A COMPARISON OF LIVE ANIMAL AND CARCASS TRAITS AMONG HEREFORD PROGENY GROUPS

by

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INTRODUCTION

Since early conceptions of animal breeding by Robert Bakewell, 1750, finishing beef cattle for market has been an important consideration. Quality of beef, both from the producer and consumer viewpoint, has been associated with quantity and distribution of fat which in turn reflects on tenderness, juiciness, and flavor of beef. The present demands by the American consumer have stimulated interest in producing an animal which will yield a higher ratio of lean to fat. In addition, the consumer has continually emphasized their preference for quality in the various retail cuts.

The industry is continually striving to find new methods of improving their saleable product and at the same time to increase efficiency and lower production cost. Great benefit could be brought to the beef industry if live animal characteristics could be found to be highly associated with meatiness providing these characteristics could be measured objectively. Ultrasonics and X-rays, in addition to conventional live animal measurements and observations, have been used in evaluating beef cattle in an attempt to identify the animal with the highest percentage of edible meat. These methods of determination are not without error.

With these thoughts in mind, the subsequent study was undertaken in an attempt to ascertain if the live animal and carcass traits of progeny from three Hereford sires differed when subjected to statistical analyses.

REVIEW OF LITERATURE

Previous workers have undertaken numerous studies in attempts to objectively evaluate sires by their progeny. The most difficult task in the evaluation of a beef carcass is to identify a particular trait or measurement which will consistently give reliable estimates of the true portion of edible or useable meat products from the carcass.

As early as 1925, practical application of predicting proportions of fat and bone were studied. Lush (1925) concluded that the per cent fat of the wholesale rib cut of the beef carcass was a more accurate indicator of the degree of fatness of the entire animal than any of the other indicators which had been studied at that time. Lush (1925) concluded that various shaped steers will likewise vary in dressing per cent. It was reported that large cattle with a fleshy measurement but small bone measurement are those which will have the highest dressing percentage. He also observed that the most important measurements for high dressing percentage and thus saleable meat products was a large heart girth in relation to a shallow chest, wide loin, large rear flank girth, high initial starting weight, small paunch girth, narrow head at the eyes, and short height at the hips.

Cook et al. (1951) reported correlations obtained on 157 Milking Shorthorn steers, although non significant (0.26), did indicate that a steer with a large heart girth graded higher at time of slaughter. Width of shoulder was not significantly correlated with dressing per cent. Correlations between slaughter grade and carcass grade were 0.69 and 0.71 respectively. These workers concluded that the visual observations for slaughter grade was a fairly good indicator of the animals carcass qualities. Carcass grade and dressing per cent had a correlation of 0.45 and 0.55. Thus it was assumed that a carcass with a high dressing per cent tends to be superior in carcass grade.

Black and Knapp (1936) obtained correlations of .82 and .81 when comparing carcass grade and slaughter grade, respectively, with the per cent of edible portion in the beef carcass. Carcasses in this study were divided into separable fat, lean, edible meat, bone, and waste.

Knapp et al. (1939) summarized the reliability of scores by seven judges with regard to certain live cattle characteristics. Results proved the judges reliable for estimates of width conformation of rump and straightness of back. The greatest variation in the score was obtained in estimating depth of flank.

Estimates for slaughter cattle carcass weight, fat thickness at the 12th rib, per cent kidney fat, rib eye area at the 12th rib, cutability, and carcass grade were accurately determined at the .01 level of significance by four experienced graders in a study reported by Gregory et al. (1962) on three groups of Angus, Hereford, and Shorthorn steers.

Butler et al. (1956b) found dressing per cent decidedly in favor of Hereford-Brahman crosses when compared to Hereford steers. The yield was 62.6 per cent and 59.9 per cent, respectively, for the steers studied. Wholesale cuts consisting of the loin, rib, and round comprised 48.8 per cent of the Hereford carcasses and 49.9 per cent of the Hereford-Brahman cross carcasses. The round with the rump was 24.7 per cent of the Hereford carcasses and 25.1 per cent of the Hereford-Brahman cross carcasses. The rib and chuck percentages were almost identical. Butler et al. (1956a) stated that there is a strong tendency toward proportional development of bone and muscling among steers of about the same age. Fat is the greatest variable and may have a marked influence on cutting yield of very fat steers.

Butler (1957) reported that heavy carcasses obtained from first cross Brahman and Hereford steers tended to have a higher percentage of hindquarter. This is not in agreement with Brinks et al. (1964) who reported a definite increase in per cent of forequarter with an increase in weight.

Wheat and Holland (1960) obtained data on 668 Hereford steers and heifers representing twelve slaughter groups and determined the relationships between slaughter and carcass grade. The weighted average ranged from .23 to .56. All were statistically highly significant except .23 which was not significant. The average correlations of .28 to .55 between slaughter and carcass grade before ribbing were highly significant. Their average correlations between slaughter grade and ribbed carcass grade ranged from .07 to .39, all but two were highly significant. Their weighted average correlations between carcass conformation and carcass grade before ribbing, after ribbing, and degree of marbling were: .42, .25, and .25, respectively. Degree of marbling was correlated (.45) before ribbing carcass grade and (.89) after ribbing carcass grade.

Data collected during the 1956-57-58 International Livestock Exposition by Good et al. (1961) was employed to study the relationship between live and carcass characteristics in slaughter steers. Significant negative correlations were obtained between fat cover at the 12th rib and the following live animal traits: width between the eyes (0.11), width of muzzle (0.23), circumference of round (0.19), and circumference of cannon (0.34). The findings indicated that broad-headed and heavy boned cattle with large rounds are desirable because their carcasses tend to contain less fat and more lean.

Correlations between slaughter grade and carcass grade tended to be less significant than between estimated live and carcass cutability in a study conducted on 204 steers by Gregory et al. (1964). Their findings were reasonable since marbling is the major contributor to the quality carcass grade. This is in agreement with Wilson et al. (1964) who reported a correlation between live estimates and carcass cutability to be 0.44. The correlation between estimated and actual quality grade was 0.25, suggesting that the prediction of yield of edible portion on a per cent basis may be more accurate than estimation of quality grade.

The inherent ability of an animal to transmit the traits of grade and type were reported by Koger and Knox (1952) and Knapp et al. (1950). Preliminary results of both studies indicated that the heritabilities of grade and type of beef cattle are about thirty per cent or greater. Therefore, we could expect progress in improving the quality of beef cattle through stringent selection.

Wiley et al. (1951) found only the shank to be significantly different when the percentage of wholesale cuts acquired from comprest and regular type Hereford steer calves were studied. The percentage of shank was greater for the regular type cattle. The estimates of percentage of separable fat, lean, and bone were not significantly different in carcasses from the two types.

Woodward et al. (1954) found highly significant correlations between final weight and slaughter grade (.40), carcass grade (.34), area of rib eye (.43), and thickness of fat (.49). Total gain on the tests was highly significantly correlated with thickness of fat (.57), area of eye (.29), and carcass grade (.35).

Branaman et al. (1962), in a study conducted on twenty-five beef type and twenty-five Holstein cattle, found no significant difference between type for per cent of kidney knob, plate, chuck, rib, round, and loin. These workers found no appreciable differences in per cent of high priced wholesale cuts on total trimmed retail steaks. Moreover, the influence of breed types was negligible. Thus, these workers concluded that the popular idea that beef-type cattle have a high per cent of high priced cuts is not substantiated from this study conducted on cattle fattened in a similar manner.

The validity of using the loin eye area lean content of a particular beef cut or various other carcass measurements to predict total carcass lean was studied by Cole et al. (1960). Results indicated a highly significant correlation between loin eye area and separable carcass lean and separable lean of the various wholesale cuts of beef. However, of all the variables investigated, separable round lean gave the most precise estimate of total carcass muscling. With the effects of carcass weight and breed eliminated, 56 to 82 per cent of the variation in carcass meatiness was accounted for by either the separable lean of the round, chuck, or foreshank.

Cole et al. (1960) found a high relationship to exist between separable lean of the 9-10-11th rib section and loin eye area. This should be expected since the eye muscle makes up a large portion of the total lean from this cut. A highly significant correlation (.43) of total separable carcass lean with loin eye area was obtained. However, separable lean of the round was more highly correlated (.95).

Cole et al. (1960) concluded that the area of loin eye was directly related to carcass weight, accounting for twenty-seven per cent of the existing variations in carcass weight. Correlation coefficients between total separable carcass lean and the lean of various wholesale cuts were: round, .95; chuck, .93; sirloin, .80; rib, .79; 9-10-11th rib cut, .74; and foreshank, .81. Separable lean of the carcass was correlated (.77) with total carcass weight. These high relationships suggest the usefulness of the measurements to predict total carcass muscling in a particular beef carcass.

Brinks et al. (1964) used photogrammetry to predict the wholesale carcass cuts of thirty-eight Hereford steers. Correlations and partial regressions on live weights indicated that as live weight increases a greater proportion is added to the forequarter, especially the cheaper cuts. The photogrammetry procedure indicated a fairly high degree of accuracy in predicting the actual pounds and per cent of wholesale cuts when adjusted to a 1,000 pound live weight basis for progeny from known sire groups. This was especially true for chilled carcasses, hindquarter, round, and loin content.

Correlations between weight of closely trimmed wholesale cuts and various body development indices were shown to be either significant or highly significant (0.97) between weight of the four closely trimmed wholesale cuts and carcass weights, Birkett et al. (1965).

Further results by Birkett et al. (1965) indicated that the adjustment for carcass weight appears necessary to reveal true relationships of the body development indices (length of rump, length of loin, circumference of round, circumference of forearm, area of loin eye, and carcass weight).

King et al. (1959) conducted a study on 120 steer carcasses weighing in a range from 204 to 745 pounds and in grades from U.S. Standard to U.S. Choice. A highly significant difference was observed when the wholesale cuts were measured by the retail trimmed method. The standard retail trim consisted of trimming the fat to one-quarter inch depth. The flank side of the loin and short ribs were removed. The shank was removed from the round and boned and the English cut and foreshank were removed from the chuck and boned. A uniform fat trim was made on the brisket, plate, and short ribs. The average per cent of loin, rib, round, and rump was found to be 47.82 per cent by the standard method of cutting as compared to 37.25 per cent for the retail trimmed method.

Cole et al. (1958) reported the findings of a study conducted on thirty-two head of Holstein, Jersey, Guernsey, Brahman, Brahman crosses, Angus, and Hereford steers. Highly significant differences between breed groups were observed for most slaughter characteristics. The differences in cutting yields of the various wholesale cuts were small, the dairy breeds tended to have the highest total mean percentage of round, loin, and rib. The differences in rib eye area taken at the 12th rib and fat covering were highly significant among the various breeds studied.

Stringer et al. (1965) found no significant differences in the retail yield values of carcasses ranging in grade from average-choice to average-good. These workers did report significant differences among fat thickness in the various grades.

Green et al. (1955) obtained a significant correlation of .30 when comparing slaughter grade with weight of round, trimmed loin, and rib of fifty steers ranging in live weights from 800 to 1,445 pounds and in U.S.D.A. grade from good to choice. A significant correlation (.29) was obtained when slaughter grade was correlated with trimmed round, loin, rib, and cross cut chuck. The kidney fat was removed from the trimmed loin and the cross cut chucks were studied with the brisket and shank on.

Hankins and Burk (1938) obtained a very high correlation of .95 between beef carcass grade and thickness of flesh, which included thickness of both fat and lean. An equivalent correlation (.95) was acquired when correlating thickness of external fat of the carcass with carcass grade. In identical work, marbling of lean was highly correlated with carcass grade (.90), thickness of external fat (.88), and thickness of flesh (.85). Kidwell et al. (1951) found a low but significant relationship existing between slaughter grade and per cent of wholesale cuts.

An evaluation of live and carcass yields on 450 beef carcasses and more than 300 live cattle were summarized by Murphey et al. (1960). The prediction of yield of retail cuts from the carcasses was based on the yield of partially boneless or boneless retail cuts from the round, loin, rib, and chuck. The simple correlations obtained between the estimated and actual yield of bone in retail cuts was 0.92.

Goll et al. (1961a) obtained data from thirty steer carcasses representing three grades: standard, good, and choice. Physical measurements had high statistical correlations of .58, .67, .55, .72, .75, .69, and .62 for length of body, length of hind leg, circumference of round, width of round, length of loin, width of shoulders, and depth of body, respectively, when correlated with carcass weight. Correlations between carcass weight and yield of cuts from the hindquarter were negative, whereas those between weight and yield of cuts from the front quarter, except for per cent rib, were positively correlated. Grades were negatively correlated with measurements reflecting skeletal size. Grades were also positively correlated with those reflecting body thickness. The important negative correlations of significance among grade and depth of body, per cent round, and per cent thick cuts were -.46, -.59, and -.53 respectively. Goll et al. (1961b) in a study conducted on ninety cattle carcasses to determine mean values for length of body, length of leg, and length of loin measured on the right side. These workers concluded that length is greatly increased in the heavy weight and lower grading carcasses. Also, the degree of finish exerts more influence on yield of wholesale cuts than conformation.

Methods of carcass analysis with reference to linear adjustments of weight was reported by Dinkel et al. (1965). Conclusions were arrived at and data collected from 467 Hereford steers. The use of ratios or per cents involving weight as the denominator did nothing more than change the sign of the relationship between the various carcass traits and weights. Thus, Dinkel et al. (1965) stated that ratios and per cents as methods of carcass analysis were not satisfactory. The validity of the treatment on carcass traits may actually be masked by the use of ratios and per cents.

Kieffer et al. (1958) reported on sire differences which were found between slaughter grade, marbling score, and per cent bone of the 9-10-11th ribs. The per cent ranges among the seven different sires with regard to yield of wholesale cuts were: loin, 17.36 - 17.96 per cent; rib, 9.14 - 9.73 per cent; round, 21.51 - 22.97 per cent; and chuck, 27.68 - 28.93 per cent. Non significant sire differences were observed for fat and lean percentages of the 9-10-11th ribs. These workers reported significant sire differences in carcass grade, slaughter grade, marbling score, and per cent bone of the 9-10-11th rib.

Orme et al. (1959) obtained relationships between various bone measurements and carcass lean as determined by separation of the 9-10-11th rib cuts. These workers, holding carcass weight constant, found length of forecannon to have a correlation of .80 to per cent primal cuts. Wellington (1953) described the procedure in obtaining these non trimmed cuts.

They found a correlation of .37 between forecannon length and per cent estimated carcass lean as determined by separation of the rib cut. By holding carcass weight constant, a higher correlation was obtained between bone and percentage yields than between bone and weight yields. When carcass weight was held constant, only length of bone gave significant and positive relationships with per cent of lean or primal cuts. When the effect of weight was removed, width and length measurement of forecannon gave the best estimates of rib eye area, accounting for 15-28 per cent of the total variation. Negative correlations indicated that for cattle of the same weight, there is a tendency for larger rib eye area to be associated with shorter lighter bones. Various bone measurements were highly related to total weight of carcass lean. These correlations approached zero when compared to per cent carcass lean.

Muscle-bone data collected on sixty-six Hereford steers by Orts and King (1959) is in agreement with Orme et al. (1959). These workers found the bone weight and weight length ratio were highly correlated to wholesale cut weights (0.87 and 0.88), rib eye area (.80 and .80), and chilled carcass weight (.95 and .86) than either length or area of the cannon bone. Length and area of the cannon had a positive relationship to all wholesale cut weights (.70 and .67), rib eye area (.63 and .70), and chilled carcass weight (.70 and .69).

Wythe (1958) reported simple correlations between various trimmed wholesale cuts and bone length and weight and found the bone weight to be the superior predictive value. The femur and tibia were superior to both fore and rear cannons as predictors.

Wythe et al. (1961) studied the relationships of various bone measurements to weights of closely trimmed wholesale cuts. Upon holding the effects of carcass weight constant, they found the weight of the tibia to be correlated (.65) to the retail trimmed boneless cushion, round, and to the sum of the retail trimmed chuck, rib, and loin (.70). Tibia weight was correlated (.51) to the area of the rib eye. These workers found the weight of various bones superior to weight length ratios as predictors of weight of cuts. The tibia proved to be superior to the forecannon. This is in agreement with Wythe (1958).

Goll et al. (1961a) obtained a correlation of .52 between hind leg length and per cent of untrimmed loin, rib, chuck, and round with the effects of carcass weight removed.

Loin eye area has been studied in other species of farm animals. Bailey et al. (1961) reported the relationships between loin eye area and various width and circumference measurements in lambs. These workers reported a simple correlation of .52 between circumference of thighs to loin eye area and also found carcass weight more highly correlated to loin eye area on young lambs slaughtered at weaning age than on older fed lambs. The simple correlations were .56 and .37 respectively. Circumference of forearm had a fairly high simple correlation (.39) with rib eye area but approached zero when carcass weight was held constant.

Kropf (1962), working with pork carcasses, studied the relationships of the per cent and length of the various bones and per cent lean cuts and carcass specific gravity values. This work indicated a positive relationship between per cent of certain bones and per cent of lean. However, the correlations were too low to be of value as predictors of cutability. Greater length of bone was associated with higher per cent of lean cuts. The length of the tibia, which had the highest correlation, accounted for only 27 per cent of the total variability in yield of lean cuts. Circumference measurements and circumference to length relationships were not strongly related to either per cent lean cuts or carcass specific gravity.

Indications of carcass merit as determined by muscle bone ratios were reported by Hankins et al. (1943). Their findings revealed significant correlations in studies designed to evaluate sires on the basis of progeny data in beef type and dual-purpose cattle. Correlation coefficients reported were: per cent separable fat of the 9-10-11th rib cut with per cent separable fat of dressed carcass (0.93), per cent separable lean of the 9-10-11th rib cut with per cent separable lean of the dressed carcass (0.90), per cent bone of the 9-10-11th rib cut with per cent bone of dressed carcass (0.80). Correlations between the muscle-bone ratio and live animal measurements provided little indication that selection could be made on conformation of live animals for this particular characteristic.

Correlations between muscle bone ratio and live measurements as reported by these workers were: circumference of cannon bone -.26 and -.04 and heart girth .13 and -.12, respectively, for beef and dual purpose type cattle. These workers concluded that the smaller the bone, the higher the muscle-bone ratio for the individual.

Carcass data obtained on 133 steers was presented by Ramsey et al. (1962). The study was made to determine the relationship of proposed yield grades and fat thickness to separable lean, fat, and bone of the entire carcass. It was reported that carcass grade was negatively related to per cent separable lean (-.70) and per cent separable bone (-.83), but positively related to per cent separable fat (0.79). Simple correlation coefficients between yield grade and per cent separable lean, fat, and bone were: -.75, 0.73, and -.51. Correlations between grades and per cent of separable lean and fat were higher than when rib eye area was included (-.79 and .83). The results are in general agreement with those of other workers who have found a low correlation between rib eye area and per cent lean of the 9-10-11th rib cut.

Crown et al. (1960) reported correlations for percentages of separable lean, fat, and bone of the 9-10-11th rib cut with the dressed carcass separable lean, fat, and bone which were 0.94, 0.97, and 0.73, respectively. All were significant at the .01 probability level, indicating that the 9-10-11th rib is a good predictor of total carcass separable lean and fat. These workers also reported correlations of .81, .96, .75 between separable lean, fat, and bone of the twelfth rib cut and the entire carcass. This indicates that the twelfth rib cut can be used to predict the carcass composition of beef cattle.

Cole et al. (1960) reported a correlation of .74 between separable lean of the 9-10-11th rib cut and separable lean of the carcass. This is considerably lower than that reported by Crown et al. (1960).

Dunn (1960) reported on the use of loin eye area ratio in a correlation study between loin eye area and weight of trimmed wholesale cuts. This ratio was in square inches of loin eye area per hundred pounds of carcass weight. He found loin eye area ratio to have a correlation of .42 to total trimmed weights of wholesale cuts. These cuts were trimmed to a standard one-quarter inch exterior fat and included the round, loin, rib, and square cut chuck. Combined trimmed round weight and chuck weight had a simple correlation of .39 to loin eye area ratio. Loin eye area ratio had a negative (-.06) correlation with untrimmed loin weight and a positive (.17) correlation with trimmed loin weight. This would seem to indicate that loin eye area is a more reliable predictor of round and chuck than it is of loin.

Kline and Hazel (1955) found a high correlation of .88 between loin eye area at the tenth and last rib of pork carcasses obtained from twenty-three hogs weighing an average of 210 pounds. Loin eye area at the last rib averaged 0.43 square inches greater than that at the tenth rib. The correlations between per cent lean cuts and loin eye area and last ribs were similar. Due to the high correlation between loin eye areas on the same carcasses, these workers found little increase in accuracy of predicting lean cuts from measuring the loin area in more than one place on the carcass.

With the variation of area of rib eye that exists dependent upon location of measurements, Cole et al. (1962) reported on a simplified method of predicting lean in the beef carcass. These workers found a correlation between area of rib eye and pounds of separable carcass lean to be .49, .50, and .55 for measurements taken at the last lumbar vertebra, the twelfth rib, and the fifth rib, respectively.

Hendrick et al. (1965) reported on the factors which tend to affect the longissimus dorsi muscle area in data collected from 1,096 good and choice steer carcasses weighing from 350 to 850 pounds. These workers found the muscle area to increase approximately fifty per cent and subcutaneous fat thickness increased approximately two fold with an increase in carcass weight from 350 to 850 pounds. A significant difference at the .01 level was obtained between right and left longissimus dorsi muscle and subcutaneous fat thickness from 295 carcasses ribbed in the conventional manner. This is not in agreement with Kline and Hazel (1955). However, no significant difference was found in the right and left sides of forty-seven good and choice steers. Longissimus dorsi muscle measurements were more highly associated with weight rather than with per cent of retail cuts.

Gottsch (1962) compared loin eye area to loin eye area ratio and found loin eye area ratio superior to loin eye area in predicting weight of total lean from the round, loin, rib, and chuck. This is in agreement with Dunn (1960) who reported that loin eye area was found to be a better predictor of round lean than loin lean. This was assumed to be due to the tremendous amount of variation of fat trim obtained from the loin.

The degree of marbling is one of the important factors which has been employed for predicting eating quality of beef. Likewise, marbling is the most important quality factor in arriving at a final quality carcass grade. Blumer and Fleming (1959) developed a qualitative method for marbling estimates on twenty-nine beef steers made up of the grades average-good to choice. These workers found that the comparison of density of fat deposits per square inch of the longissimus dorsi muscle to be quite accurate. The one problem encountered was that additional time in measuring resulted in a 10 to 30 per cent increase in the marbling estimate based on total fat in the sample.

The importance of intramuscular fat present at the 12-13th rib interface of the longissimus dorsi muscle was reported by Cook et al. (1964). They found a highly significant difference existing between marbling score and ether extract among the various locations within the longissimus dorsi. Uniform distribution of intramuscular fat was found to vary significantly among anatomical locations. However, the most uniformily distributed marbling patterns was exhibited at the 10-13th thoracic region and decreased toward muscle extremities. This is in agreement with Palmer et al. (1958) who reported significant correlations between marbling and ether extracts obtained from the longissimus dorsi muscle.

Tuma et al. (1962) reported that marbling levels significantly influenced tenderness of the longissimus dorsi muscle obtained from twenty-four Hereford females from eighteen to ninety months of age. The panel score means indicated that steaks from carcasses displaying "slightly abundant" marbling were more tender than those from carcasses with a lesser degree of marbling. Shear force values were significantly lower ($P < .005$) for steaks from the "slightly abundant" marbling carcasses and further indicated the important relationship between marbling and tenderness.

Carpenter and Palmer (1961) studied on a comparative basis the rib eye area and the degree of marbling as influenced by methods of ribbing. The statistical analysis revealed that the average rib eye area for the left and right sides were 9.44 and 8.76 square inches respectively, which are significantly different. Fifty-seven per cent of the carcasses had a higher marbling score on the left side as compared to nineteen per cent which showed higher degrees of marbling on the right side. The remaining per cent showed no differences between sides. Differences observed between sides were attributed to methods of ribbing. The differences in marbling did account for highly significant correlations.

Webb et al. (1964) stated that the following factors are associated with tenderness of beef muscle: (1) chronological age; (2) inheritance; (3) chemical constituents of muscle; (4) biochemical changes during the aging process; (5) ante morten treatment; (6) degree and dispersion of fat in the carcass; and (7) livestock management. These workers investigated the above factors on twelve steers of varying ages. Results showed that meat from the younger cattle was significantly more tender than that from older cattle. Panel tenderness values were significantly negatively correlated (-.67) with Warner-Bratzler shear value.

The influence of sex and age differences on tenderness was reported by Adams and Arthand (1963). These workers found a significant difference in tenderness attributed to sex. Tests among least squares sex means revealed that steers were significantly more tender than bulls. However, no significant difference was found between the tenderness of bulls and heifers or between heifers and steers. A simple correlation of 0.29 existed between shear value and the age of the animal at time of slaughter. This is in agreement with Suess et al. (1965a), who reported significant sex differences in tenderness.

Tenderness of meat is not the only attribute to sex and age of the individual but also Blumen (1963) reported that tenderness of meat is affected by cooking conditions. Also the subjective means of evaluating tenderness by a taste panel has a tendency to introduce a large amount of variability.

Christians et al. (1961) reported the findings of studies conducted during a three year period on 176 Angus carcasses from forty-three heifers and 133 steers by twenty-four sires. These workers found that animals, sides, and ribs were the main sources of variation of tenderness when analyzed statistically. The 12th rib steak was more tender than the 8th or 9th rib steaks and the dorsal cores were more tender than the lateral cores. However, sire differences were not statistically significant.

Suess et al. (1965b) reported small negative correlations when comparing per cent carcass fat and taste panel tenderness scores. These workers found a small positive correlation between per cent carcass muscle as determined by the physical separation of the 9-10-11th rib cut and taste panel tenderness scores. The majority of the relationships found among palatability and quantitative carcass traits were small and not significant.

MATERIALS AND METHODS

Twenty-eight steers and twenty-three heifers owned by the Clifford Houghton Ranch of Tipton, Kansas were used in this study. The animals were divided into two trial groups, Trial A and Trial B, constituting steers and heifers respectively. The animals studied were the progeny of three Hereford bulls: Royal Husker K31, M. Crusty Domino, and Onward Rupert. The cattle were long yearlings at the time of slaughter and had been managed and fed as a group since birth at the Houghton ranch. The calves were weaned on April 23, 1964 and then placed on a concentrate-roughage growing ration. Prior to weaning, the calves had free access to a rolled creep milo ration. Following the brief growing period the cattle were placed on a high concentrate finishing ration consisting of 80 per cent milo, 10 per cent corn, 10 per cent bran, and one and one-half pounds of 42 per cent protein per day. The heifers from Trial B were slaughtered in January, 1965 and averaged 861 pounds at slaughter. In February of 1965, the steers of Trial A were slaughtered and averaged 1,051 pounds.

Prior to both the growing and slaughtering phase of the experiment, a visual grading of the cattle was made by the author and his major professor. The calves at weaning were scored for U.S.D.A. feeder grade (to the nearest one-third of a grade), forearm score, over top score, round score, bone score, and condition score. At slaughter time, the cattle were scored for the above characteristics (excluding feeder grade) plus

U.S.D.A. slaughter grade (to the nearest one-third of a grade). In addition, a classification score was given which evaluated type, size, quality, shoulder and chest, rib and back, loin, rump, thighs and round, feet and legs, and head and neck (Table 26).

Each animal was individually identified, weighed, and classified at the Houghton ranch prior to shipment to the Kansas City Stockyards. The cattle were consigned to the Mauer-Neuer Meat Packing Company of Kansas City, Missouri. Individual slaughter weights were obtained at 7:00 A.M. in Kansas City the following day just prior to the slaughtering.

The cattle were all slaughtered under the standard packing house procedures. Each carcass was tagged with its identifying number while on the kill floor to insure suitable identification in the cooler.

Gross carcass data were obtained from the entire lot of steers and heifers. The carcasses were graded to one-third of a quality (final) grade by a U.S.D.A. grader and a conformation grade was given each carcass prior to ribbing in accordance with U.S.D.A. standards. The right side of each carcass was ribbed between the 12th and 13th rib. The grader assigned each carcass a marbling score and carcass grade after ribbing. A numerical score was assigned each grade with the larger numbers being assigned to the higher grading carcasses, (Table 27). The U.S.D.A. marbling scores range from 1 to 36 (Table 28); rib eyes with the most marbling receiving the highest scores and smaller numbers being assigned to rib eyes with less marbling.

Cross sections of the longissimus dorsi muscle and fat cover were traced on acetate tracing paper between the twelfth and thirteenth rib. Area of rib eye muscle was determined through the use of a compensating polar planimeter. Fat depth over the twelfth rib was determined by the average of measurements obtained at one-quarter, one-half, and three-quarter distance from the chine bone as described by Naumann (1952).

The random digit table, Snedecor (1956), was used in procuring a random sample of fifteen steers and fifteen heifer carcasses for use in the detailed carcass phase. The carcasses were separated into wholesale cuts consisting of the round, loin, rib, and chuck. A standard one-quarter inch fat trim on the round, loin, and chuck was obtained with the aid of the employees of Maurer-Neuer Packing Company. The intact rib was purchased and shipped to the meats laboratory of Kansas State University for trimming and physical separation studies. The 6-7-8th rib cut was removed for use by the College of Home Economics for cooking and organoleptic data. The twelfth rib cut was removed for freeze-drying studies and standard chemical analyses. The 9-10-11th rib cut was physically separated into fat, lean, and bone and the weights were recorded to the nearest one-hundredth of a gram.

All correlation coefficients in this study are simple correlation coefficients, likewise, the analyses of variance and least significant difference analyses were computed in accordance with those outlined by Snedecor (1956). The statistical calculations were made possibly by the use of the IBM 650 Digital Computer.

STATISTICAL ANALYSIS

These data were analyzed statistically in an attempt to determine if some simplified method could be employed in predicting the carcass yield of wholesale cuts and various other carcass characteristics produced from the progeny of three Hereford bulls. In like manner, retail cuts were studied for sire differences on the consumer exceptance level.

Simple correlations were obtained between all characteristics studied. The degrees of freedom for all correlation coefficients found in Table 8 and 9 and thus levels of significance for steers and heifers will be identical. The significant level for the correlations obtained are as follows: a correlation of .30 is significant at the .05 level and a correlation of .39 is significant at the .01 level. The simple correlation coefficients presented in Table 3 concerning per cent sum trimmed wholesale cuts and per cent total fat trim with other carcass characteristics differ from the previously stated correlations. The levels of significance for the correlations obtained are: a correlation of .43 is significant at the .05 level and a correlation of .54 is significant at the .01 level. The preceding levels of significance were determined according to the method stated by Snedecor (1956). In order that sire differences could be studied, a completely randomized design of analysis of variance was obtained on all characteristics. The levels of significance for the first twenty steer variables studied are: at the .05 level (3.38) with 25 degrees of freedom. The levels of significance for the first twenty heifer variables are: at the .05 level (3.49) with 20 degrees of freedom. The detailed study involving fifteen randomly selected steer and heifer carcasses resulted in identical levels of significance at the .05 level. The levels of significance are: at the .05 level (3.88). Those traits which expressed significance in the analysis of variance test at the .05 level were further tested by the least significant difference test to identify the superior sires for the various traits. The L.S.D. test was conducted at the .05 level on unreplicate and replicate samples. Results obtained are presented in Appendix Tables 8 through 25.

Simple correlation coefficients of weaning muscling score, feeder grade, slaughter grade, and slaughter muscling score with preslaughter and carcass characteristics. Simple correlations between the weaning and slaughter muscle score and feeder and slaughter grade for steers and heifers studied with other preslaughter and carcass characteristics are found in Table 1. The correlations between classification score and slaughter grade and muscling score are all highly significant. The correlation of .85 between slaughter grade and classification score for the heifers was the highest and was closely followed by the heifer slaughter muscle score (.84) and the steer slaughter grade (.70). This indicates slaughter grade has an excellent relationship with classification score and this coexistence is not influenced by sex. The high correlation for steers of .84 for slaughter muscle score and .52 for heifers indicates the influence of natural muscling when establishing a classification score. Weaning bone score was more highly correlated (.59) and (.47) for steers and heifers respectively with weaning muscle score than was slaughter bone score (.45) and (.36) with slaughter muscle score, although not statistically identical, they are predictors of visual muscling score both at weaning and slaughter time.

Table 1. Simple correlation coefficients of weaning muscling score, feeder grade, slaughter grade, and slaughter muscling score with preslaughter and carcass characteristics for steers and heifers.

	Weaning Muscling Score		Feeder Grade		Slaughter Grade		Slaughter Muscling Score	
	S	H	S	H	S	H	S	H
Adjusted weaning weight	.04	.12	-.07	.29	.31*	.17	.22	.13
Weaning bone score	.59**	.47**	.44**	.53**	-.14	.12	.10	.27
Slaughter bone score	.19	.16	.28	.42**	.35*	.28	.45**	.36*
Classification score	.06	.41**	.19	.50**	.70**	.85**	.84**	.52**
Hide weight	.03	.10	-.20	.15	.21	.17	.25	.25
Chilled carcass weight	.04	.29	-.19	.31*	.33*	.60**	.25	.20

* Significant at the .05 level
** Significant at the .01 level
S Steers
H Heifers

Of the four traits studied, all were not significantly correlated with adjusted weaning weight except for slaughter grade of the steer group, which was significant at the .05 level. This indicates that desirability of muscling and grade may not be expressed in terms of adjusted weaning weight of calves in this study. The non significant correlation obtained between weaning bone score and slaughter muscling score and weaning muscling score and slaughter bone score show a lack of continuity of these traits. Furthermore, the prediction of slaughter bone score is valid when predicting this trait by the weaning bone score (.48), which is significant at the .01 level.

Simple correlation coefficients of rib eye area, fat thickness at the 12th rib and marbling score with other carcass characteristics. Rib eye area was significantly correlated with chilled carcass weight (.70) and (.57) and conformation score (.38) and (-.37) but was not significantly correlated with marbling score, quality grade, and fat thickness at the twelfth rib. Marbling score was highly significantly correlated with quality grade (.90) and (.82) for both steers and heifers. Much of the variation in quality (final) carcass grade is attributed to marbling score as it accounts for 97 per cent of the variation of carcass grade. Fat thickness at the twelfth rib was highly correlated with conformation score (.50) and (.39) as was dressing per cent (.55) and (.32) for the steers and heifers, respectively. Table 2 illustrates correlations of rib eye area, fat thickness at the twelfth rib, and marbling score with other

Table 2. Simple correlation coefficients of rib eye area, fat thickness at the twelfth rib, and marbling score with other carcass characteristics.

	Rib Eye: Area :		Fat Thickness: (12th rib) :		Marbling: Score :	
	S	H	S	H	S	H
Chilled carcass weight	.70**	.57**	.39**	.27	.10	.14
Conformation score	.38*	.37*	.50**	.39**	.33*	.10
Marbling score	-.19	.15	.28	.01		
Maturity score	.00	-.12	.00	.57**	.00	.34*
Quality grade	-.13	.07	.23	.10	.90**	.82**
Dressing per cent	.60**	.04	.55**	.32*	.14	.11
Rib eye area			.25	-.13	-.19	.15
Fat thickness (12th rib)	.25	-.13			.28	.01
Side weight	.50**	.69**	.55**	.40**	.10	.02
Trimmed round	.38*	.84**	.17	.17	-.08	-.22
Round fat trim	.14	-.28	.46**	.50**	-.29	.31*
Trimmed loin	.51**	.63**	.39**	.36*	.00	-.10
Loin fat trim	.43**	-.38*	.39**	.64**	.22	.31*
Trimmed chuck	.41**	.80**	.59**	.20	.07	.01
Chuck fat trim	.45**	.20	.21	.54**	.21	.22
Trimmed rib	.74**	.42**	.68**	.54**	-.17	.00
Rib fat trim	.19	.33*	.46**	-.08	-.30*	.12
Wt. lean 9-10-11th rib	.45**	.68**	.50**	.28	.08	-.13
Wt. fat 9-10-11th rib	.57**	.24	.73**	.73**	.10	.40**
Ether extract	.08	.33*	.29	-.02	.39**	.64**

* Significant at the .05 level
** Significant at the .01 level
S- Steers
H Heifers

carcass characteristics.

Marbling score was not significantly correlated with trimmed wholesale cuts and fat trim from the wholesale cuts, except in a few instances. The heifers marbling scores showed significant correlations of (.31) and (.31) with round fat trim and loin fat trim, respectively. Marbling score for the steers was significant at the .05 level resulting in a correlation of (-.30) with rib fat trim. Ether extract was highly significantly correlated (.39) and (.64) with marbling score but was not significantly correlated (.29) and (-.02) with fat thickness at the twelfth rib. Rib eye area for the heifers was significantly correlated (.33) with ether extract and steers showed a non significant correlation (.08) for this characteristic.

The weight of the separable lean of the 9-10-11th rib was highly correlated (.45) and (.68) with rib eye area. The steers exhibited a high correlation (.50) when correlating lean of the 9-10-11th rib with fat thickness at the twelfth rib. Separable fat from the 9-10-11th rib showed high significant correlations (.73) and (.73) with fat thickness at the twelfth rib. Highly significant correlations were shown to exist between rib eye area and the various trimmed wholesale cuts for both steers and heifers. The highly significant correlation with rib eye area obtained were: trimmed round (.38) and (.48), trimmed loin (.51) and (.63), trimmed chuck (.41) and (.80), and trimmed rib (.74) and (.42). Loin and round fat trim were highly significantly correlated for steers (.46) and (.39), these results were also shown for heifers when significant correlations of (.50) and (.64) were obtained when correlating these characteristics with fat thickness. Side weight was highly significantly correlated (.50) and (.69) with rib eye area for both trial groups. Significant correlations (.57) and (.34) in the heifer group were observed for maturity score with fat thickness at the twelfth rib and marbling score, respectively.

Simple correlation coefficients of per cent sum trimmed wholesale cuts and per cent total fat trim with the other carcass characteristics. Per cent sum trimmed wholesale cuts were non significantly correlated with slaughter muscle score and classification score as shown in Table 3. Per cent total fat trim was significantly negatively correlated (-.79) with Trial B per cent sum trimmed wholesale cuts. Per cent sum trimmed wholesale cuts for Trial A were significantly negatively correlated with ether extract (-.60), slaughter grade (-.50), and chilled carcass weight (.55). As for the heifers, significant negative correlations with per cent sum trimmed wholesale cuts are: ether extract (-.55), quality grade (.57), and fat thickness at the 12th rib (-.50).

In Trial B, per cent total fat trim was significantly negatively correlated with slaughter bone score (-.56), classification score (-.44), and rib eye area (-.61). Significant positive correlations for Trial B were obtained among per cent total fat trim with ether extract (.49) and fat thickness at the twelfth rib (.55). Trial A showed significant positive correlations when per cent total fat trim was correlated with ether extract (.50) and fat thickness at the twelfth rib (.47).

Table 3. Simple correlation coefficients of per cent sum trimmed wholesale cuts and per cent total fat trim with other carcass characteristics.

	[a]Per cent sum trimmed wholesale cuts		[b]Per cent total fat trim	
	S	H	S	H
Per cent total fat trim	-.15	-.79**		
Wt. lean 9-10-11th rib	.15	.04	.09	-.23
Ether extract	-.60**	-.55**	.50*	.49*
Slaughter grade	-.50*	.11	.15	-.27
Slaughter muscling score	-.24	.14	.21	-.32
Slaughter bone score	-.07	.47*	.01	-.56**
Classification score	-.30	.39	.02	-.44*
Chilled carcass weight	-.55**	-.08	.11	.01
Quality grade	-.19	-.57**	-.14	.50*
Marbling score	-.20	.44*	-.15	.40
Rib eye area	-.12	.40	.29	-.61**
Fat thickness 12th rib	-.39	-.50*	.47*	.55**

[a]Sum trimmed wholesale cuts expressed in per cent for the round, loin, chuck, and rib

[b]Total fat trim for the wholesale cuts consisting of the round, loin, chuck, and rib expressed as a per cent

* Significant at the .05 level

** Significant at the .01 level

S Steers

H Heifers

Simple correlation coefficients of trimmed round, trimmed chuck, trimmed loin, and trimmed rib with individual and fat trim from the wholesale cuts. Trimmed round in Table 4 was highly significantly correlated with trimmed chuck (.54) and (.90), trimmed loin (.90) and (.80), and trimmed rib (.53) and (.61) for the steers and heifers respectively. Non significant correlations were obtained in all instances when trimmed round was correlated with various wholesale fat trim. Trimmed chuck was highly significantly correlated at the .01 level for steers and heifers, with trimmed loin (.71) and (.90) and trimmed rib (.63) and (.75). The steer trial group showed a highly significant correlation of (.57) and (.51) for loin fat trim and rib fat trim when correlated with trimmed chuck. A significant correlation (.30) was observed between trimmed loin and chuck fat trim and a highly significant correlation (.44) was observed in the steer group with trimmed loin and rib fat trim. The steers and heifers exhibited a highly significant correlation of (.73) and (.84) with trimmed loin and trimmed rib which follows the general pattern of a high relationship amongst the various trimmed wholesale cuts. The trimmed rib was significantly correlated in all instances with fat trim except for heifer rib fat trim which was not significantly correlated (.21). Trimmed rib was significantly correlated for steers and heifers respectively with round fat trim (.42) and (.33), chuck fat trim (.43) and (.49), and rib fat trim (.42).

Table 4. Simple correlation coefficients of trimmed round, trimmed chuck, trimmed loin, and trimmed rib with individual trimmed and fat trim from the wholesale cuts.

	Trimmed: Round :		Trimmed: Chuck :		Trimmed: Loin :		Trimmed: Rib :	
	S	H	S	H	S	H	S	H
Trimmed round								
Round fat trim	.11	-.11	.05	.19	-.05	.27	.42**	.33*
Trimmed chuck	.54**	.90**						
Chuck fat trim	.17	-.02	.21	.22	.30*	.25	.39**	.50**
Trimmed loin	.90**	.80**	.71**	.90**				
Loin fat trim	.10	-.20	.57**	-.01	.23	.22	.43**	.49**
Trimmed rib	.53**	.61**	.63**	.75**	.73**	.87**		
Rib fat trim	.25	.25	.51**	.25	.44**	.27	.42**	.21

* Significant at the .05 level
** Significant at the .01 level
S- Steers
H Heifers

<u>Simple correlation coefficients of age at slaughter and juiciness score with other characteristics of the 6-7-8th rib.</u> Table 5 shows the relationship of the age at slaughter and juiciness score with various physical characteristics of the 6-7-8th rib. The steer and heifer groups showed that age at slaughter was significantly correlated with cooking total losses (-.58) and (.34), shear value (.73) and (.35), and press fluid value (.62) and (.31). Age at slaughter for the steers showed significant correlations with flavor fat score (.32) and tenderness score (-.48). This was not true of the heifers which showed a correlation of (-.10) and (-.22) between age at

slaughter and flavor fat score and tenderness score respectively. Juiciness score was highly significantly correlated for both groups with cooking total losses (-.56) and (-.45) and press fluids value (.60) and (.43) for each respective trial group. The juiciness score for the steers in Trial A was significantly correlated with flavor fat score (.62) and flavor lean score (.31). Non significant correlations were observed between juiciness score and flavor fat score, flavor lean score, tenderness score, and shear value for the heifers.

Table 6 and 7 contains the means and standard deviation of the 46 characteristics of the steers and heifers which are included in this study.

Table 5. Simple correlation coefficients of age at slaughter and juiciness score, with other characteristics of the 6-7-8th rib.

	Age at Slaughter:		Juiciness Score:	
	S	H	S	H
Cooking losses total	-.58**	.34*	-.56**	-.45**
Flavor score fat	.32*	-.10	.62**	.10
Flavor score lean	.18	.35*	.31*	.12
Tenderness score	-.48**	-.22	.06	.16
Shear value	.73**	.35*	.23	.03
Press fluid value	.62**	.31*	.60**	.43**

* Significant at the .05 level
** Significant at the .01 level
S Steers
H Heifers

Table 6. Standard deviations of steer characteristics studied.

	Mean	Standard Deviation
Adjusted weaning weight	501.80	49.35
Weaning muscling score	14.20	4.14
Feeder grade	12.40	2.34
Weaning bone score	3.93	2.11
Slaughter grade	11.80	4.33
Slaughter muscle score	12.53	5.34
Slaughter bone score	3.33	1.6
Classification score	80.73	5.6
Ranch weight	1056.33	95.11
Kansas City weight	1023.66	91.68
Shrink per cent	3.05	1.01
Hide weight	102.20	27.45
Chilled carcass weight	641.93	65.95
Conformation score	12.26	1.16
Marbling score	14.53	4.26
Maturity score	3.00	0.0
Quality grade	11.26	1.50
Dressing per cent	62.66	1.43
Rib eye area	10.62	1.04
Fat thickness 12th rib	.92	.26
Side weight	317.26	65.78
Trimmed round	65.77	14.66
Round fat trim	4.39	2.13
Trimmed loin	51.10	12.17
Loin fat trim	2.96	2.76
Trimmed chuck	80.89	14.88
Chuck fat trim	1.97	1.26
Trimmed rib	27.04	1.56
Rib fat trim	2.76	2.43
Weight lean 9-10-11th rib	2.92	1.06
Weight fat 9-10-11th rib	4.99	2.67
Weight rib eye 9-10-11th rib	1.78	.29
Ether extract (per cent fat)	8.69	1.53
Cooking time (minutes/pound)	40.17	2.69
Cooking losses volatile per cent	16.17	1.47
Cooking losses dripping per cent	6.63	2.02
Cooking losses total per cent	22.79	1.58
Flavor score fat	5.42	1.27
Flavor score lean	5.72	2.78
Tenderness score initial	6.01	1.23
Tenderness score number of chews	25.26	2.88
Tenderness score chew score	6.07	1.05
Shear value	16.08	3.42
Juiciness score	5.70	1.51
Press fluid	6.96	2.31
Age at slaughter	512.93	46.78

Table 7. Standard deviations of heifer characteristics studied.

	Mean	Standard Deviation
Adjusted weaning weight	503.66	26.28
Weaning muscling score	12.53	5.57
Feeder grade	11.53	3.12
Weaning bone score	2.93	2.50
Slaughter grade	12.26	3.29
Slaughter muscle score	12.20	5.91
Slaughter bone score	3.20	2.31
Classification score	81.33	5.10
Ranch weight	909.80	73.75
Kansas City weight	870.33	63.31
Shrink per cent	4.28	3.77
Hide weight	82.86	10.91
Chilled carcass weight	561.93	47.50
Conformation score	11.20	1.58
Marbling score	16.33	3.59
Maturity score	3.06	.67
Quality grade	10.80	3.07
Dressing per cent	64.47	4.97
Rib eye area	10.76	1.33
Fat thickness 12th rib	.80	.26
Side weight	275.13	78.42
Trimmed round	57.70	6.14
Round fat trim	4.19	2.93
Trimmed loin	46.24	4.29
Loin fat trim	3.32	1.23
Trimmed chuck	68.98	6.39
Chuck fat trim	1.21	1.74
Trimmed rib	26.51	2.55
Rib fat trim	.25	.02
Weight lean 9-10-11th rib	3.08	1.61
Weight fat 9-10-11th rib	5.06	3.00
Weight rib eye 9-10-11th rib	1.79	.11
Ether extract (per cent fat)	8.73	2.27
Cooking time (min./lb.)	42.13	2.53
Cooking losses volatile per cent	15.72	2.32
Cooking losses dripping per cent	5.44	2.58
Cooking losses total per cent	21.77	1.57
Flavor score fat	5.66	1.03
Flavor score lean	5.89	1.23
Tenderness score initial	6.10	.30
Tenderness score number of chews	24.66	2.60
Tenderness score chew score	6.12	1.09
Shear value	16.06	3.12
Juiciness score	5.79	1.21
Press fluid	7.60	1.86
Age at slaughter	503.86	24.40

DISCUSSION

A quick review of the conditions involved in this study might be warranted prior to drawing any conclusions. The mean weights for the steers and heifers at slaughter were 1,051 pounds and 861 pounds. This could be generally termed as current ideal weights for slaughter cattle. Although the steers were larger, the heavier weight was not necessarily an indication of excessive fatness. The steers and heifers in this study were all fed the same basic ration of 80 per cent milo, 10 per cent corn, 10 per cent bran, and one and one-half pounds of 42 per cent protein which was prepared at the Houghton Ranch. The standard deviations of all characteristics studied, as noted in Tables 6 and 7, in general were small, thus indicating a high degree of consistency within the various measurements.

Slaughter grade for steers and heifers was highly significantly correlated (.70) and (.85) with classification score. The correlations obtained are in agreement with most estimates presented in the literature. Cook et al. (1951) obtained a similar correlation of (.71) when comparing slaughter grade with classification score for 157 slaughter steers. This substantiates the hypothesis that cattle possessing high classification scores will in like manner be most desirable from a slaughter grade standpoint. Classification score is critical of the cattle which lack indications of natural muscling. The indicators of muscling objectively appraised in a classification score are: width and thickness over the rib, loin and rump, natural muscling in the round with emphasis in width of round through the stifle region, a large forearm which appears muscular, and finally, size and ruggedness of bone exemplified by a well rounded cannon.

The slaughter bone score was an indicator of slaughter muscle score, for in this study a significant correlation of (.45) and (.36) was obtained for steers and heifers, respectively. This also resembles the correlation of (.57) noted by Boughton (1958) between bone appraisal and muscling appraisal of the live animal. Slaughter grade was highly significantly correlated with slaughter muscling score (.75) and significantly correlated (.35) with slaughter bone score in Trial A. The heifers of Trial B exhibited a highly significant correlation (.91) between slaughter grade and slaughter muscling score. A non significant correlation (.28) was observed between slaughter grade and slaughter bone score. Work presented by Boughton (1958) showed similar correlations and live grade was highly significantly correlated with bone appraisal (.46) and muscling appraisal (.81). With the above findings, one is led to believe that judges place considerable emphasis upon muscling and bone when estimating slaughter grade.

It was interesting to note the similarity between the correlations in this study and those presented by Dunn (1960) and Boughton (1958). This study involved the closely trimmed wholesale cuts trimmed to one-quarter of an inch. Correlations were obtained between rib eye area expressed in square inches and other characteristics obtained in physical separation of the 9-10-11th rib. In the study conducted by Dunn (1960), loin eye area expressed per hundred pounds of carcass weight was significantly correlated with trimmed round, loin, rib, and chuck. These correlations were not calculated on a within year or within year and breed basis.

The rib eye area in this study was not significantly correlated (-.12) for steers and (.40) for heifers with the sum per cent trimmed wholesale cuts. Boughton (1958) experienced similar results with correlations of .11 for steers and .08 for heifers between loin eye area and percentage of wholesale cuts. Dunn (1960) observed a correlation of .19 between loin eye area and percentage trimmed wholesale cuts. Individual trimmed loin, chuck, and rib in this study were highly significantly correlated with rib eye area correlations of (.51) and (.63) for trimmed loin for steers and heifers, (.41) and (.80) trimmed chuck for steers and heifers, and (.74) and (.42) trimmed rib for steers and heifers. This is in agreement with Dunn (1960) who reported significant correlations between individual trimmed wholesale cuts and rib eye area. It can be stated from the results of this work that the individual trimmed wholesale cuts are very good indicators of total trimmed wholesale cuts. The trimmed wholesale cuts when expressed as a percentage is not valid when predicting the percentage in terms of rib eye area. The trimmed chuck and round in this study accounted for 75 and 65 per cent of the variation in trimmed wholesale cuts, while the loin eye area accounted for approximately 19 per cent of the variation. Cole et al. (1960) reported that separable lean of the chuck and round accounted for 86 and 90 per cent of the variation in carcass lean whereas loin eye area accounted for 18 per cent or less of separable carcass lean.

The use of trimmed chuck and round is not as good an indicator of muscling in the carcass as trimmed loin and rib but from an economic standpoint the trimmed chuck and round should be used as indicators of trimmed wholesale cuts. The highly significant correlation of the trimmed chuck and round with the other trimmed wholesale cuts substantiates their use as predictors of wholesale cuts. One should remember that the validity of prediction of wholesale cuts will be lowered when using trimmed chuck and round.

Upon correlating fat thickness at the twelfth rib with the three most valuable of the four wholesale cuts (round, loin, and rib), the correlations indicated that the trimmed round, loin, and rib were significantly lower than those noted when correlating the rib eye area with the trimmed wholesale cuts. Therefore fat thickness at the twelfth rib in this study was not a suitable indicator of the three valuable trimmed wholesale cuts.

A small negative correlation (-.19) for steers and a non significant correlation (.15) for heifers was noted between rib eye area and marbling score. Bray and Merkel (1957) also observed a low correlation between loin eye area and marbling score in their work with U.S. prime and choice Hereford steers. This indicates that the grader cannot predict marbling scores using rib eye area as the sole criterion. The rib eye area was significantly correlated (.38) and (.37) with conformation score for the steers and heifers, respectively. This indicated that a large rib eye area is associated with a desirable shaped carcass. This is not in agreement with Dunn (1960) who reported a negative non significant correlation (-.10) between conformation score and loin eye area. The negative and non significant correlations for steers and heifers reported between final carcass grade and trimmed round (.12) and (-.28), trimmed loin (.18) and (.06), trimmed chuck (.11) and (.02) and trimmed rib (-.04) and (.07) did not account for enough of the variation in carcass grade to warrant their use as indicators in this study. Due to the high correlation between rib eye area and carcass grade, it would be safe to assume that rib eye area has an accelerating influence over carcass grade. This is to the contrary of an assumption made by Clifton (1952) who reported that loin eye area does not enhance carcass grade but instead has a depressing effect upon the grade.

Kansas City live weight and 24 hour chilled carcass weight were both highly significantly correlated with rib eye area. In the steer trial, the rib eye area was highly significantly correlated with Kansas City live weight (.61) and 24 hour chilled carcass weight (.97). The heifers exhibited high correlations between rib eye area and Kansas City live weight

(.60) and 24 hour chilled carcass weight (.90). Cole et al. (1960) found that when loin eye area was adjusted for carcass weight, negative non significant correlations were noted for carcass weight and live weight. In this study, live and chilled carcass weights were excellent indicators of trimmed whole cuts. Live animal and carcass weights were highly significant at the .01 level when correlated with the individual trimmed wholesale cuts.

The fat thickness at the twelfth rib was not significantly correlated in the trial groups in this study with the live and carcass weight. This then makes it apparent that the fat thickness at the twelfth rib does not necessarily increase as the steer or heifer carcass becomes heavier. This is contrary to the work presented by Kropf and Graf (1959) which showed an increase in total fat trim as the grade and weight of the carcass increased. However, carcass grade cannot be determined by fat thickness at the twelfth rib as the correlation between these traits were low and non significant.

Quality or final carcass grade was very highly significantly correlated in Trial A (.90) and in Trial B (.82) with marbling score. Since carcass grade and marbling score were so closely related it was not surprising to note that marbling score was not significantly correlated with fat thickness at the twelfth rib. A non significant correlation (.10) and (.14) for steers and heifers was obtained between chilled carcass weight and marbling score. Further investigation of correlations between marbling score and live weight proved to be non significant. Results are in disagreement to that reported by Dunn (1960) who found correlations of .42 and .45 between marbling score and live and carcass weights.

In the heifer group, per cent trimmed wholesale cuts was significantly negatively correlated (-.79) with per cent total fat trim. It may be assumed that as the total fat trim increased, the percentage of trimmed wholesale cuts decreased. Per cent total fat trim was also significantly negatively correlated in the heifer group with rib eye area (-.61) and fat thickness at the twelfth rib (.55).

The use of carcass grade and conformation score as an adequate indicator of trimmed wholesale cut yields is questionable. The steer group lacked consistency in correlations between carcass grade and conformation score with the various wholesale cuts. Conformation score was significantly correlated with trimmed loin (.34), trimmed chuck (.52), and trimmed rib (.53) but non significantly correlated with trimmed round (.10). Carcass grade in all instances was not significantly correlated with trimmed round (.12), trimmed loin (.18), trimmed chuck (.11), and trimmed rib (-.04). The heifers of Trial B showed similar inconsistencies in these correlations of carcass grade and conformation score with the trimmed wholesale cuts. Conformation score was significantly negatively correlated with trimmed round (-.42). Negative and non significant correlations were obtained between conformation score and trimmed loin (-.05), trimmed chuck (-.18), and trimmed rib (.25). Carcass grade in Trial B was negatively and non significantly correlated with trimmed round (-.28), trimmed loin (.06), trimmed chuck (.02), and trimmed rib (.07). However, carcass grade was significantly correlated with marbling score (.90) for steers and (.82) for heifers. Although only the steers showed a significant correlation (.42) between carcass grade and conformation, it might be stated that only marbling score and conformation score of those carcass characteristics studied may be reliable when indicating the carcass grade according to this work. Wheat and Holland (1959) noted a smaller correlation (.25) between carcass conformation and carcass grade.

The prediction of wholesale yields by the physical separation of the 9-10-11th rib cut is sporadically under review. Significant correlations obtained in this study justify the use of the physical separation process. The heifers exhibited highly significant correlations between separable lean of the 9-10-11th rib and trimmed round (.80), trimmed loin (.65), trimmed chuck (.70), and trimmed rib (.60). High correlations were also obtained for steers except for a non significant correlation between the 9-10-11th rib and trimmed round (.29). Separable lean of the 9-10-11th rib was significantly correlated with trimmed loin (.53), trimmed chuck (.70), and trimmed rib (.45). Results of this study indicate that the separable lean of the 9-10-11th rib is an excellent predictor of trimmed wholesale cuts. The separable fat of the 9-10-11th rib was a good indicator of the individual fat trim from the various wholesale cuts. The fat of the 9-10-11th rib for the steer group was significantly correlated with loin fat trim (.39), chuck fat trim (.34), and rib fat trim (.42). The heifers had high significant correlations (.56), (.86), and (.81) for round fat trim, loin fat trim, and chuck fat trim when correlated with separable fat of the 9-10-11th rib.

Thus the analysis of the 9-10-11th rib as a predictor of lean and fat in the various wholesale cuts is valid. Labor and cost is the main obstacle which hampers the use of the 9-10-11th rib.

The influence of age at slaughter with consumer acceptability of meat has been a controversial subject for some time. Age at slaughter was highly significantly correlated in this study for the steer group with fat flavor score (.32), initial tenderness score (-.48), tenderness score number of chews (.33), tenderness score chew score (-.55), and shear value (.73). The heifers, unlike the steers, showed a great many variations within these correlations. Age at slaughter was negatively and non significantly correlated with fat flavor score (-.10), initial tenderness score (-.22), tenderness score number of chews (.37), tenderness score chew score (-.15), and shear value (.35). It should be noted that only two of the characteristics listed for heifers showed any significance when correlated with age at slaughter. Highly significant correlations were found between age at slaughter in both trial groups and marbling score and final carcass grade. The correlations obtained were as follows for steers and heifers: marbling score (-.57) and (-.49), and final carcass grade (-.52) and (-.47). Due to the findings in the study it would be well to identify age at slaughter with marbling score and carcass grade. It is evident that the marbling score is going to be increased or decreased with the fluctuation in age. As has been stated previously, marbling greatly influences carcass grade so an intimate relationship between these three characteristics is established.

The validity of associating eating quality of meat with age at slaughter in this study is somewhat fogged by the inconsistency found within these correlations. However, this doesn't mean that we should abandon the idea that age does influence the tenderness, juiciness, or flavor of meat.

In analyzing the differences in the various sires studied, similar trends are established in both trial groups. Tables 8 thru 25 in the Appendix establishes the outstanding sires for the various characteristics which were significantly superior in various phases of the experiment.

It should be noted before further interpretation of the tables is undertaken that the majority of the variation between sires was limited due to the size of the population involved. An experiment of this nature would be more meaningful if, in the design, more individuals were included in the sample size.

This, of course, would have enhanced the statistical results obtained in this study.

One sire in the preslaughter and slaughter phase was significantly superior to the others tested at the .05 level. In Trial A, the steer group, Onward Rupert was significantly superior in weaning bone score over Royal Husker K31 and M. Crusty Domino for this characteristic at the .05 level. Royal Husker K31 also showed superiority over M. Crusty Domino. The heifer progeny also favored Onward Rupert in weaning bone score, slaughter bone score, ranch weight, Kansas City weight, chilled carcass weight, and side weight. The traits studied were all significantly superior to those transmitted to the progeny of Royal Husker K31 and M. Crusty Domino.

Royal Husker K31, on the other hand, surpassed the other sires concerning traits related to quality. In the steer trial, Royal Husker K31 was significantly superior ($P < .05$) to the other sires in chuck fat trim, tenderness score, initial score, and tenderness score chew score. In the heifer group, like the steers, Royal Husker K31 was superior in the traits associated with quality. The following are the traits in which the progeny of Royal Husker K31 were significantly superior: marbling score, quality (final) grade, and ether extract.

When speaking of saleable products, whether at weaning, slaughter, or retailing of meat, Onward Rupert surpassed the other sires. Significance of the superiority of Onward Rupert over the other sires was expressed in terms of trimmed round, trimmed loin, trimmed chuck, and lean of the 9-10-11th rib when examining the data.

In this study, although these bulls are quite desirable from a breeding standpoint, we have shown that the bull with the highest classification score tends to produce progeny which are superior for their muscling and thus a higher proportion of saleable carcass lean. The M. Crusty Domino sire was hampered by producing the late born calves, thus the lighter and younger calves at slaughter.

SUMMARY

Twenty-eight steers and twenty-three heifers bred and raised by the Clifford Houghton Ranch of Tipton, Kansas were used in this study. A random sample of fifteen steers and fifteen heifers were selected from the fifty-one head for detailed carcass analysis.

Simple correlations were calculated between twelve live animal, eighteen carcass, and sixteen detailed carcass characteristics for both the steer and the heifer trial groups in this study. The live animal characteristics included: adjusted weaning weight, weaning muscle and bone score, feeder and slaughter grade, slaughter muscle and bone score, classification score, ranch and Kansas City weight, shrink per cent, and age at slaughter. The carcass characteristics studied included: hide weight, chilled carcass weight, conformation, marbling and maturity score, quality grade, dressing per cent, rib eye area, side weight, weight of the trimmed round, loin, chuck, and rib, and fat trim from the round, loin, chuck and rib. The outside fat of the various wholesale cuts were trimmed to one-quarter inch depth. The detailed carcass characteristics constituted the sixteen remaining traits: weight of the lean, fat and rib eye of the 9-10-11th rib, ether extract, cooking time, cooking losses volatile, drip and total, flavor score for fat and lean, tenderness score initial, number of chews and chew score, shear value, juiciness score, and press fluid.

A highly significant correlation was found between slaughter grade and classification score for steers (.70) and heifers (.85). Slaughter grade was significantly correlated in the steer and heifer groups respectively with trimmed round (.58) and (.57), trimmed loin (.65) and (.55), trimmed chuck (.58) and (.62), and trimmed rib (.44) and (.63).

Carcass grade was very highly correlated with marbling score (.90) in the steer group and (.82) in the heifer group. This indicates the very dominant influence of marbling in determining carcass grade under the present U.S.D.A. grading standards. In the steer trial group, carcass grade was non significantly correlated with trimmed round (.12), trimmed loin (.18), trimmed chuck (.11), and trimmed rib (-.04). The heifers exhibited similar non significant correlations between carcass grade and trimmed round (-.28), trimmed loin (.06), trimmed chuck (.02), and trimmed rib (.07).

The rib eye area was highly significantly correlated with individual wholesale cuts: trimmed loin (.51) and (.63), trimmed chuck (.41) and (.80), and trimmed rib (.74) and (.42) for steers and heifers respectively. Non significant correlations (-.12) and (.40) were obtained between rib eye area and sum per cent trimmed wholesale cuts for steers and heifers.

This study indicated that quality grade or final carcass grade is a poor indicator of yield of wholesale cuts. Thus, it becomes apparent of the faults in our present U.S.D.A. grading standards. The producer of market cattle is most interested in the production of a desirable market product. According to our present grading standards, this would constitute an animal of extremely high carcass quality. In order that a carcass possess these high quality standards, the animal must have been of the proper breeding and also fed under the proper environment. However, the chief saleable product from the carcass is red meat. Therefore we should select cattle that characterize the meat type individual and are suitable for slaughter at approximately 1,000 pounds. Thus we may conclude that additional studies need to be undertaken before the breeders place too much emphasis on these traits of carcass quality in their improvement program. More emphasis should be on the selection of herd sires and matrons which have the desirable muscle characteristics to pass to their offspring. One must recall that 50 per cent of the characteristics passed to the offspring is the result of the cow and 50 per cent is credited to the bull. As we have shown in this study, results indicate that sires of comparable classification score tend to transmit varying characteristics to their progeny produced from a closed cow herd. In conclusion, if we are to produce the proper quantities of meat to feed our nation, more emphasis must be put on red meat and less on the quality factors. To identify the true merit of a carcass, one should select the weight of any wholesale cut, as they are easily obtained, and any one is satisfactory when predicting the total trimmed wholesale cut.

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APPENDIX

Table 8. L.S.D. for steer weaning bone score.
Trial A

	Mean:	Difference : M. Crusty Domino:	Difference : Royal Husker K31:
Onward Rupert	4.60	1.10*	.54*
Royal Husker K31	4.16	.66*	
M. Crusty Domino	3.50		

* Significant at the .05 level

Table 9. L.S.D. for steer chuck fat trim.
Trial A

	Mean:	Difference : M. Crusty Domino:	Difference : Onward Rupert:
Royal Husker K31	2.30	.60*	.38
Onward Rupert	1.92	.22	
M. Crusty Domino	1.70		

* Significant at the .05 level

Table 10. L.S.D. for steer tenderness score initial score.
Trial A

	Mean:	Difference : Onward Rupert:	Difference : M. Crusty Domino:
Royal Husker K31	6.34	.58*	.40
M. Crusty Domino	5.94	.18	
Onward Rupert	5.76		

* Significant at the .05 level

Table 11. L.S.D. for steer tenderness score number of chews. Trial A

	Mean:	Difference : Royal Husker K31:	Difference : M. Crusty Domino:
Onward Rupert	27.60	4.60*	2.40
M. Crusty Domino	25.20	2.20	
Royal Husker K31	23.00		

* Significant at the .05 level

Table 12. L.S.D. for steer tenderness score chew score. Trial A

	Mean:	Difference : Royal Husker K31:	Difference : M. Crusty Domino:
Royal Husker K31	6.32	.50*	.24
M. Crusty Domino	6.08	.26	
Onward Rupert	5.82		

* Significant at the .05 level

Table 13. L.S.D. for heifer weaning bone score.
Trial B

	Mean:	Difference : M. Crusty Domino:	Difference : Royal Husker K31:
Onward Rupert	3.80	1.20*	1.05*
Royal Husker K31	2.75	.15	
M. Crusty Domino	2.60		

* Significant at the .05 level

Table 14. L.S.D. for heifer slaughter bone score.
Trial B

	Mean:	Difference : M. Crusty Domino:	Difference : Royal Husker K31:
Onward Rupert	12.80	1.20*	.55
Royal Husker K31	12.25	.65	
M. Crusty Domino	11.60		

* Significant at the .05 level

Table 15. L.S.D. for heifer ranch weight.
Trial B

	Mean:	Difference : M. Crusty Domino:	Difference : Royal Husker K31:
Onward Rupert	954.40	111.90*	25.03*
Royal Husker K31	929.37	85.87*	
M. Crusty Domino	833.50		

* Significant at the .05 level

Table 16. L.S.D. for heifer Kansas City weight. Trial B

	Mean:	Difference : M. Crusty Domino:	Difference : Royal Husker K31:
Onward Rupert	917.00	107.56*	23.63
Royal Husker K31	884.37	75.93*	
M. Crusty Domino	809.44		

* Significant at the .05 level

Table 17. L.S.D. for heifers chilled carcass weight. Trial B

	Mean:	Difference M. Crusty Domino:	Difference : Royal Husker K31:
Onward Rupert	595.40	78.77*	25.40
Royal Husker K31	570.00	51.23*	
M. Crusty Domino	518.77		

* Significant at the .05 level

Table 18. L.S.D. for heifers marbling score. Trial B

	Mean:	Difference M. Crusty Domino:	Difference : Royal Husker K31:
Royal Husker K31	19.37	6.77*	3.49*
M. Crusty Domino	15.88	3.28*	
Onward Rupert	12.60		

* Significant at the .05 level

Table 19. L.S.D. for heifer quality grade.
Trial B

	Mean:	Difference : Onward Rupert:	Difference : M. Crusty Domino:
Royal Husker K31	11.50	1.50*	.95*
M. Crusty Domino	10.55	.55	
Onward Rupert	10.00		

* Significant at the .05 level

Table 20. L.S.D. for heifer carcass side weight.
Trial B

	Mean:	Difference : M. Crusty Domino:	Difference : Royal Husker K31:
Onward Rupert	292.40	40.80*	11.00
Royal Husker K31	281.40	29.80*	
M. Crusty Domino	251.60		

* Significant at the .05 level

Table 21. L.S.D. for heifer trimmed round.
Trial B

	Mean:	Difference : M. Crusty Domino:	Difference : Royal Husker K31:
Onward Rupert	63.40	10.76*	6.32*
Royal Husker K31	57.08	4.44	
M. Crusty Domino	52.64		

* Significant at the .05 level

Table 22. L.S.D. for heifer trimmed loin.
Trial B

	Mean:	Difference : M. Crusty Domino:	Difference : Royal Husker K31:
Onward Rupert	49.30	7.24*	1.94
Royal Husker K31	47.36	5.30*	
M. Crusty Domino	42.06		

* Significant at the .05 level

Table 23. L.S.D. for heifer trimmed chuck.
Trial B

	Mean:	Difference M. Crusty Domino:	Difference : Royal Husker K31:
Onward Rupert	72.74	8.46*	1.82
Royal Husker K31	70.94	7.64*	
M. Crusty Domino	63.28		

* Significant at the .05 level

Table 24. L.S.D. for heifer weight lean 9-10-11th rib.
Trial B

	Mean:	Difference : M. Crusty Domino:	Difference : Royal Husker K31:
Onward Rupert	3.56	.98*	.44
Royal Husker K31	3.12	.54*	
M. Crusty Domino	2.58		

* Significant at the .05 level

Table 25. L.S.D. for heifer ether extract.
Trial B

	Mean:	Difference : Onward Rupert:	Difference : M. Crusty Domino:
Royal Husker K31	10.07	3.60*	.40
M. Crusty Domino	9.67	3.20*	
Onward Rupert	6.47		

* Significant at the .05 level

Table 26. Score card for feeder and slaughter characteristics.

Tattoo____________________Weight____________________

Feeder grade________________

Muscling

Slaughter grade_______Fore arm score_______Over top score_____

Rounds score____________Bone score____________________

Condition score__________________________

Classification Score

Type	Size	Quality	Shoulder & Chest	Rib & Back	Loin
14	10	6	8	10	10

Rump	Thighs & Rounds	Feet & Legs	Head & Neck	Total
10	12	12	8	

Table 27. Numerical values for feeder grade, slaughter grade and carcass grade scoring system.

	Minus	Average	Plus
Prime	12	15	16
Choice	11	12	13
Good	8	9	10
Standard	5	6	7
Commercial	2	3	4
Utility, Cutter and Canner	-1	0	1

Table 28. Numerical values for marbling scoring system.

	Minus	Average	Plus
Extremely Abundant	34	35	36
Very Abundant	31	32	33
Abundant	28	29	30
Moderately Abundant	25	26	27
Slightly Abundant	22	23	24
Moderate	19	20	21
Modest	16	17	18
Small	13	14	15
Slight	10	11	12
Traces	7	8	9
Practically Devoid	4	5	6
Devoid	1	2	3

Table 29. Numerical values for carcass maturity score system.

	Minus	Average	Plus
A-maturity	1	2	3
B-maturity	4	5	6
C-maturity	7	8	9

Table 30. Numerical values for feeder and slaughter muscling scores.

	Minus	Average	Plus
Very Heavy Muscle	16	17	18
Heavy Muscle	13	14	15
Moderately Heavy Muscle	10	11	12
Medium Muscle	7	8	9
Slightly Light Muscle	4	5	6
Light Muscle	1	2	3

Table 31. Numerical values for feeder and slaughter visual bone score.

Very Rugged	6
Rugged	5
Moderately Rugged	4
Medium	3
Slightly Light	2
Light	1

Table 32. Numerical values for scoring flavor, juiciness, and tenderness of beef lean.

Score:	Flavor:	Juiciness:	Tenderness:
7	Very desirable	Very juicy	Very tender
6	Desirable	Juicy	Tender
5	Moderately desirable	Moderately juicy	Moderately tender
4	Slightly desirable	Slightly dry	Slightly tough
3	Neutral	Dry	Tough
2	Slightly undesirable	Very dry	Very tough
1	Undesirable	Extremely dry	Extremely tough

Table 33. Data from the steers used in this study.*

	A.N.:	A.W.W.:	W.M.S.:	F.G.:	W.B.S.:	S.G.:	S.M.S.:	S.B.S.:
Royal Husker K31								
	3063	460	14	12	4	14	13	3
	3065	511	14	12	4	11	10	3
	3077	479	15	13	5	12	14	3
	3097	501	15	12	5	11	13	3
	3126	543	15	13	4	12	13	3
	3149	526	16	12	5	12	12	3
	3157	531	14	12	4	12	12	4
	3159	553	15	13	4	13	14	4
	3177	466	14	12	4	8	9	2
	3178	545	15	12	4	13	14	3
	3179	527	11	11	3	12	14	3
	3181	592	16	13	4	13	14	3
M. Crusty Domino								
	3095	399	14	12	4	10	12	4
	3158	491	11	12	3	13	13	3
	3176	540	16	14	4	13	14	3
	3186	526	14	12	4	12	12	3
	3189	541	14	12	3	11	11	3
	3191	567	14	12	3	14	16	4
Onward Rupert								
	3024	485	16	14	5	11	13	4
	3025	480	15	13	5	13	15	4
	3034	455	15	13	4	12	13	4
	3053	487	15	13	4	13	12	3
	3089	434	15	13	5	11	12	3
	3163	530	13	12	4	12	11	3
	3167	502	12	11	4	9	9	3
	3172	524	14	12	5	11	13	3
	3183	564	15	13	5	12	15	3
	3195	381	15	13	5	13	14	4

Table 33 (Cont.).

	A.N.	Cl.S.	R.W.	K.W.	S.P.	H.W.	C.C.W.	Con.S.	Ma.S.	Mat.S.	Q.G.
Royal Husker K31											
	3063	84	1155	1120	3.0	111	711	13	16	3	12
	3065	75	1130	1085	3.9	93	691	14	26	3	14
	3077	82	1025	1000	2.4	97	628	13	18	3	13
	3097	88	1255	1230	1.9	110	803	13	15	3	12
	3126	78	1165	1130	3.0	101	714	12	23	3	14
	3149	74	1095	1070	2.2	108	703	13	18	3	13
	3157	81	1050	1015	3.3	98	650	13	12	3	10
	3159	88	1130	1080	4.4	105	668	13	18	3	13
	3177	67	880	850	3.4	86	539	12	17	3	12
	3178	82	1115	1090	2.2	109	690	13	18	3	13
	3179	89	1100	1095	0.4	102	668	10	14	3	10
	3181	88	1075	1050	2.3	102	652	13	16	3	13
M. Crusty Domino											
	3095	82	1020	1000	1.9	110	627	13	11	3	10
	3158	84	1070	1030	3.7	92	635	13	18	3	13
	3176	83	1095	1065	2.7	97	690	14	17	3	11
	3186	80	1060	1025	3.3	113	666	14	18	3	13
	3189	76	1025	995	2.9	94	624	10	14	3	10
	3191	92	1170	1115	4.7	106	693	12	17	3	13
Onward Rupert											
	3024	84	845	825	2.3	91	500	11	17	3	12
	3025	86	1075	1020	5.1	107	673	13	16	3	13
	3034	81	1045	1000	4.3	96	616	12	13	3	10
	3053	80	1150	1120	2.6	103	715	13	26	3	14
	3089	77	1070	1050	1.8	111	663	12	9	3	10
	3163	75	1110	1085	2.2	116	683	12	11	3	10
	3167	72	1000	965	3.5	104	598	10	15	3	11
	3172	83	1315	1265	3.8	125	829	14	12	3	10
	3183	81	1130	1090	3.5	112	674	11	9	3	10
	3195	83	990	965	2.5	107	601	12	12	3	10

Table 33 (Cont.).

	A.N.	D.P.	R.E.A.	F.T.	A.S.	S.W.	T.R.	R.F.T.	T.L.	L.F.T.	T.C.
Royal Husker K31											
	3063	63.4	10.56	.81	523						
	3065	63.6	99.81	1.21	529						
	3077	62.8	11.10	1.00	519						
	3097	65.2	12.35	1.17	528						
	3126	63.1	10.15	1.21	503						
	3149	65.7	11.59	1.11	539						
	3157	64.0	12.19	.76	512	320	66.5	3.5	53.5	3.5	81.5
	3159	61.8	10.91	.87	518	328	65.3	4.7	52.0	4.0	79.5
	3177	63.4	9.25	.73	520	264	54.0	4.0	43.0	2.0	75.5
	3178	63.3	10.54	1.23	506	340	65.5	4.5	54.0	4.0	87.5
	3179	61.0	10.12	.71	539						
	3181	62.0	11.85	.89	508	319	67.3	4.7	50.5	3.5	79.5
M. Crusty Domino											
	3095	62.7	11.00	.78	538	310	65.5	4.5	50.0	3.0	80.5
	3158	61.6	8.36	.80	494	316	67.5	4.5	50.0	2.0	78.0
	3176	64.7	11.90	1.80	506	341	67.0	5.0	54.0	4.0	88.0
	3186	64.9	10.65	.85	491						
	3189	62.7	10.00	.78	491	310	66.5	3.5	48.0	3.0	78.5
	3191	62.1	10.61	.80	485	343	75.0	3.0	59.0	3.0	87.5
Onward Rupert											
	3024	60.6	8.23	1.19	520						
	3025	65.9	10.60	1.36	539						
	3034	61.6	10.15	.83	529	306	63.5	4.5	48.5	3.5	84.9
	3053	63.8	11.80	1.03	537						
	3089	63.1	11.50	.95	521	329	70.0	5.5	53.5	2.5	84.0
	3163	62.9	10.80	1.10	527	335	69.0	5.0	54.5	1.5	80.0
	3167	61.9	10.46	.70	517	298	64.0	4.0	48.5	1.5	72.0
	3172	65.5	12.19	1.38	522						
	3183	61.8	11.19	.70	539						
	3195	62.2	9.90	.90	522	300	60.0	5.0	47.5	3.5	76.5

Table 33 (Cont.).

	A.N.:	C.F.T.:	T.R.[a]:	R.F.T.[b]:	W.L.:	W.F.:	W.R.E.:	E.E.:	C.T.:	C.L.V.:	C.L.D.:
Royal Husker K31											
	3157	2.5	27.5	2.5	3.0	5.7	2.3	8.55	40.7	17.8	6.4
	3159	2.5	27.3	2.7	2.9	4.4	1.9	11.25	41.3	14.4	7.3
	3177	1.5	24.1	2.9	2.9	4.3	1.4	7.76	41.1	17.8	7.1
	3178	2.5	27.6	3.4	3.3	5.7	1.8	11.20	38.7	16.1	6.9
	3181	2.5	28.4	1.6	2.6	5.9	1.9	10.85	37.3	15.1	6.5
M. Crusty Domino											
	3095	1.5	26.5	2.5	3.3	4.5	2.0	7.10	37.8	15.6	5.9
	3158	2.0	25.1	1.9	2.2	4.7	1.5	9.90	39.2	15.0	7.1
	3176	2.0	29.7	3.3	3.6	6.7	2.3	8.60	41.0	15.8	6.7
	3189	1.5	25.0	3.0	2.6	4.4	1.8	7.02	37.8	17.3	7.3
	3191	1.5	27.9	3.1	3.5	5.4	2.0	7.09	40.2	20.0	6.6
Onward Rupert											
	3034	2.1	26.7	2.3	3.2	4.2	1.4	8.21	44.3	16.2	5.5
	3089	2.0	28.0	4.0	2.7	5.0	1.6	8.10	38.8	15.9	6.8
	3163	2.0	28.9	4.1	3.2	5.8	1.9	9.20	37.5	15.1	7.7
	3167	2.0	25.5	1.5	2.7	3.5	1.5	6.65	39.7	15.3	5.7
	3195	1.5	27.4	2.6	2.2	4.7	1.5	8.97	47.2	15.2	6.0

Table 33 (Concl.).

	A.N.	C.L.T.	F.S.F.	F.S.L.	T.S.I.	T.S.NO.C.	T.S.C.S.	S.V.	J.S.	P.F.
Royal Husker K31										
	3157	24.1	5.7	5.8	6.4	22	6.4	14.8	5.8	7.1
	3159	21.6	5.8	6.0	6.5	22	6.4	12.7	6.1	7.3
	3177	24.8	5.2	6.0	6.0	25	6.2	19.6	5.0	5.8
	3178	22.9	5.8	5.8	6.6	24	6.4	14.8	6.2	7.3
	3181	21.7	5.0	5.2	6.2	22	6.2	12.6	5.6	7.4
M. Crusty Domino										
	3095	21.5	5.4	6.0	5.2	29	5.4	22.4	6.3	8.0
	3158	22.1	5.6	5.9	6.5	23	6.5	11.2	5.8	6.6
	3176	22.5	5.8	5.8	6.2	22	6.4	15.7	5.6	6.4
	3189	24.6	5.4	5.8	5.9	25	6.2	12.5	5.8	6.4
	3191	26.6	4.4	5.5	5.9	27	5.9	15.4	4.8	5.8
Onward Rupert										
	3034	21.7	5.8	5.9	5.9	25	5.9	22.0	6.4	8.0
	3089	22.7	5.6	5.8	5.9	29	6.0	14.3	5.0	7.7
	3163	22.8	5.6	5.8	5.8	25	5.8	18.7	6.0	6.8
	3167	21.1	5.4	5.5	5.6	30	5.8	17.0	5.6	6.3
	3195	21.2	4.9	5.1	5.6	29	5.6	17.6	5.6	7.6

* Code for observations found in Table 33.

A.N.	Animal number	T.L.	Trimmed loin
A.W.W.	Adjusted weaning weight	L.F.T.	Loin fat trim
W.M.S.	Weaning muscling score	T.C.	Trimmed chuck
F.G.	Feeder grade	C.F.T.	Chuck fat trim
W.B.S.	Weaning bone score	T.R.[a]	Trimmed rib
S.G.	Slaughter grade	R.F.T.[b]	Rib fat trim
S.M.S.	Slaughter muscling score	W.L.	Weight lean 9-10-11th rib
S.B.S.	Slaughter bone score	W.F.	Weight fat 9-10-11th rib
Cl.S.	Classification score	W.R.E.	Weight rib eye 9-10-11th rib
R.W.	Ranch weight	E.E.	Ether extract
K.W.	Kansas City weight	C.T.	Cooking time
S.P.	Shrink per cent	C.L.V.	Cooking losses volatile per cent
H.W.	Hide weight	C.L.D.	Cooking losses dripping per cent
C.C.W.	Chilled carcass weight	C.L.T.	Cooking losses total per cent
Con.S.	Conformation score	F.S.F.	Flavoring score fat
Ma.S.	Marbling score	F.S.L.	Flavor score lean
Mat.S.	Maturity score	T.S.I.	Tenderness score initial
Q.G.	Quality score	T.S.No.C.	Tenderness score number of chews
D.P.	Dressing per cent	T.S.C.S.	Tenderness score chew score
R.E.A.	Rib eye area (12th rib)	S.V.	Shear value
F.T.	Fat thickness (12th rib)	J.S.	Juiciness score
S.W.	Side weight	P.F.	Press fluid
T.R.	Trimmed round	A.S.	Age at slaughter
R.F.T.	Round fat trim		

Table 34. Data from the heifers used in this study.*

	A.N.:	A.W.W.:	W.M.S.:	F.G.:	W.B.S.:	S.G.:
Royal Husker K31						
	3005	536	16	12	3	13
	3031	506	14	12	3	12
	3160	523	12	11	2	13
	3161	519	14	13	4	12
	3166	571	13	11	3	11
	3171	484	11	11	3	13
	3175	502	10	10	2	12
	3184	544	10	12	2	12
M. Crusty Domino						
	3019	510	16	14	3	14
	3071	462	14	12	3	10
	3117	470	11	10	3	10
	3156	488	11	11	2	11
	3164	496	12	11	2	12
	3169	489	11	10	2	11
	3170	510	14	12	3	12
	3187	511	14	12	2	12
	3190	533	11	12	3	12
	3192	511	11	11	3	12
Onward Rupert						
	3067	489	14	12	4	13
	3134	502	14	12	3	13
	3148	479	13	12	4	12
	3180	488	13	11	3	14
	3182	546	14	13	5	12

Table 34 (Cont.).

	A.N.:	S.M.S.:	S.B.S.:	Cl.S.:	R.W.:	K.W.:	S.P.:	H.W.:
Royal Husker K31								
	3005	13	3	87	995	950	4.5	96
	3031	12	2	76	995	955	4.0	97
	3160	14	3	85	905	860	4.9	75
	3161	12	3	82	875	815	6.8	77
	3166	11	3	72	890	840	5.6	76
	3171	14	4	87	910	865	4.9	72
	3175	10	2	78	960	910	5.2	81
	3184	11	3	81	905	880	2.7	85
M. Crusty Domino								
	3019	15	3	88	890	840	5.6	73
	3071	10	3	74	840	790	5.9	73
	3117	8	2	75	730			
	3156	9	4	79	815	785	3.6	80
	3164	11	2	78	840	795	5.3	70
	3169	10	2	70	790	770	2.5	71
	3170	12	3	83	815	790	3.0	84
	3187	12	3	83	840	805	4.1	68
	3190	12	4	81	945	910	3.7	97
	3192	12	3	78	830	800	3.6	99
Onward Rupert								
	3067	13	4	86	1045	985	5.7	92
	3134	13	4	87	910	885	2.7	75
	3148	13	4	81	970	935	3.6	96
	3180	16	3	86	947	910	3.9	94
	3182	12	4	81	900	870	3.3	98

Table 34 (Cont.).

	A.N.:	C.C.W.:	Con.S.:	Ma.S.:	Mat.S.:	Q.G.:	D.P.:	R.E.A.:
Royal Husker K31								
	3005	596	11	15	3	11	62.7	11.10
	3031	614	11	21	3	12	64.2	12.51
	3160	552	10	21	3	11	64.1	12.85
	3161	544	12	16	3	11	66.7	9.28
	3166	536	11	21	3	12	63.8	12.00
	3171	572	12	19	3	11	66.1	9.91
	3175	580	12	22	4	13	63.7	10.21
	3184	566	11	20	3	11	64.3	11.30
M. Crusty Domino								
	3019	596	12	19	3	11	64.2	12.75
	3071	510	11	15	3	10	64.5	9.91
	3117							
	3156	476	11	15	3	11	60.6	10.31
	3164	513	11	15	3	11	64.5	9.42
	3169	494	11	19	3	11	64.1	7.92
	3170	490	11	11	3	9	62.0	10.51
	3187	523	12	14	3	10	64.9	9.21
	3190	584	11	20	3	11	64.1	11.42
	3192	483	11	15	3	11	60.3	11.15
Onward Rupert								
	3067	649	11	13	3	11	65.8	11.45
	3134	566	11	13	3	10	63.9	11.60
	3148	613	11	12	3	9	65.5	12.19
	3180	596	11	15	3	11	65.4	12.45
	3182	553	11	10	3	9	63.5	10.70

Table 34 (Cont.).

	A.N.:	F.T.:	A.S.:	S.W.:	T.R.:	R.F.T.:	T.L.:	L.F.T.:	T.C.:
Royal Husker K31									
	3005	.53	498						
	3031	.85	478	306	63.9	3.6	52.0	4.0	77.0
	3160	.60	488	271	60.6	3.4	45.0	2.0	71.5
	3161	1.11	508	266	50.0	5.0	44.9	5.1	65.5
	3166	.51	497						
	3171	.62	480	281	57.4	5.1	47.1	2.9	72.0
	3175	1.46	498	283	53.5	5.5	47.8	5.2	68.6
	3184	1.10	495						
M. Crusty Domino									
	3019	.56	439						
	3071	.65	432						
	3117		452						
	3156	.40	469	232	50.4	3.1	39.5	1.0	59.5
	3164	.51	485	250	51.4	4.6	42.6	2.4	66.1
	3169	.62	476	240	48.5	4.5	39.5	5.0	55.9
	3170	1.01	482						
	3187	1.05	449	250	52.4	3.6	42.2	3.8	62.9
	3190	.71	461	286	60.5	4.5	46.5	3.5	72.0
	3192	.61	449						
Onward Rupert									
	3067	1.00	505	319	66.1	5.9	54.9	4.1	78.5
	3134	.62	483	278	59.3	3.2	49.4	3.1	68.9
	3148	.73	510	301	65.6	3.4	49.2	3.3	76.5
	3180	.95	492	294	63.0	4.5	46.9	2.1	72.7
	3182	.89	476	270	63.0	3.0	46.1	2.4	67.1

Table 34 (Cont.).

	A.N.:	C.F.T.:	T.R.[a]:	R.F.T.[b]:	W.L.:	W.F.:	W.R.E.:	E.E.:
Royal Husker K31								
	3031	2.0	28.9	1.1	3.5	6.1	2.5	13.25
	3160		24.0		3.1	4.0	2.2	7.50
	3161	1.5	26.3	.2	2.6	6.4	1.6	10.65
	3171	1.5	27.0		3.2	5.3	2.3	9.45
	3175	1.9	28.9	.1	3.2	6.6	1.6	9.50
M. Crusty Domino								
	3156	.4	21.3	.2	2.2	3.6	1.6	11.00
	3164	1.4	23.6	.4	2.6	4.3	1.3	9.00
	3169	1.1	23.4	.1	2.6	5.3	1.6	11.65
	3187	1.6	26.4	.1	2.7	5.8	1.7	7.95
	3190	1.5	28.1	.4	2.8	5.3	1.9	8.77
Onward Rupert								
	3067	1.0	30.0		3.2	5.4	1.6	7.81
	3134	.6	29.1	.4	3.4	3.8	1.6	5.80
	3148	1.5	28.8	.2	3.6	5.3	2.4	5.85
	3180	1.3	26.7	.3	4.2	4.5	1.6	7.75
	3182	.9	25.2	.3	3.4	4.2	1.4	5.15

Table 34 (Cont.).

	A.N.:	C.T.:	C.L.V.:	C.L.D.:	C.L.T.:	F.S.F.:	F.S.L.:	T.S.I.:
Royal Husker K31								
	3031	41.4	16.8	4.7	21.5	6.0	6.0	6.4
	3160	46.2	16.8	5.2	20.8	5.6	5.6	6.2
	3161	41.4	13.8	6.5	20.3	5.8	5.9	5.6
	3171	41.4	16.7	6.0	22.9	5.7	5.8	6.2
	3175	39.5	16.8	6.9	23.6	5.8	6.0	6.3
M. Crusty Domino								
	3156	44.7	13.8	4.1	17.9	5.1	5.5	6.1
	3164	44.8	11.0	4.5	20.6	5.5	5.1	5.9
	3169	41.5	15.8	5.0	20.9	5.5	6.4	6.2
	3187	43.8	16.2	5.7	21.9	6.2	6.2	6.2
	3190	36.9	15.5	6.7	22.2	6.1	6.0	6.5
Onward Rupert								
	3067	38.6	11.3	5.8	22.0	5.5	6.0	5.9
	3134	42.2	16.3	5.3	21.6	5.1	5.2	5.5
	3148	44.9	17.9	5.0	22.8	6.0	6.1	6.6
	3180	42.5	18.6	5.4	24.1	5.5	6.2	6.0
	3182	42.2	18.6	4.9	23.5	5.6	6.4	5.9

Table 34 (Concl.).

	A.N.:	T.S.NO.C.:	T.S.C.S.:	S.V.:	J.S.:	P.F.:
Royal Husker K31						
	3031	21	6.4	13.4	6.4	7.2
	3160	26	5.9	15.8	6.1	8.1
	3161	28	5.4	23.0	5.9	8.1
	3171	23	6.3	12.9	5.0	7.2
	3175	24	6.4	14.0	5.8	6.9
M. Crusty Domino						
	3156	25	6.0	17.0	5.9	8.2
	3164	25	6.0	16.2	5.9	8.5
	3169	24	6.2	16.3	6.2	7.6
	3187	24	6.3	14.6	5.7	6.8
	3190	23	6.5	12.1	6.3	8.5
Onward Rupert						
	3067	26	6.0	15.9	5.3	7.5
	3134	30	5.5	21.6	5.9	7.8
	3148	22	6.5	13.8	5.5	7.8
	3180	21	6.5	15.0	5.5	7.0
	3182	28	6.0	19.4	5.5	6.9

* Code for observations found in Table 34.

A.N.	Animal number	T.L.	Trimmed loin
A.W.W.	Adjusted weaning weight	L.F.T.	Loin fat trim
W.M.S.	Weaning muscling score	T.C.	Trimmed chuck
F.G.	Feeder grade	C.F.T.	Chuck fat trim
W.B.S.	Weaning bone score	T.R.[a]	Trimmed rib
S.G.	Slaughter grade	R.F.T.[b]	Rib fat trim
S.M.S.	Slaughter muscling score	W.L.	Weight lean 9-10-11th rib
S.B.S.	Slaughter bone score	W.F.	Weight fat 9-10-11th rib
Cl.S.	Classification score	W.R.E.	Weight rib eye 9-10-11th rib
R.W.	Ranch weight	E.E.	Ether extract
K.W.	Kansas City weight	C.T.	Cooking time
S.P.	Shrink per cent	C.L.V.	Cooking losses volatile per cent
H.W.	Hide weight	C.L.D.	Cooking losses dripping per cent
C.C.W.	Chilled carcass weight	C.L.T.	Cooking losses total per cent
Con.S.	Conformation score	F.S.F.	Flavoring score fat
Ma.S.	Marbling score	F.S.L.	Flavor score lean
Mat.S.	Maturity score	T.S.I.	Tenderness score initial
Q.G.	Quality score	T.S.No.C.	Tenderness score number of chews
D.P.	Dressing per cent	T.S.C.S.	Tenderness score chew score
R.E.A.	Rib eye area (12th rib)	S.V.	Shear value
F.T.	Fat thickness (12th rib)	J.S.	Juiciness score
S.W.	Side weight	P.F.	Press fluid
T.R.	Trimmed round	A.S.	Age at slaughter
R.F.T.	Round fat trim		

A COMPARISON OF LIVE ANIMAL AND CARCASS TRAITS AMONG HEREFORD PROGENY GROUPS

by

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B. S., California State Polytechnic College, 1964

AN ABSTRACT OF A MASTER'S THESIS

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ABSTRACT

The production of lean meat has become somewhat perplexed by the demands put forth by the American consumer. These demands put on the producer have resulted in the selection of beef cattle with natural muscling characteristics. Assistance would be rendered to the producer if live animal measurements could accurately predict the cattle which possesses a high proportion of lean meat per unit of body weight.

Live and carcass data was obtained on twenty-eight steers and twenty-three heifers which were the progeny of three Hereford bulls. The U.S.D.A. carcass grades represented were choice and good.

A highly significant correlation was found between slaughter grade and classification score for steers (.70) and heifers (.85). Slaughter grade was significantly correlated in the steer and heifer groups respectively with trimmed round (.58) and (.57), trimmed loin (.65) and (.55), trimmed chuck (.58) and (.62), and trimmed rib (.44) and (.63).

Carcass grade was highly correlated with marbling score (.90) in the steer group and (.82) in the heifer group. This indicates the very dominant influence of marbling in determining carcass grade under the present U.S.D.A. grading standards. In the steer trial group, carcass grade was not significantly correlated with trimmed round (.12), trimmed loin (.10), trimmed chuck (.11), and trimmed rib (-.04). The heifer carcass data exhibited similar non significant correlations between carcass

grade and trimmed round (-.28), trimmed loin (.06), trimmed chuck (.02), and trimmed rib (.07).

The rib eye area was highly significantly correlated with individual wholesale cuts: trimmed loin (.51) and (.63), trimmed chuck (.41) and (.80), and trimmed rib (.74) and (.42) for steers and heifers respectively. Non significant correlations (-.12) and (.40) were obtained between rib eye area and sum per cent trimmed wholesale cuts for steers and heifers.

This study indicated that quality grade or final carcass grade is a poor indicator of yield of wholesale cuts. Thus, it becomes apparent of the faults in our present U.S.D.A. grading standards. The producer of market cattle is most interested in the production of a desirable market product. According to our present grading standards, this would constitute an animal of extremely high carcass quality. In order that a carcass possess these high quality standards, the animal must have been of the proper breeding and also fed under the proper environment. However, the chief saleable product from the carcass is red meat. Therefore, we should select cattle that characterize the meat type individual and are suitable for slaughter at approximately 1,000 pounds. Thus, we may conclude that additional studies need to be undertaken before the breeders place too much emphasis on these traits of carcass quality in their improvement program. More emphasis should be on the selection of herd sires and matrons which have the desirable muscle characteristics to pass to their offspring. One must recall that 50 per cent of the characteristics passed to the offspring is the result of the cow and 50 per cent is credited to the bull. Furthermore, it may be concluded that to identify the true merit of a carcass, one should select the weight of any wholesale cut as they are easily obtained and any one is satisfactory when predicting the total trimmed wholesale cut.