	F	4-10	Lost Tag			
	71	F	4-24	168	320	413	10.5
	72	F	4-23	169	390	504	13.3
	74	F	4-23	Lost Tag			
	79	F	3-28	195	390	447	11.7
H38	1	F	2-20	231	410	372	12.3
	3	F	2-22	229	Lost Tag		
	4	F	2-24	227	500	458	12.3
	8	F	2-27	224	430	399	11.7
	11	F	2-28	223	428	396	12.0
	40	F	3-22	201	Lost Tag		
	42	F	3-24	199	415	425	11.0
	44	F	3-25	198	400	412	10.3
	45	F	3-26	Lost Tag			
	48	F	3-29	194	358	374	11.7
	49	F	3-30	192	322	339	11.3
	55	F	4-1	191	375	397	11.3
	58	F	4-6	186	380	412	12.0
	62	F	4-8	184	344	375	11.0
	65	F	4-1	191	440	467	11.0
	9	M	3-1	222	486	454	11.7
	10	M	2-27	224	455	422	11.3
	19	M	3-3	220	440	415	11.3
	20	M	3-4	219	410	388	10.7
	22	M	3-6	217	450	429	12.0
H38	25	M	3-7	216	540	516	12.7
	29	M	3-22	201	410	411	11.3
	41	M	3-23	200	445	454	11.3

Appendix Table I continued

Sire	Calf no.	Sex	Birth Date	Age	Weaning weight	Adj. weaning weight	Conformation score
H38	46	M	3-26	197	340	351	9.5
	47	M	3-27	196	460	478	11.7
	52	M	4-6	died			
	56	M	4-5	187	450	482	11.7
	59	M	4-7	185	365	397	10.0
	63	M	4-7	185	350	380	10.5
	76	M	4-18	174	380	435	12.0
	80	M	5-9	153	280	351	9.7
	39	M	3-18	205	410	410	11.3
S39	5	M	2-26	225	400	371	11.0
	7	M	2-27	224	370	345	12.0
	12	M	3-1	222	525	490	12.3
	23	M	3-8	215	400	384	11.3
	27	M	3-24	199	430	441	12.0
	51	M	4-8	184	350	382	11.3
	100	M	died at birth				
	2	F	2-21	230	480	435	12.7
	6	F	2-25	226	400	369	11.5
	13	F	2-28	223	432	403	12.0
	14	F	3-3	220	400	378	10.7
	60	F	4-7	185	360	391	12.3
	66	F	4-14	178	320	358	10.7
	68	F	4.16	lost tag			
	71	F	4-23	169	410	482	13.0
	73	F	4-22	170	350	408	12.0
	75	F	4-20	172	320	368	11.0
H40	G 3	M	4-5	187	284	350	10.0
	6	M	4-12	180	350	447	12.0
	8	M	4-15	177	300	387	11.0
	9	M			155 sick		
	10	M			150 sick		

Appendix Table I continued

Sire	Calf no.	Sex	Birth Date	Age	Weaning weight	Adj. weaning weight	Conformation score
H40	5	M	4-4	188	390	445	12.0
	1	F	4-3	189	300	367	10.0
	2	F	4-4	188	262	321	9.7
	4	F	4-4	188	320	394	10.3
	7	F	4-13	179	328	420	12.0
A93	S54	M	4-6	186	490	533	12.7
	61	M	4-8	184	290	315	11.0
	79	M	4-30	162	280	336	10.0
	28	F	3-24	199	464	474	11.7
	31	F	3-18	205	440	440	11.7
	77	F	4-21	171	394	458	12.5

Appendix Table II Performance Data

Sire	Calf no.	10/9/70 weight	1/11/71 avg. weight	Gain	Gain/day
G11	21	430	597	167	1.76
	26	402	564	162	1.71
	53	430	570	140	1.47
	64	350	529	179	1.88
	78	398	563	165	1.74
S36	33	424	559	135	1.42
	36	492	676	184	1.94
	37	542	605	153	1.61
	38	450	604	154	1.62
	50	458	623	165	1.74
S37	66	302	420	118	1.24
	69	318	475	157	1.65
	70	394	544	150	1.58
	77	334	468	134	1.41
	80	384	489	105	1.11
H38	20	398	553	155	1.63
	29	440	581	141	1.48
	41[a]	422	593	171	1.80
	46	316	456	140	1.47
	47	440	654	214	2.25
	56	424	570	146	1.54
	9	448	586	138	1.45
	19	414	583	169	1.78
	22	428	622	194	2.04
	59	340	456	116	1.22
	63	336	482	146	1.54
S39	5	376	557	181	1.91
	7	358	460	102	1.07
	12	504	662	158	1.66
	23	382	537	155	1.63
	27	392	518	126	1.33
H40	3	266	393	127	1.34
	5	put on test late - no post weaning gain			
	6	340	514	174	1.83
	8	296	416	120	1.26
A93	54	462	574	112	1.18
	61	274	478	204	2.15
	79	260	388	128	1.35

[a] bulls

Appendix Table III Performance Data 12/4/70

Sire	Calf no.	Method I conf.	Method II fat	Method II muscle	Method II frame	Method II structure	Method III frame	Method III muscle
G11	21	12.5	4.8	5.0	6.5	6.4	3.8	3.0
	26	11.8	4.5	5.3	4.8	6.8	3.0	3.0
	53	12.3	4.8	5.0	5.3	6.8	3.3	3.0
	64	11.5	5.5	3.8	5.8	6.0	3.5	3.8
	78	12.5	5.5	4.8	6.5	7.3	3.8	3.0
S36	33	12.0	4.5	4.5	6.0	6.8	3.5	3.0
	36	12.5	4.8	4.8	6.8	6.5	4.0	3.0
	37	11.8	3.8	5.5	6.5	6.3	3.8	2.8
	38	12.3	4.5	5.3	6.8	6.8	4.0	3.0
	50	13.0	4.8	6.0	6.5	7.3	3.5	2.3
S37	66	13.0	4.8	3.8	3.8	6.0	2.0	3.5
	69	11.0	4.0	4.5	4.3	6.3	2.3	3.3
	70	11.8	4.8	5.5	6.0	6.5	3.8	2.5
	77	10.3	3.5	4.5	3.8	5.8	2.0	3.5
	80	11.8	5.0	5.5	5.3	7.0	2.8	2.8
H38	20	11.0	3.8	5.5	3.8	5.0	2.5	3.0
	29	12.8	6.3	5.8	6.8	7.0	4.0	2.3
	41[a]	12.5	5.3	5.3	6.0	6.8	4.0	3.0
	46	10.0	3.8	3.5	3.0	5.0	2.0	4.3
	47	13.3	5.0	6.5	6.8	8.8	4.0	2.0
	9	12.3	5.5	5.5	6.5	6.5	3.8	2.8
	19	11.8	3.0	6.0	3.5	5.5	2.0	2.3
	22	13.0	5.8	6.0	7.3	7.5	4.0	2.5
	59	11.0	4.5	4.3	3.3	5.3	2.0	3.5
	63	9.5	4.8	3.3	3.5	4.8	2.3	4.0
S39	5	11.8	4.3	5.3	5.0	7.3	2.8	2.8
	7	11.3	4.3	5.0	3.8	7.0	2.3	3.0
	12	13.3	5.0	6.3	6.3	7.0	3.8	2.5
	23	11.5	4.8	5.0	5.3	7.3	3.0	3.0
	27	12.5	4.8	5.0	6.0	7.3	3.8	3.0
H40	3	10.0	5.3	4.0	3.3	6.0	2.0	3.5
	5	12.3	4.3	5.3	4.8	7.0	2.8	3.0
	6	11.5	4.0	5.3	4.8	7.3	2.8	3.0
	8	11.0	5.8	4.8	4.0	7.3	2.5	3.0
A93	54	13.8	6.0	6.3	7.0	7.8	3.8	2.3
	61	11.5	4.8	4.3	4.0	6.0	2.0	3.3
	79	10.3	5.0	3.3	3.3	5.8	2.0	4.0

[a] bulls

Appendix Table IV Slaughter Grading Scores 6/28/71

Sire	Calf no.	Method I conf.	Method II fat	Method II muscle	Method II frame	Method II structure	Method III frame	Method III muscle
G11	26	12.75	3.25	5.00	5.25	5.00	2.75	3.38
	53	12.00	5.50	5.00	6.25	5.00	3.63	3.13
	64	11.50	5.00	3.75	6.00	3.25	3.38	2.88
	78	12.25	5.25	4.50	6.00	3.00	3.38	2.75
S36	33	12.50	3.75	4.50	5.25	5.50	2.38	2.38
	36	13.50	3.75	6.00	6.25	6.50	3.88	3.25
	37	13.00	2.00	5.13	5.75	5.50	3.63	3.13
	38	13.00	2.75	4.75	6.25	5.25	3.88	3.00
	50	12.75	3.25	5.50	6.00	5.75	3.38	3.00
S37	66	11.00	6.50	3.75	3.50	4.75	1.75	3.38
	69	11.75	3.75	4.00	3.75	5.00	2.25	2.88
	70	12.00	4.00	5.50	5.25	5.75	3.00	3.00
	77	12.25	3.25	4.50	4.25	5.50	2.38	2.63
	80	12.50	4.00	5.50	5.00	5.50	2.75	2.75
H38	9	12.50	4.75	5.25	6.75	6.50	4.13	3.13
	19	12.30	2.75	5.25	5.00	5.50	2.75	2.50
	22	12.50	3.75	5.50	7.00	6.25	3.50	3.00
	59	11.00	5.00	5.50	3.75	6.00	2.25	3.00
	63	11.30	4.50	5.00	5.25	5.00	3.00	3.00
	20	11.50	3.00	6.00	4.00	4.50	2.25	2.88
	29	12.00	3.75	5.75	6.00	5.25	3.38	2.63
	41[a]	11.80	4.75	6.00	6.25	5.75	3.38	3.13
	46	10.50	4.25	4.50	3.75	5.25	2.38	3.25
	47	13.00	4.75	7.25	6.75	7.25	4.00	2.63
	56	12.00	4.25	6.50	6.75	6.00	3.13	2.25
S39	5	12.75	3.75	5.50	5.50	5.00	3.13	3.00
	7	12.25	4.00	5.25	4.50	5.75	2.38	2.75
	12	13.25	2.75	5.50	6.00	5.75	3.25	2.88
	23	13.75	4.00	5.63	5.75	6.25	2.38	5.75
	27	12.75	5.25	6.63	6.25	6.50	4.00	2.75
H40	3	11.75	3.75	5.25	4.00	6.00	2.13	2.75
	5	12.25	4.00	5.25	4.75	5.75	2.88	3.00
	6	12.75	3.50	5.50	5.13	5.00	3.25	2.75
	8	12.50	5.50	5.50	5.88	5.50	3.50	2.88
A93	54	13.75	4.25	6.50	6.75	6.25	3.75	2.50
	61	12.25	3.50	5.25	4.75	5.50	2.75	3.25
	79	12.00	5.25	4.75	4.75	5.50	2.88	3.13

[a] bulls

Appendix Table V 140 Day Test

Sire	Calf no.	1/11/71 weight	5/31/71 weight	6/28/71 weight	140 gain/day	168 gain/day
G11	26	564	949	1034	275	280
	53	570	941	977	265	242
	64	529	883	954	253	253
	78	563	881	939	227	224
S36	33	559	872	947	224	231
	36	676	990	1055	224	226
	37	605	999	1073	282	279
	38	604	990	1049	276	265
	50	623	934	1020	222	236
S37	66	420	685	712	189	174
	69	475	802	880	234	241
	70	544	875	964	237	250
	77	468	778	866	222	237
	80	489	856	933	248	264
H38	20	553	594	1034	287	286
	29	581	1013	1062	309	286
	41[a]	593	969	1030	269	260
	46	456	790	893	239	260
	47	654	1102	1164	320	304
	56	570	1037	1110	334	321
	9	586	966	1027	272	263
	19	583	890	971	219	231
	22	622	853	1033	237	245
	59	456	779	824	231	219
	63	482	829	878	248	236
S39	5	557	888	948	237	233
	7	460	786	851	233	233
	12	662	1042	1124	272	275
	23	537	903	987	262	268
	27	518	854	920	240	239
H40	3	393	824	875	308	287
	5	468	814	899	247	257
	6	514	917	997	288	288
	8	416	835	930	299	306
A93	54	574	965	1049	279	283
	61	478	859	930	272	269
	79	436	774	834	276	265

[a] bulls

Appendix Table VI Adjusted Yearling Weight

Sire	Calf no.	Yearling weight	Age at 4/5/71	Adj. yearling weight	WDA
G11	26	780	379	751	2.06
	53	794	365	799	2.19
	64	716	362	717	1.96
	78	775	348	814	2.23
S36	33	742	381	716	1.96
	36	836	400	770	2.11
	37	800	383	767	2.10
	38	845	382	810	2.22
	50	778	369	778	2.13
S37	66	592	356	640	1.75
	69	670	354	716	1.96
	70	724	352	804	2.20
	77	620	378	641	1.76
	80	712	372	732	2.01
H38	20	754	397	697	1.91
	29	830	379	788	2.16
	41[a]	820	378	791	2.17
	46	674	375	651	1.78
	47	895	374	869	2.38
	56	825	365	819	2.24
	9	782	400	720	1.97
	19	750	398	694	1.90
	22	822	395	763	2.09
	59	626	363	632	1.73
	63	685	363	681	1.87
S39	5	720	403	659	1.80
	7	642	402	590	1.62
	12	860	400	791	2.17
	23	746	393	695	1.90
	27	686	377	581	1.59
H40	3	630	365	661	1.82
	5	650	366	679	1.86
	6	765	358	820	2.25
	8	684	355	732	2.01
A93	54	770	364	784	2.15
	61	686	362	671	1.84
	79	578	340	604	1.65

[a] bulls

Appendix Table VII   Anscan at Weaning (11/16/70) and Yearling Time (3/8/71)

Sire	Calf no.	Weight	Age	REA	Fat	Weight	REA	Fat
G11	26	416	239	4.92	.15	730	8.20	.40
	53	490	225	5.80	.25	718	7.08	.40
	64	422	222	4.08	.20	650	5.84	.35
	78	472	208	5.16	.25	714	7.32	.45
S36	33	486	241	4.76	.20	700	8.28	.50
	36	562	260	5.80	.25	802	7.32	.45
	37	500	243	4.44	.30	746	9.20	.35
	38	514	242	4.80	.30	766	8.00	.50
	50	534	229	4.08	.30	734	5.40	.40
S37	66	358	216	4.32	.20	554	5.76	.50
	69	378	214	4.60	.15	588	7.00	.30
	70	440	212	5.20	.20	654	7.00	.30
	77	369	238	4.72	.20	572	7.20	.30
	80	392	232	4.48	.20	628	7.40	.40
H38	20	469	257	6.24	.20	710	9.72	.40
	29	494	239	5.36	.20	760	9.00	.40
	41[a]	456	238	4.04	.20	770	7.20	.40
	46	355	235	3.80	.20	628	7.20	.40
	47	516	234	4.40	.20	824	7.48	.40
	56	452	225	5.20	.15	754	7.64	.40
	9	493	260	4.84	.30	724	7.76	.45
	19	476	258	5.56	.30	712	8.92	.50
	22	494	255	5.40	.25	824	7.68	.50
	59	378	223	4.24	.20	580	5.20	.45
	63	392	223	4.80	.15	640	6.52	.40
S39	5	442	263	4.12	.20	668	7.88	.30
	7	390	262	5.12	.25	562	6.72	.50
	12	550	260	4.68	.20	798	7.36	.40
	23	430	253	4.00	.20	674	6.16	.45
	27	405	237	4.56	.20	632	7.32	.30
H40	3	318	225	3.56	.20	544	6.00	.40
	5	396	239	5.48	.15	568	7.36	.30
	6	410	218	4.24	.20	662	7.88	.40
	8	336	215	4.28	.20	576	6.20	.30
A93	54	494	224	5.40	.25	734	8.08	.50
	61	378	222	5.32	.20	620	6.60	.40
	79	304	200	3.96	.15	517	6.60	.25

[a] bulls

Appendix Table VIII Anscan at Slaughter (6/28/71)

Sire	Calf no.	Weight	REA	Fat	Cutability	Adj. REA
G11	26	1034	---	.50	---	---
	53	977	---	.55	---	---
	64	954	---	.50	---	---
	78	939	---	.60	---	---
S36	33	947	---	.60	---	---
	36	1055	---	.60	---	---
	37	1073	---	.70	---	---
	38	1049	---	.50	---	---
	50	1020	---	.55	---	---
S37	66	712	8.57	.30	2.74	10.56
	69	880	---	.45	---	---
	70	964	---	.30	---	---
	77	866	---	.50	---	---
	80	933	---	.40	---	---
H38	20	1034	12.96	.40	2.36	12.08
	29	1062	13.28	.45	2.45	12.83
	41[a]	1030	12.12	.40	2.63	11.92
	46	893	10.70	.45	2.88	11.44
	47	1164	10.51	.50	3.72	9.67
	56	1110	12.77	.50	2.86	12.05
	9	1027	12.51	.50	2.74	12.32
	19	971	---	.70	---	---
	22	1033	12.90	.65	3.01	12.67
	59	824	---	.50	---	---
	63	878	10.44	.45	2.92	11.28
S39	5	948	---	.40	---	---
	7	851	---	.65	---	---
	12	1124	10.83	.55	3.64	10.03
	23	987	---	.50	---	---
	27	920	10.19	.50	3.23	10.70
H40	3	875	---	.55	----	---
	5	899	---	.35	----	---
	6	997	---	.45	----	---
	8	930	---	.40	----	---
A93	54	1049	---	.50	----	---
	61	930	---	.45	----	---
	79	834	10.57	.50	2.90	11.79

[a] bulls

Appendix Table IX   Carcass Traits

Sire	Calf no.	Sl. WDA	Hot Car. weight	Hot Car. WDA	Dressing Percent	Carcass length	Round length
G11	26	2.23	612	1.32	59.2	46.0	24.5
	53	2.18	577	1.29	59.1	47.2	24.6
	64	2.14	549	1.23	57.5	46.3	24.1
	78	2.17	564	1.31	60.1	46.6	25.0
S36	33	2.04	594	1.28	62.7	46.6	24.2
	36	2.18	669	1.38	63.4	47.7	24.2
	37	2.30	678	1.45	63.2	46.9	25.1
	38	2.25	661	1.42	63.0	48.2	25.1
	50	2.25	630	1.39	61.8	47.8	24.9
S37	66	1.62	408	.93	57.3	42.8	22.8
	69	2.01	541	1.24	61.5	44.9	23.5
	70	2.21	579	1.33	60.1	46.0	24.6
	77	1.87	535	1.16	61.8	43.5	23.1
	80	2.05	586	1.29	62.8	45.2	23.6
H38	20	2.15	625	1.30	60.4	45.6	24.1
	29	2.29	657	1.42	61.9	46.9	24.6
	41[a]	2.22	606	1.31	58.8	48.0	25.0
	46	1.95	499	1.09	55.9	45.1	23.6
	47	2.54	711	1.55	61.1	48.4	25.6
	56	2.47	674	1.50	60.7	47.2	24.6
	9	2.12	618	1.28	60.2	46.5	25.1
	19	2.01	589	1.22	60.7	44.8	23.8
	22	2.16	628	1.31	60.8	45.6	24.6
	59	1.84	491	1.10	59.6	42.6	32.1
	63	1.96	528	1.18	60.1	43.6	23.9
S39	5	1.95	578	1.19	61.0	45.6	24.1
	7	1.75	519	1.07	61.0	43.3	23.0
	12	2.32	686	1.42	61.3	46.8	24.7
	23	2.07	609	1.28	61.7	46.0	24.0
	27	2.00	565	1.23	61.4	46.2	24.1
H40	3	1.95	522	1.16	59.7	45.0	22.9
	5	1.94	553	1.19	61.5	45.2	23.4
	6	2.26	603	1.36	60.5	46.8	24.1
	8	2.12	563	1.28	60.5	46.0	24.1
A93	54	2.34	638	1.42	60.8	47.1	25.3
	61	2.08	552	1.24	59.4	45.8	23.3
	79	1.97	497	1.17	59.6	44.5	24.0

[a] bulls

Appendix Table X   Carcass Traits

Sire	Calf no.	REA	REA/cwt.	Adj. LEA	Fat	Fat/cwt.
G11	26	11.78	1.14	11.56	.50	.040
	53	11.30	1.16	11.45	.40	.041
	64	9.31	.98	9.57	.40	.042
	78	9.09	.97	9.43	.45	.048
S36	33	10.42	1.10	10.75	.55	.058
	36	11.35	1.08	11.37	.65	.062
	37	9.63	.90	9.36	1.50(.90)	.140
	38	9.38	.89	8.67	.70	.068
	50	10.80	1.06	10.68	.55	.054
S37	66	8.78	1.23	10.82	.20	.028
	69	9.13	1.04	9.85	.65	.074
	70	10.71	1.11	10.94	.30	.031
	77	9.39	1.08	10.23	.45(.55)	.052
	80	10.39	1.11	10.83	.40	.043
H38	20	13.11	1.27	12.86	.30	.029
	29	13.07	1.23	12.03	.55(.60)	.052
	41[a]	13.18	1.28	12.96	.35	.034
	46	10.64	1.19	11.57	.25	.028
	47	12.05	1.04	11.09	.60	.052
	56	12.90	1.16	12.18	.50	.045
	9	10.03	.97	9.88	.40(.45)	.040
	19	10.61	1.09	10.79	.75	.077
	22	10.19	.99	9.51	.60	.058
	59	9.37	1.14	10.52	.50	.061
	63	10.94	1.25	11.84	.25	.028
S39	5	10.79	1.14	11.13	.40	.042
	7	9.77	1.15	10.56	.60	.070
	12	11.08	.99	10.93	.60	.053
	23	11.15	1.13	11.23	.45	.046
	27	9.64	1.05	9.99	.40	.043
H40	3	10.20	1.17	11.04	.60	.069
	5	11.55	1.28	12.30	.35	.039
	6	10.02	1.11	10.04	.45	.045
	8	9.69	1.04	10.11	.40(.35)	.043
A93	54	11.27	1.07	10.48	.50	.048
	61	8.54	.92	8.89	.40	.043
	79	10.90	1.31	12.10	.40	.048

[a] bulls

Appendix Table XI Carcass Measurements

Sire	Calf no.	Conf.	Mat.	Marb.	Final Grade	& Kidney	Yield Grade	Color lean	Texture lean
G11	26	C	A	Mt+	C	2.0	2.76	6	6
	53	C-	A	Mt+	C	3.0	2.72	6	6
	64	C-	A-	Mt	C	3.0	3.25	6	6
	78	C-	A-	Sm+	C-	2.5	3.40	7	6
S36	33	C	A-	Me-	C	3.0	3.45	7	7
	36	C	A-	Me+	C+	3.5	2.81	7	6
	37	C+	A-	Mt-	C	4.0	5.13	7	7
	38	C	A-	Sm+	C-	4.0	4.64	7	7
	50	C+	A-	Sm+	C-	2.5	3.38	7	7
S37	66	C-	A-	Sm+	C-	1.5	2.05	7	6
	69	C	A-	Mt-	C	4.5	4.21	7	6
	70	C	A	Sm	C-	3.0	2.67	6	6
	77	C+	A-	Mt-	C	2.5	3.44	7	7
	80	P-	A-	Me	C+	4.5	3.35	7	7
H38	20	P	A	Sl+	G+	1.5	1.78	6	6
	29	C+	A	Sl+	G+	2.5	2.88	5	5
	41[a]	C+	A	Sl-	G-	2.0	1.91	5	5
	46	C+	A-	Sl	G	1.5	1.94	6	6
	47	P	A	Sl+	G+	2.0	3.33	5	5
	56	P-	A	Sl	G	2.5	2.75	5	7
	9	C-	A	Sm	C-	2.0	3.22	6	6
	19	C	A-	Mt	C	2.5	3.77	6	6
	22	C+	A-	Sm	C-	2.5	3.69	6	7
	59	C	A-	Sm+	C-	2.0	3.05	6	6
	63	P-	A-	Sl	G	1.5	1.96	6	7
S39	5	C	A-	Mt+	C	3.5	2.99	6	6
	7	C	A-	Me	C+	2.5	3.38	6	6
	12	C+	A-	Mt-	C	2.0	3.55	7	7
	23	C	A-	Sm+	C-	2.5	2.93	7	6
	27	C-	A-	Sm-	C-	3.5	3.31	6	6
H40	3	C-	A-	Sl+	G+	2.5	3.26	7	6
	5	C	A-	Sl	G	2.5	2.32	7	7
	6	C	A-	Sl+	G+	2.0	3.17	7	7
	8	C	A-	Sm+	C-	1.5	2.88	7	7
A93	54	P-	A-	Me	C+	2.0	3.03	7	7
	61	C-	A-	Mt+	C	4.0	3.71	7	6
	79	C-	A-	Sm+	C-	3.0	2.53	6	6

[a] bulls

EVALUATION OF PERFORMANCE TESTED SIRES

by

RAY E. PURDY

B.S., Oklahoma State University, 1967

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Animal Science and Industry

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1971

ABSTRACT

This study was designed to determine the value of performance tested sires of different breeds and types and the use of visual appraisal and objective measurements in evaluating the performance of offspring. The project involved thirty-one steers and six bull calves by seven performance tested sires. All calves received a growing ration for 94 days after weaning followed by a finishing ration for 168 days. All animals were slaughtered immediately after the 168 day feeding period at Wilson Certified Foods Packing Plant, Kansas City, Kansas, with carcass data collected.

Sire had a highly significant ($P<.01$) effect on adjusted weaning weight and finishing period average daily gain. Sire by sex interaction had a highly significant ($P<.01$) effect on adjusted weaning weight which indicates that some sires produced heavier weaning male than female calves and vice-versa. Sex had a highly significant ($P<.01$) effect on test ADG with bulls having higher ADG and better efficiency than steers. Age had a significant ($P<.05$) effect on weaning weight and post-weaning ADG.

Sire and age had highly significant ($P<.01$) effects on U.S.D.A. slaughter grade. Age had a highly significant ($P<.05$) or highly significant ($P<.01$) effects on all traits scored as feeders except the predeposition of fat score. Simple correlations between feeder and slaughter scores with carcass traits were very similar and indicate that scoring feeder steers has similar value in a selection program to scoring of these steers at slaughter. Grading systems where several traits were scored were more valuable than one where a single score was placed on the animal.

Simple correlation coefficients between estimated fat thickness and ribeye area with actual fat thickness and ribeye area were 0.75 and 0.65,

respectively. These results indicate that more work is needed in relating anscan estimations with actual carcass measurements of these two traits.

Sire had a highly significant ($P < .01$) effect on marbling, hot carcass weight, dressing percent, color of lean and carcass length, which all have an economical value. Carcass and round length were highly significant ($P < .01$) related to many performance traits. This indicates that selecting for these performance traits should also result in selecting for taller and longer bodied animals.