RELATIONSHIPS AMONG LIVE AND CARCASS CHARACTERISTICS OF SLAUGHTER STEERS

by

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INTRODUCTION

On today's market, the packer buyers are paying higher prices for fatter, higher grading cattle. This is a result of greater consumer demand for the higher quality beef in the meat trade. The economic law of supply and demand controls the meat industry. Consumer preference governs the kind and amount of beef that will be consumed at a certain price. The consumer will buy more beef at a higher price if the cut of beef meets consumer approval. Todays consumers of all economic levels are desiring a high quality cut of meat with a high ratio of lean meat to bone and fat.

From the packer standpoint, as well as the consumer, the desirable carcass has good conformation, sufficient outside fat cover for aging and ample, fine, high quality marbling for palatability and juiciness along with a large proportion of lean to fat and bone. While carcass grade is determined by conformation, quality, and finish, slaughter grade and dressing percent are used now by most of the buyers in the stock yards as an on the hoof evaluation. Slaughter grade is determined by the conformation and finish of the live animal. One of the major problems in the beef industry is to devise a system of live animal evaluation, that would be of practical use in determining the amount of muscle, fat cover, and quality of the meat in both slaughter and breeding cattle. The present system of slaughter grades are subject to human error and do not indicate the amount of muscling, the thickness of outside fat cover, or the proportion of edible meat in the carcass.

Studies have shown that the composition of beef carcass vary considerably in the proportion of muscle to fat and bone even though the individual animals

have similar grade, weight, age, and inheritance.

The goal of a sound, economical, beef production program should be to produce a maximum of high quality meat per animal and do it efficiently. In selecting animals for breeding and production purposes, conformation is one of the very important factors. Measurements taken on various parts of the animal furnish an objective evaluation of body conformation. If relationships exist between live animal measurements and carcass characteristics, these live animal measurements could be used as an index in selecting breeding stock.

It is of economic importance to be able to determine if an animal is heavy muscled and sufficiently finished to attain a desired grade without additional outside fat. The excess fat is undesirable to the processor and consumer and is also uneconomical from the producer's standpoint.

The thought behind this study is that some live animal measurements and characteristics might offer a guide to carcass merit which could be used in the selection of breeding stock, herd sires in particular and in the selection of superior market animals.

REVIEW OF LITERATURE

Weseli (1957) in a study of 153 steers that comprised the carcass contest at the 1956 International Livestock Exposition at Chicago, took the following live body measurements: forearm circumference, cannon circumference, and a lateral and frontal measurement of the cannon.

A visual slaughter grade and bone estimation was taken on each steer. The carcass measurements used in his work consisted of carcass cannon frontal, lateral and circumference measurements, area of loin eye, marbling scores,

fat thickness and dressing percentage. From these data analyses of variance and correlations were computed between live body measurements, between carcass characteristics, and between live and carcass characteristics.

Weseli (1957) noted positive correlations between live weight and live cannon circumference, fat cover, area of loin eye, dressing percentage, circumference of forearm and cannon bone.

Weseli (1957) found that steers scored as having large bones or having large live cannon circumferences tended to have large fore arms independent of live weight. A marked decrease in significant correlations was noted when weight was held constant as compared to the simple correlations with a wide range in live weight.

The majority of the simple correlations between live steer characteristics and carcass characteristics were significant (Weseli, 1957).

A partial correlation between live cannon circumference and carcass cannon circumference was highly significant. Weseli (1957) reported that in steers of similar weight, the correlation between live cannon circumference and area of loin eye was nonsignificant, however the partial correlation between live cannon circumference and circumference of forearm was highly significant. Those steers of similar weight that were appraised of having large bones tended to have a lower dressing percentage. Among steers of the same weight, those steers with heavier bone tended to have less fat thickness. Weseli (1957) noted in his work that partial correlations involving bone score, loin eye area, and carcass cannon lateral measurements were nonsignificant among steers of similar weights.

Simple correlations between visual slaughter grade and carcass cannon measurement and fat thickness were highly significant. Weseli (1957) noted

breed differences between live cannon circumference measurements and fat thickness and dressing percentage. Within the Shorthorn breed the live cannon circumference measurement was significantly correlated with dressing percentage and fat thickness. Within the Angus and Hereford breeds, these correlations were found to be nonsignificant. The negative partial correlations between live cannon circumference and dressing percent and fat thickness were significant within the Hereford breed.

Dressing percentage was negatively correlated with carcass cannon circumference. Weseli (1957) stated that the steers with large loin eyes tended to carry less outside fat, while large cannon circumference tended to be associated with large loin eye area. A correlation of (.44) was reported between fat thickness and dressing percentages.

A highly significant partial correlation between carcass cannon circumference and dressing percentage (-.57) was noted by Weseli (1957). Steers in this study with large loin eye tended to have less fat covering than steers with small loin eyes. Partial correlations involving loin eye area with dressing percentage, carcass cannon circumference, and marbling score were nonsignificant. The partial correlation between fat thickness and dressing percentage was significant (.31). The highly significant partial correlation between fat thickness and carcass cannon circumference (-.27) shows that among steers of similar weight, the fatter animals had a slightly smaller cannon circumference. It was also noted in Weseli's (1957) work that among steers of similar live weight, fatness and marbling score was not significantly related.

In the work of McMeekan (1950) it was stated that there is a definite positive correlation between the total weight of bone and total weight of

muscle tissue in each animal. It is impossible to get a carcass with a heavy amount of muscling without associated with that muscling a heavy weight of bone. Muscles are attached to bones which they operate; therefore, their size and shape must, for mechanical reasons, be associated with the size and shape of the bones. In most instances, fine boned animals will kill out with a smaller percentage of lean meat and a larger proportion of fat than will a heavier boned animal of the same weight.

McMeekan (1950) pointed out that the shorter and thicker the bone, the greater the depth or thickness of muscle lying over that bone. A deep cut of meat in the rear quarter is associated with a short, flat, thick bone rather than a longer, thin bone.

Boughton (1958) took measurements on 30 Hereford steers and 53 Hereford heifers. The body measurements taken were width between the eyes, width of muzzle, circumference of cannon, circumference of forearm, width of round, length of round, length from top of the tailhead to bottom of the round and circumference of round. The cattle were weighed and a visual estimation of bone size, degree of muscling, and visual grade were made by a committee of six appraisers. The carcass data collected included size of rib eye, fat cover over 12th rib, marbling score and color score. In general, correlations between live-animal measurements were lower for steers than for heifers.

The eye to eye measurement was significantly correlated with width of muzzle in steers, however, when weight was held constant the correlation only approached significance.

In the study by Boughton (1958), only the width of the round was significantly correlated with width between the eyes in steers before the effect

of weight was removed. Simple and partial correlation coefficients between width of muzzle and circumference of fore-cannon in heifers were significant.

Live grade among steers was significantly correlated with muscling appraisal which indicated that judges place considerable emphasis upon muscling when estimating live cattle grades. Live weight was generally well correlated with live measurements in both steers and heifers.

Correlations between head measurements and carcass characteristics in both steers and heifers were low and nonsignificant. Area of loin eye was significantly correlated with width of muzzle in heifers. The simple correlation for steers, between eye to eye width and area of loin eye was significant as was the eye to eye and fat cover correlation. Circumference of fore-cannon and forearm were not significantly correlated with area of the longissimus dorsi muscle in either steers or heifers (Boughton, 1958). Muscling appraisal was correlated with the area of loin eye.

In the data, Boughton (1958), the animals with large loin eye area tended to have less fat cover over the 12th rib. It was also noted that heifers possessed a larger loin eye area and thicker fat cover over the 12th rib than did steers of equal weight. Fat thickness was not significantly correlated with marbling score of either steer or heifer carcasses in this study. The carcass weight was correlated with area of longissimus dorsi and with fat at the 12th rib in steers.

Relationship between meat production characters and body measurements as well as relationship among the body measurements were studied by Yao et al. (1953). Nineteen live animal measurements and eight carcass measurements were taken on 101 beef Shorthorn steers and 62 Milking Shorthorn steers. These steers were sired by 18 and 10 sires respectively and were nursed until

they reached 500 pounds. They were fed individually to a live weight of 900 pounds after which the live animal measurements were taken and the steers slaughtered. The live animal measurements were height of withers, height of chest floor, height at flank, depth of chest, length of body, length of rump, length of coupling, length of nose, width between eyes, width of muzzles, width at shoulder, width at chest, width at last rib, width at loin, width at hips, circumference at fore flank, circumference at navel, circumference at rear flank and circumference of skin bone. Beef characters had a general trend of positive correlation with all width and circumference measurements. All height, length, and head measurements were negatively correlated with slaughter grade. All width measurements were positively correlated with all circumference measurements.

Birth weight was positively correlated with height at floor of chest, length of body and circumference at shin bone, but negatively correlated with all the width measurements. Birth weight was also negatively correlated with all the beef characters.

Yao et al. (1953) found that carcass grade was negatively correlated with most of the height measurements. Cook et al. (1951) and Knapp and Cook (1933) obtained similar results.

Yao et al. (1953) pointed out that higher the birth weight, the narrower the chest would be. He also showed that a steer with a heavier birth weight tended to have a poorer slaughter grade, carcass grade and dressing percentage than one with a lighter birth weight. A small negative correlation between growth rate characters and head measurements indicates a slight tendency for animals with smaller heads to have faster growth than those with larger heads, however, he points out that most of the correlations

were not significant. Growth rate characters had a negative correlation with circumference measurements showing that those animals with a smaller circumference would have a better growth rate than those with a larger circumference.

Efficiency was also negatively correlated with dressing percentage, thus a faster growing steer would dress out less.

Yao et al. (1953) and Knapp and Cook (1933) showed that all width measurements were positively correlated with all circumference measurements and could be regarded as another group of measurements which indicated the thickness and meatiness of the beast and thus called fleshing measurements.

Yao et al. (1953) found the three head measurements were moderately correlated to each other. He also showed the width of muzzle to be positively correlated with the depth of chest, length of body, length of rump, width between the eyes and circumference of the fore and rear flanks. The width between the eyes showed a positive correlation with the depth of chest, length of body and circumference of the fore and rear flanks.

All the height measurements with length measurements were positively correlated although not all were significant. Yao et al. (1953) suggested they could be regarded as one group of measurements which indicated the size of animal. They were also found to be negatively correlated with beef characters and could be called non-meat production measurements or skeletal measurements; this is in agreement with Cook et al. (1951) and Knapp et al. (1933). Height of flank was the only measurement significantly correlated with circumference of shin bone. Results obtained by Yao et al. (1953) showed that the length of rump was not correlated with the length of coupling but was correlated with all of the width measurements. Yao et al. (1953)

developed indexes for the evaluation of beef characters by the use of the following formulas in which the related body measurements with simple correlations to the characters were used as numerators and those with negative correlations as denominators:

Index of slaughter grade — $\frac{\text{circumference at navel}}{\text{height of floor of chest X length of rump}}$

Index of carcass grade — $\frac{\text{circumference at rear flank}}{\text{height at withers}}$

Index of dressing percentage — width at shoulders X circumference at fore flank

A general index for the relationship between beef and characters and body measurements could be expressed with the following formula:

Index for beef character — $\frac{\text{width X circumference}}{\text{height X length}}$

This formula would be an aid in the selection of animals especially in connection with a long time breeding program.

Black et al. (1938) and Lush (1928) found high correlations between body measurement ratios and slaughter grade, dressing percentage, and fatness of steers when the ratios were expressed in the same way as in the above formula, but low correlations when the ratios were expressed in other ways. Knapp and Cook (1933) suggested that the ratio of heart girth and height at withers could be regarded as an expression of the amount of meat on the animals.

Dawson et al. (1955) collected and studied data on eight beef production performance records and nineteen body measurements from 58 Milking Shorthorn steers, during a period from 1943 through 1949. The steers were offspring of nine bulls and 51 cows. The steers were slaughtered at a live weight of approximately 900 pounds, and the body measurements of each steer were always

taken by the same man just before slaughtering.

The 19 body measurements were four height measurements, three length measurements, three head measurements, five width measurements, three circumference measurements and one shin bone circumference measurement. Each measurement was taken three times and the average used.

Dawson et al. (1955) found the heritability of birth weight was 50.6 percent, very close to the revised estimate for Hereford steers obtained by Knapp and Clark (1950), however, the estimate is higher than the estimate obtained by Dawson et al. (1947) in beef Shorthorn cattle. The heritability for days to weaning at 500 pounds live weight was 45.1 percent while the heritability for days to final weight was even higher, 56.6 percent. The heritability, Dawson et al. (1955) estimates for the three beef characters were high and close to each other. They were 58.3 percent for slaughter grade, 66.7 percent for carcass grade, and 69.1 percent for dressing percentage. This differs from work reported by Knapp and Cook (1946) and Knapp and Clark (1950) on Hereford cattle. Some of this difference may be due to breed differences.

The heritability estimates for the height measurements range from 4.6 to 65.5 percent. The height at the withers was the highest and the height at flank was the lowest in heritability. All three length measurements have zero heritability. Dawson et al. (1955) noted for the head measurements, width between the eyes had a heritability of 63.1 percent and the width of muzzle 50.0 percent. Length of nose had zero heritability. All five width measurements had low heritability estimates ranging from zero to 15.1 percent. This may be an indication that these measurements were controlled chiefly by the environmental conditions.

Dawson et al. (1955) stated for the circumference measurements, only the circumference at the fore flank had a heritability of 32.3 percent. He also found the heritability of the shin bone circumference to be 33.5 percent. The heritability percentages were classified by Dawson et al. (1955) as 40 to 70 percent, high heritability; 20.0 to 40 percent medium heritability; and low heritability from 0 to 20 percent.

Kohli, et al. (1951) in a study of 157 Milking Shorthorn steers found that height of withers, which is almost entirely a skeletal measurement was significantly correlated with length of body, width of shoulders, average daily gain and final age of marketing. With width of shoulder and average daily gain, height of shoulders had a low but negative significant correlation. With length of body, birth weight, and days to weaning and final weight, height at withers had low but significant positive correlations. The results found in this study showing a negative correlation between height of withers and efficiency does not hold true for the work done by Black et al. (1938). According to Kohli et al. (1951) there is a slight indication that the shorter the legs of a steer, the greater would be his daily gain. Height of chest floor, also a skeletal measurement, had significant positive correlation with birth weight and length of body and significant negative correlations with circumference of fore flank and width of shoulder. Circumference of fore flank, which measures bone structure and condition of fleshing, had small significant positive correlations with width of shoulder, days to weaning and days to final weight, but had a small significant negative correlation with average daily gain and efficiency. Similar results were reported by Lush (1932) but differ from those found by Black et al. (1938) who did not find circumference of fore flank (heart girth) to be correlated

appreciably with rate of gain. This difference may have been due to difference in age and breeding of the steers.

Width of shoulder, which measures bone structure and condition of fleshing, had no significant associations with any of the measures of performance in the steers. These differ from those of Black et al. (1938) in so far as the relation between width of shoulder, average daily gain and efficiency are concerned. Length of body, which is largely a skeletal measure was found by Kohli et al. (1951) to have a small negative correlation with average daily gain and small positive correlations with days to weaning and days to final weight. Black et al. (1938) found efficiency of gain to be highly correlated with length of body as well as height at withers.

Average daily gain had high positive correlation with efficiency and high negative correlations with days to final weight. This is logical as the greater the daily gain of an animal the less time will be required to reach the desired weight at slaughter and a smaller amount of feed needed for maintenance and fattening. Dawson et al. (1947) found with beef Shorthorn calves that were heavier at birth tended to reach weaning weight, (500 pounds) and final weight, (900 pounds), sooner than lighter calves. Kohli et al. (1951) pointed out that the steers tended to vary independently with regard to the body dimensions measured as shown by the lack of high correlation between them except for a fairly high association between height at withers and height at floor of chest. Circumference of fore flank appears to be the best of the five measurements studied for use in the selection of breeding animals so far as relations to the measures of performance studied is concerned. Steers with a high average daily gain in general had a high feed efficiency. In this study Kohli et al. (1951) showed that the height of

withers, height at floor of chest or efficiency of gain was not significantly effected by the different rations. However, he did state that the more compact steer tended to have greater average daily gains and to be more efficient in their feed utilization.

Cook et al. (1951) studied body measurements and carcass characteristics in Milking Shorthorn steers. Most correlations between the five body measurements and slaughter grade, carcass grade and dressing percentage were not high enough to be of much predictive value. However a considerable number were high enough to be of some selective value in a long-time breeding program. Height at withers had significant negative correlations with slaughter grade, carcass grade and dressing percentage for the 157 steers. The negative relationships indicate that the slaughter grade as well as the carcass grades tends to be better in shorter than taller steers. Height at floor of chest had similar correlations to those for height at withers.

Cook et al. (1951) stated that circumference of fore flank had a significant positive correlation with only slaughter grade which was a slight indication that a steer with a larger heart girth graded higher at the time of slaughter. Width of shoulder was significantly and positively correlated with slaughter grade and carcass grade. Width of shoulder was not significantly correlated with dressing percent as Black et al. (1938) also found.

Length of body, Cook et al. (1951) had a low significant negative correlation with carcass grade, slaughter grade and dressing percent. Average daily gain had a low significant positive correlation with carcass grade and dressing percentage.

Correlations between slaughter grade and carcass grade were the highest found--0.69 for the 157 steers. This finding is in agreement with the work

of Black et al. (1938). Significant positive correlations were also obtained with dressing percent. Thus Cook et al. (1951) concluded that this visual observation for slaughter grade is a fairly good indication of the animals carcass qualities. Carcass grade and dressing percentage had a correlation of 0.45. Therefore it can be concluded that a carcass with a high dressing percentage tends to be superior in carcass grade.

Green (1954) gathered data on 50 steers studying the relationship between live animal measurements and wholesale cuts. According to judging standards, width of body in the dorsal area is desired and wide bodies are secured in the animals of excellence. Uniformity of width is also desired but at times uniformity seems to be secured at the sacrifice of width. Sometimes, especially in show animals, uniformity is secured less by basic structural uniformity than by a covering of fat applied under the skin which helps to fill various depressions. If type for production might be divorced from type for show purposes, perhaps then more emphasis could be placed on having animals large where it is important as far as furnishing meat is concerned and less attention be paid to uniformity of lines and other probably esthetic values. However, for maximum efficiency, type and production must go hand in hand.

Green et al. (1955) found that such measurements as pin to poll and shoulders points to hooks was of little value in predicting the value of preferred cuts. Green et al. (1955) suggested that there was a need for study of body measurements that may lead to newer views in show ring standards.

Average daily gain and economy of gain were positively correlated with time from weaning to slaughter and from birth to slaughter in work done by

Black and Knapp (1932b). Grade of animal shows a higher correlation with economy of gain than with average daily gain. However, both are significant. Grade of animal, whether feeder, slaughter, or carcass was correlated with percent of edible portion in carcass. In fact, percent of edible portion seems to be a good measure of beefiness. Tenderness was found to be correlated with percent fat.

Lush (1932) in a study of 241 steers stated that pelvis width, pelvis length, hook width, and cannon circumference are not good measurements for dressing percent. As in the case of gain, cannon circumference is more important than the other three. It should be small. A steer ideal for large gains need not necessarily be ideal for a high dressing percent. Thus, a large paunch girth indicates a steer which will gain rapidly and a small paunch girth indicates a steer which will have a high dressing percent. A large heart girth is desirable from both standpoints, but is not important so far as gain is concerned. The loin according to Lush (1932) should be narrow for high gain, but wide for high dressing percent. The body should be long for gain, but short for high dressing percent.

These data by Lush (1932) shows a tendency for large initial weight to be associated with large gains, high dressing percentages and high final values of the steers. However, when the measurements are also taken into consideration, initial weight itself becomes less important. On the whole, the regression coefficients indicate that steers with large fleshy measurements but small bony measurements will have the highest dressing percentages and the most valuable meat at the end of the feeding period. Large fleshy measurements but small bony measurements indicate a steer which is fatter and more heavily muscled than other steers of the same skeletal dimensions.

Lush (1932) stated that one of the most important measurements for high dressing percent and meat value was a head narrow at the eyes.

Stonaker et al. (1950) studied type and performance records on small type and conventional type Hereford steers. The small type steers have significantly smaller rates of gains, slaughter weights, carcass weights, and weights of carcass cuts. For most of these characteristics the weights have been approximately 20 percent less than those of conventional types. Significant differences have not been found in days on feed, digestible nutrients per pound of gain, percent of carcass in the different wholesale cuts, or percent of separable fat, lean, and bone in the 9-10-11 rib cut.

Green (1954) reported that the correlation between live weight and dressing percentage was quite low. He also noted that width of shoulders is quite reliable in predicting dressing percentage. Shoulder width correlated reasonably well with depth of twist, live weight, heart girth, width of crops, width of thighs and width of hooks. From this work Green suggested that width of shoulders is a good estimation of the amount of muscle tissue to be expected in a carcass. There are reasons to believe that width of shoulder is determined quite largely by the amount of muscle. Hammond (1955), as a cross section through the shoulder area included relatively few other parts that would probably contribute much variation in width of shoulder. Variation in thickness of hide, weight of long bones and ribs could contribute some, but most likely little, to the differences in the width of shoulder.

Depth of twist on cattle that are not excessively finished could also be used as a determination of muscling since this area is composed primarily of muscle tissue.

According to Green (1954) width of crops is difficult to measure with a

high degree of accuracy. The main structural parts in common between the width of shoulders and crops were the vertebrae which could have a direct effect on the width of crops and some effect upon the width of shoulders by determining the distance between ribs in the dorsal area. The muscles of the two structures differ, but some of the differences in the correlation of the two width measurements may be due to general quantitative muscling. Width through the thighs is also an indicator of muscling.

Stanley and McCall (1945) stated that when corrected for height at the withers, correlations of length of body and cannon circumference with daily gain were significant. A significant negative correlation was observed between height at withers, corrected for weaning weight and daily gain, indicating greater gain from steers weighing heavy in relation to height. Significant positive correlations with carcass grade are: corrected cannon circumference, corrected fullness at stifle and corrected height at withers. Stanley and McCall (1945) said that in view of the fact that the appearance of a steer is not a dependable criterion of its growth rate and gain efficiency, an effort should be made to acquire a maximum of those feeder qualities associated with carcass quality, such as thickness of body, weight for height, quality, size of bone, and quiet disposition. Light colored hair and weight for age may also be associated with rapid growth in feeder cattle.

Smith et al. (1950) studied the relative accuracy and repeatability of live animal and photographic measurements of beef cattle using data from 10 cows, 23 yearlings, and 10 calves. He found high estimates of repeatability for the body measurements studies; namely (1) length of body, (2) height of withers, (3) depth of chest, and (4) patella to patella. Estimates of the repeatability for body length varied from .546 to .898 for live animal

measurements and .726 to .844 for photographic measurements. Height of withers ranged from .888 to .906 from the live animal measurements and .908 to .927 for the photographic measurements. For depth of chest, estimates of repeatability varied from .784 to .914 for live animal and .807 to .908 for photographic measurements. Repeatability for the round measurement (patella to patella) was lower with a range of .463 for the cows to .769 for the yearlings.

Knapp et al. (1939) studied the difference of scoring of cattle by different judges on various days. The judges were best able to recognize differences in width of body, with conformation of rump and straightness of back next in order. Differences between animals accounted for the smallest percentages of variance in scale, bone and symmetry. Variations between judges were largest in depth of rear flank, smallest in rump and these differences were all significant except in the latter case. On the basis of this study, the general conclusion was that scoring as a technique or evaluation of differences of animals was subject to considerable error and therefore was probably of very doubtful value when differences between animals were small. When the population to be studied shows large differences, the scoring technique was undoubtedly the simpliest way to evaluate differences in conformation.

In a study of 123 steers, conducted by Tallis et al. (1959), ten linear body measurements were taken in duplicate on eight Hereford steers by two investigators. The components of variance due to steers, investigators, steer and investigator interaction and measurement error were estimated and compared. Results from this study indicated that heart girth, circumference at navel, length of body, width of chest, depth of chest and height at hooks

and withers had the highest steer components and lowest investigator, interaction and error components. After this first study, additional cattle were measured.

Significant differences in circumference at navel, height at hooks, height at withers and body length were found between calves sired by bulls, from different lines of breeding when compared on a constant weight basis. Ratios of weight to height and weight to length were calculated and correlated with dressing percentage, area of rib eye and edible portion. In both steer and heifer data, the two ratios were positively correlated with area of rib eye and negatively correlated with edible portion, (Tallis et al., 1959). These ratios were positively correlated with dressing percentage in steers but not in heifers.

Percent edible portion is highly influenced by the amount of fat trim in the carcass. Therefore, a ratio of edible portion to bone was calculated and correlated with the weight to height and weight to length ratios. The edible portion to bone ratio was also influenced by the degree of fatness of the carcass (Tallis et al., 1959).

Hankins et al. (1943) showed indications that muscle-bone ratio was a rather definitely inherited character. If these traits were present in bulls selected for breeding, one would expect a high transmitting ability of these characteristics to the progeny. Thus, increasing the muscle-bone ratio, the circumference at shin bone, fore flank circumference and width measurements of the body should increase in the progeny of the bulls selected for these traits.

Hankins et al. (1943) made a study of the relationships between muscle bone ratio, various live body measurements, various carcass characteristics,

and various production factors within the beef Shorthorn type and Milking Shorthorn type cattle.

For the two types of cattle the correlations were determined between muscle-bone ratio and percentage of separable fat, but in neither case was the value significant. This would indicate that muscle-bone ratio can be increased without materially affecting the ability of an animal to fatten. Therefore, feeding of steers over a longer or shorter period of time would be the controlling factor in determining the degree of fatness. It should be expected that the smaller the bone, the higher the muscle-bone ratio. However, Hankins, et al. (1943) found none of their correlations to be high enough to be of any value. Results from this study show that little can be gained in muscle-bone ratio by the selection for type and quality as they are usually evaluated. Some studies have shown that certain body measurements were associated with slaughter and carcass grades. For example, such measures as height at the withers, heart girth and width of body have been shown to be correlated with grade (Black et al., 1938). The correlation between height at withers and grade was negative and the others positive.

Correlations for carcass measurements were in most instances, higher than those for the live animal measurements. The only significant correlation observed by Hankins and Burk (1938) was the muscle-bone ratio and the thickness of muscling and fat over the 12th rib. No correlation was found between muscle-bone ratio and efficiency of gain. This would indicate that in selecting for efficiency of gain there would not be a tendency to select against a high muscle-bone ratio.

Knapp and Nordskob (1946) studied the heritability estimates of scores at weaning, slaughter steer grades, dressing percentage and area of eye muscle

on 177 steers sired by 23 bulls. Within sire groups, score at weaning and weaning weight correlation was 0.68 while the slaughter steer grade and final feed lot weight was correlated 0.64. Carcass grade had a correlation with final feed lot weight of 0.54. Area of eye muscle and final feed lot weight had a correlation of 0.14 which was not highly significant. Knapp and Nordskob (1946) observed significant differences between sire groups in weaning score, slaughter steer grade, carcass grade and area of eye muscle. Differences between sire groups in carcass yield were not significant and indicate that this factor was largely of environmental control. Knapp and Nordskob (1946) indicated according to their work the variations in area of eye muscle were apporximately 69 percent heritable.

Knapp and Nordskob (1946) concluded that there seems to be less heritability in the measures of quality of product than in measures of growth, there is ample opportunity for selection for these characteristics.

Knox and Koger (1946) made observations on 350 grade Hereford steers from 1937 to 1945, studying gains, finished grade, carcass grade, dressing percentage and their relationship to compact, medium and rangy type steers. The rangy steers had a significantly greater initial weight, gain, and dressing percentage. The compact type had a slight nonsignificant advantage in grade when finished and in gain expressed as percent of initial weight. The medium type was intermediate in each case. There was no difference between the three types in average carcass grades. There was a slight but not significant tendency for the compact cattle to rank high on percent gain and fat grade. The fact that the average weight of the rangy steers in this trial was greater than that of the compact steers is noteworthy, but not surprising as height and length contribute to size. When these dimensions are reduced,

weight will decrease if other factors remain unchanged.

The consistency with which the rangy steers outweighed and gained more than the steers of the other types suggested that gain made in the feed lot may be correlated with the weight of the feeders steers. For each pound of increase in initial weight there was a corresponding increase in feed lot gain of .184 pound irrespective of type. Thus Knox and Koger (1946) say that greater gains of the rangy cattle were due to size and associated feeding capacity and growth rate rather than to body form. Dressing percentage also showed a consistent and significant difference, with the rangy type ranking first and the compact type last, however, the difference between compact and medium were small. The difference observed here is surprising, but was probably due to higher condition or to less paunchiness of the rangy steers. In this study, the rangy steers were as thick as the compact steers, but differed from them in the proportion of height and length to depth and in size due to greater height and length. Some compact steers make very rapid gains; therefore, it is obvious that some strains of compact cattle may be superior in this respect. From the results of this work, however, it appears that the development of rapidly gaining strains will be more difficult if size is reduced by too greatly restricting height and length to secure compactness. A compact animal has been described as one in which height and length are small in comparisons to depth and width. In this study by Knox and Koger (1946), the cattle were fed the same rations and managed under similar conditions.

The variation in market price of steers is associated with the market value of the carcass which in turn is valued according to their presumed eating qualities. Cartwright et al. (1958) studied the relationship of ration and

inheritance to certain production and carcass characteristics of 18 Hereford and 20 Brahman and Hereford crossbred yearling steers. The crossbred steers gained more weight per day of age at slaughter and had significantly higher dressing percent and chilled carcass weight per day of age, but sire differences were not significant. Chilled carcass weight per day of age probably more nearly measures true rate of beef production than any other criterion studied. The crossbreds, in work done by Cartwright et al. (1958), were scored lower as feeders and higher as slaughter cattle. The two scores were not entirely measures of the same characteristics but was an indicator of degree of change. It appears that the crossbreds, as indicated by a statistically significant larger difference in scores, either responded to the feed lot regime to a greater extent than Herefords or that their longer legs, somewhat drooping rump and greater general ranginess were more acceptable to the judges as more flesh was added although they did not gain as much weight on test and did not add as much finish. The Herefords carried more finish than the crossbreds except for the measure of the thickness of fat over 9-10-11 ribs and kidney fat, but ether extract was the only measure of fat for which the Herefords were significantly higher. There was a breed difference in the amount of fat deposited at different locations. Actual area of eye muscle was higher for the crossbreds because they were heavier, but smaller per 100 pound carcass weight because eye muscle development is not directly proportional to weight increase.

Weight of eye muscle was similar to area except for per day of age, the crossbreds producing significantly heavier rib eyes. There were no significant sire differences for rib eye measurements but this differs from studies by Knapp and Nordskob (1946), Knapp and Clark (1950) and Shelby et al.

(1955) which have reported heritability estimates of rib eye area of 69, 68, and 72 percent respectively after adjustment for weight of animal. Measurements of separable lean in the 9-10-11 ribs and estimated lean in the carcass were closely parallel. Differences between sires are statistically significant for separable lean per day of age and an estimate of heritability of five percent was obtained. Cushion round, being a relatively lean cut, follows a pattern similar to those of the more direct measures of lean. Cartwright et al. (1958) stated that calves which were larger at birth tended to develop more lean meat. This is in agreement with Woodward et al. (1954). The generally less acceptable appearance of the crossbreds as slaughter animals tends to diminish after the animals are slaughtered and on the hoof. The eye muscle measurements were not significantly correlated with gain to 180 days except on a 150 pound carcass weight basis.

MATERIALS AND METHODS

The animals used in this study consisted of 152 Angus steers, 64 Hereford steers and 37 Shorthorn steers that were exhibited in the carcass steer show at the 1957 International Livestock Exposition held in Chicago. The steers were bred and fed by individuals from various localities and were exhibited by their owners in the carcass show. The live weight of the steers ranged from 800 pounds to 1300 pounds and the age varied from 12 to 18 months.

On November 28, two head measurements were taken while the steers were in the squeeze chute to be mouthed for proper age classification. The two measurements were width between the eyes and width of muzzle. The eye to eye measurements were taken by placing a sliding vernier claipers over the anterior dorsal portion of the eye. The width of muzzle was taken by placing the

sliding vernier calipers over the muzzle just posterior to the nostrils at the widest part of the muzzle.

Immediately after weighing, for show classification, two body measurements were taken, circumference of cannon and circumference of round. A flexible steel tape was used to measure the circumference of cannon bone in centimeters. This measurement was taken midway between the knee and pastern joint of the left metacarpus. An unstretchable cord was used to measure the circumference of round. The end of the cord was placed at the point of the left pin bone (tuber ischii) and the cord was run under the rear flank, between the hind legs, and up over the twist and rear portion of the round to the point of origin (the left pin bone). The cord was then measured with a steel tape to determine the circumference measurement in centimeters.

On November 29, the group of steers were shown and placed numerically according to type, finish, quality, and conformation by a committee of three judges. The steers were shown according to age and breed making a total of twelve classes. While the steers were being shown, a committee of two visually scored their muscling. The breakdown on muscling score was very heavy muscled, 6; heavy muscled, 5; moderately heavy muscled, 4; medium muscled, 3; slightly light muscled, 2; and light muscled, 1. The steers were not handled during the muscle scoring.

Immediately after the steers had been placed on foot, they were weighed and moved directly to Swift and Company for slaughter. This weight was used for determining dressing percentage.

The steers were slaughtered on Saturday, November 30 and the carcasses were allowed to hang in the cooler for 48 hours before ribbing. On Monday, December 2, the left side of each carcass was ribbed between the 12th and

13th rib. At this time a tracing of the longissimus dorsi muscle was made using 9x12 aquebee acetate sheeting. An outline of the fat cover over the 12th rib was also made on the tracing from which the thickness of fat cover at the 12th rib was determined. From this tracing, the area of eye muscle was determined with the aid of a planimeter which gives the area of the tracing in square inches.

A marbling score was made on each carcass according to the standards set by the United States Department of Agriculture. The marbling score being the highest for the rib eye with the most marbling and lowest for the rib eye with the least marbling. The USDA marbling scores range from one to ten. The data were statistically analyzed in accordance with the procedures for simple and partial correlations coefficients as outlined by Snedecor (1956).

The complete data on the carcass steers from the 1957 contest are presented in Table 8 of the Appendix. The following information for each steer is recorded; loin eye area, fat cover over the 12th rib, marbling score, visual muscling appraisal, cannon bone circumference, round circumference, width between the eyes, and width of muzzle. Breed, live weight and dressing percentage are also included in the data.

Data collected from 23 steers of other breeds are included in Table 8 of the Appendix. The other breeds consisted of 4 Galloway, 16 Red Poll, 1 Santa Gertrudis, and 2 Charolis.

CORRELATION ANALYSES

The purpose of this study is to study live animal measurements and their relationship to carcass characteristics. The correlations between the various live animal measurements are also studied as well as the carcass characteristics.

Differences in characteristics due to breed are not considered in this study. Therefore, correlations involving characteristics were computed without regard to breed of animal.

All live animal characteristics and carcass measurements are correlated without the removal of the effect of weight. Most of these simple correlations between live weight and other characteristics, listed in Table 1, are highly significant. In addition to simple correlations between characteristics, partial correlations between characteristics with the effect of weight removed are computed.

A simple correlation is the relationship between two characteristics when the range in weight (800 pounds-1300 pounds) encountered in this study is not considered. A partial correlation is the relationship between two characteristics independent of live weight or when the effect of weight is removed so the relationships are among steers of similar weight.

Table 1. Simple correlations between live weight and other characteristics.

Measurement	Correlation
Muscle score	.131*
Eye to eye	.546**
Width of muzzle	.367**
Circumference of cannon	.547**
Circumference of round	.724**
Dressing percent	.260**
Marbling score	.110
Area of loin	.360**
Fat cover	.289**

*Significant at .05 level
**Significant at .01 level

Correlations between live steer characteristics. Simple correlations between live steer characteristics are given in Table 2. With the exception of the correlations between muscling scores and width of muzzle and circumference of cannon, all the correlations are of an absolute magnitude ranging from .022 to .624 and are all highly significant except the correlation between muscle score and width of eyes. Steers scored with a higher muscling score tended to have narrower muzzles. Circumference of round is positively correlated with muscling score indicating steers that have a higher muscling score also have a larger circumference of round. Steers that are wider between the eyes, also, are wider through the muzzle and a larger width between the eyes is associated with a larger cannon circumference. Width between eyes is positively correlated with the circumference of round as is the width of muzzle.

Table 2. Simple correlation between live steer characteristics.

	Eye to eye	Width of muzzle	Cir. of cannon	Cir. of round
Muscle score	.022	-.126*	-.007	.184**
Eye to eye		.456**	.511**	.473**
Width of muzzle			.484**	.387**
Circumference of cannon				.624**

*Significant at .05 level
**Significant at .01 level

A positive correlation between width of muzzle and circumference of cannon indicates a wide muzzle is associated with a large cannon bone. Circumference of cannon is positively correlated with circumference of round indicating a larger cannon is associated with a larger round measurement.

The muscle score is not significantly correlated with eye to eye measurement.

Partial correlations between live steer measurements independent of live weight are presented in Table 3. Muscle score is negatively correlated with the width of muzzle indicating steers with a greater width of muzzle are given lower muscling scores. The eye to eye correlation is highly significant (.328) with width of muzzle indicating steers that were wide between the eyes were also wide through the muzzle. Width of eyes and muzzle are positively correlated with circumference of cannon (.302) and (.363) respectively. A highly significant positive correlation (.395) is noted between circumference of cannon and circumference of round revealing that steers with larger cannon bone measurement also had a larger round circumference measurement. Correlations between circumference of round and eye to eye measurement and muscle score are nonsignificant. In comparing Tables 2 and 3 a decrease is noted in the correlations when the effect of weight is removed, however, the majority of the simple correlations that are significant are also significant when the influence of weight is removed.

Table 3. Partial correlations between live animal characteristics independent of live weight.

	Eye to eye	Width of muzzle	Cir. of cannon	Cir. of round
Muscle score	-.060	-.189*	-.009	.130
Eye to eye		.328**	.302**	.134
Width of muzzle			.363**	.189*
Circumference of cannon				.395**

*Significant at .05 level
**Significant at .01 level

Correlations between live steer and carcass characteristics. Simple correlations between live steer characteristics and carcass characteristics are presented in Table 4. While a part of the simple correlations are significant others are nonsignificant. Muscling score is highly significantly correlated (.325) with dressing percentage showing that the higher dressing steers are scored as being heavier muscled. Muscling socre is correlated (.138) with area of loin, although the correlation is not high, it does indicate higher muscle score tended to have larger loin area. Width between the eyes is positively correlated (.230) with area of loin. Width of muzzle is negatively correlated (-.138) with dressing percentage. Muzzle width is also negatively correlated with marbling score, however, this correlation is not significant. The correlation (.177) between area of loin and muzzle width is positive and is highly significant. Circumference of cannon, though not significant is negatively correlated with dressing percentage and fat cover. Circumference of cannon is negatively correlated (-.223) with marbling score. Area of loin is positively correlated (.214) with circumference of cannon indicating the steer with larger cannon bones tended to have a larger loin eye. Circumference of round is positively correlated (.175) with dressing percent. Area of loin is highly significantly correlated (.375) with round circumference, revealing animals with a larger round circumference tended to have more loin eye area. Fat cover is not significantly correlated with any of the live animal measurements. Marbling score is not significantly correlated with any of the live animal characteristics except circumference of cannon.

The partial correlations between live animal characteristics and carcass characteristics with the effect of weight removed are presented in Table 5.

Table 4. Simple correlations between live steer and carcass characteristics.

	Dressing percent	Marbling score	Area of loin	Fat cover
Muscle score	.325**	.101	.138*	.050
Eye to eye	-.054	.021	.230**	.032
Muzzle width	-.138*	-.116	.177**	-.051
Circunference of cannon	-.108	-.223**	.214**	-.105
Circumference of round	.175**	-.075	.375**	.058

*Significant at .05 level
**Significant at .01 level

Muscling score is significantly correlated (.304) with dressing percent indicating the steers that appeared to be dressier are scored higher in muscling score. Muscling score is not significantly correlated with marbling score, area of loin or fat cover when the effect of weight is removed. In the simple correlations, muscle score and area of loin eye are significant but are nonsignificant in the partial correlations. Eye to eye measurement is negatively correlated with dressing percent. This partial correlation is highly significant (-.241) and the simple correlation is nonsignificant. A negative correlation (-.157) is noted between fat cover and eye to eye measurement. The correlation between muzzle width and dressing percent is negative and highly significant (-.260) indicating steers with wider muzzles have lower dressing percentage.

Muzzle width is negatively correlated with marbling score, (-.170) and also negatively correlated with fat cover (-.176) after the effect of weight has been removed. Muzzle width is not significantly correlated with area of loin in steers of the same weight. A highly significant negative (-.310)

Table 5. Partial correlations between live steer and carcass characteristics independent of live weight.

	Dressing percent	Marbling score	Area of loin	Fat cover
Muscle score	.304**	-.043	.098	.013
Eye to eye	-.241**	-.005	.043	-.157*
Muzzle width	-.260**	-.170*	.052	-.176*
Circumference of cannon	-.310**	-.340**	.021	-.328**
Circumference of round	-.020	-.200**	.177*	-.229**

*Significant at .05 level
**Significant at .01 level

correlation is noted between circumference of cannon and dressing percent indicating those steers with large cannon bone measurement tended to have a lower dressing percentage. Negative correlations of (-.340) and (-.328) were found between cannon circumference and marbling score and fat cover respectively. These partial correlations indicated that steers with larger cannon circumference tended to have lower marbling scores and less fat cover over the 12th rib. Circumference of cannon is not significantly correlated with area of loin when the effect of weight is removed.

Circumference of round is nonsignificantly correlated with dressing percent but a significant negative correlation is noted between circumference of round and marbling score (-.200). A positive correlation (.177) is obtained between circumference of round and area of loin, indicating a slight tendency for the steers that have a large loin eye area to have a large round circumference measurement when the effect of weight is removed. Circumference of round in animals of the same weight is found to be negatively correlated with fat cover. This would indicate that steers in this study with more fat cover

tended to have a smaller round circumference measurement. In the partial correlations, area of loin is significantly correlated with only one of the live animal characteristics. Except for the positive correlation between muscling score and dressing percent, and the loin eye correlations, all of remaining correlations between live steer and carcass characteristics were negative correlations.

Correlations between carcass characteristics. Simple correlations between carcass characteristics are presented in Table 6. Dressing percent is significantly correlated with marbling score (.227) which indicates the higher dressing steers tended to have a higher marbling score when the effect of weight is not considered. Area of loin is correlated with dressing percent (.298). A highly significant correlation (.352) was noted between dressing percent and fat cover indicating the fatter steers have a higher dressing percent. Marbling score is also highly significantly correlated (.254) with fat cover indicating the fatter steers, without the difference in range of weight taken into account, tended to have higher marbling scores. The simple correlation between area of loin and fat cover is nonsignificant.

Table 6. Simple correlations between carcass characteristics.

	Marbling score	Area of loin	Fat cover
Dressing percent	.227**	.298**	.352**
Marbling score		.007	.254**
Area of loin			-.065

*Significant at .05 level
**Significant at .01 level

Partial correlations between carcass characteristics independent of live weight are presented in Table 7. Holding live weight constant decreases the correlation between dressing percent and marbling score, the partial correlation being (.206) and the simple correlation (.227). Dressing percent and area of loin are significantly correlated (.227) when the effect of weight differences is removed, compared to a simple correlation of (.298). A highly significant correlation (.300) for steers of a similar weight between dressing percent and fat cover indicates the fatter steers have higher dressing percentages. Marbling score and area of loin are not significantly correlated when live weight is held constant. Fat cover is significantly correlated (.234), when live weight is held constant, with marbling score indicating that the fatter steers tended to have higher marbling scores. Area of loin is negatively correlated (-.190) with fat cover when the effect of weight is removed. This indicates steers with larger loin eye area tended to have less fat cover. The simple correlation between area of loin and fat cover where a wide range in live weight existed is nonsignificant.

Table 7. Partial correlations between carcass characteristics independent of live weight.

	Marbling score	Area of loin	Fat cover
Dressing percent	.206**	.227**	.300**
Marbling score		-.035	.234**
Area of loin			-.190*

*Significant at .05 level
**Significant at .01 level

DISCUSSION

In interpreting and discussing the results in this study, the fact that the steers are a very select group must be taken into consideration when arriving at conclusions. The group of steers are more similar in type and degree of finish than an unselected group would be because of their selection for entry in the carcass show. The steers were fed in various localities under varied feeding systems and programs and are from highly different breeding programs. Most of the steers would fall into the choice and prime grades both on foot and in the carcass.

Even though some correlations may be statistically significant, they may be of little use or value in selection in a practical livestock program. It should also be pointed out that the relationships between the various characteristics used in this study might be quite different in an unselected group of steers. The steers in this study were selected and fed for the carcass show because of their excellent beef type. It would be reasonable to expect higher correlations between live animal measurements and carcass muscling in an unselected group of steers. The relationship between fat cover and dressing percent would also be greater.

The simple correlation between width of eyes and live weight (.546) indicates that a large part of the differences in the width between the eyes is due to differences in the live weight of the steers. The heavier older steers tended to be wider between the eyes than the lighter steers.

Live weight and circumference of cannon bone are significantly correlated (.547). One would expect the heavier steers to have heavier bone primarily because of their larger frames and partly because of the differences of age in this set of steers. Weseli (1957) found a correlation of (.47) between

live weight and circumference of cannon bone. The correlation between circumference of round and live weight, (.724) indicates that the round circumference increases in size as the steer becomes heavier. Dressing percentage and fat cover are significantly correlated with live weight, (.260 and .289) indicating a tendency that the heavier steers carry more fat cover over the 12th rib. One would expect the heavier steers to have a higher dressing percentage because much of the increased weight is due to fat in older, more mature individuals. However, the dressing percentage of the cattle would vary considerably because of the various distances the steers were transported and various conditions under which they were handled prior to weighing. This agrees with findings of Weseli (1957), however, his correlations were higher being (.39 and .49).

Area of loin and live weight is positively correlated (.360). As expected, the heavier steers possess a larger loin eye area. Weseli (1957) found a similar correlation (.32) between live weight and area of loin eye in his study. Marbling score is not correlated with live weight. This follows the common belief that marbling is independent of age in yearling or older cattle. This is in agreement with Weseli (1957) and Boughton (1958).

Muscle score is not significantly correlated with the width between the eyes but is significantly correlated (-.126) with muzzle width before the effect of weight is removed, and (-.189) after the effect of weight is removed. The visual muscle score is highly significantly correlated (.184) with round circumference before the differences in weight are corrected. The partial correlation is nonsignificant. This correlation shows that steers given higher muscling scores tended to have larger round circumference measurements. This is an interesting observation as the muscle score was placed on each steer

without handling the animal. Most of the cattle were very highly groomed and were carrying long winter hair coats.

Muscle score is found to be highly correlated, both simple (.325) and partial (.304), with dressing percent. This correlation indicates the higher dressing, trimer steers are given a higher muscling score. Muscling score is not correlated with marbling score. This is what would be expected as marbling is commonly thought to be independent of other live animal characteristics.

Area of loin eye is significantly correlated (.138) with muscling score in steers of different weights, however, the correlation is positive but nonsignificant in steers of similar weight. This would indicate that the heavier steers in this study were scored higher for muscling. Both correlations are positive and indicate that the differences of muscling and area of loin eye can be detected without handling the animal. A higher correlation might be expected if the animals were handled to give an estimation of the amount of finish the animal is carrying and to determine any false impressions due to grooming of hair coat. Muscling score and fat cover over the 12th rib have a correlation of near zero indicating that difference in width and thickness of the animal due to finish could be detected as fat without physically handling the animals. Width between the eyes is highly significantly correlated with muzzle width, both simple and partial correlations being (.456) and .328) respectively. This is in accordance with the findings of Boughton (1958). However, in his study, when the live weight was held constant, the correlation only approached significance.

The eye to eye measurement is highly significantly correlated (.511) with circumference of cannon bone when the effect of weight is not removed. In

steers of a constant weight the correlation is (.302) which is also highly significant. This would indicate that the width between the eyes is a good indication of the amount of bone in an animal with the wider faced steers possessing heavier bone. Width between the eyes is highly significantly correlated (.473) with round circumference when live weight is not held constant. This would be expected as the larger steers would possess wider head measurements along with greater round circumference measurement. However, the partial correlation in steers of a constant weight only approached significance. Thus, eye to eye width is not a good indication of round circumference in steers of similar weight. Dressing percent is not significantly correlated with width of eyes in steers of different weights, however, when the live weight is held constant the correlation is highly significant, (-.241). This correlation indicates that steers with large width between the eyes tended to have lower dressing percentages. This is in agreement with Lush (1932).

Eye to eye correlations with marbling score are very near zero.

Area of loin is highly significantly correlated with width between the eyes in steers of various live weights. However, in steers of constant live weights the correlation is nonsignificant. These correlations indicate that rib eye area is not related to width of eyes in steers of the same weight. Thus, width of eyes would not be a criteria for estimating rib eye area in steers of a highly select group. Width of eyes and fat cover have a simple correlation near zero, however, the partial correlation is significantly negatively correlated. Thus, the steers with larger width of eyes tend to have a smaller amount of fat cover over the 12th rib.

Width of muzzle is highly significantly correlated, both simple (.484) and partial (.363), with cannon circumference. This indicates that the

heavier boned steers tend to be wider through their muzzles. Width of muzzle is highly significantly correlated (.387) with circumference of round in steers of various weights. The partial correlation, although not as high as the simple correlation is significant (.189), indicating wide muzzles are related with large round circumferences. Width of muzzle has a negative significant correlation (-.138) with dressing percentage before the differences in live weight are corrected. The correlation (-.260) is even higher in steers of the same weight meaning that steers with wide muzzle measurements had a lower dressing percentage.

A simple correlation (-.116) between marbling score and muzzle width is nonsignificant, but the partial correlation (-.170) is significant. It is difficult to draw any conclusions from this correlation as marbling is commonly regarded as being independent of live animal characteristics.

Area of loin and width of muzzle are highly significantly correlated (.177) in the simple correlation, however, this correlation approaches zero when differences in live weight are corrected. This correlation would indicate that area of loin eye is independent of muzzle width in steers of similar weight.

Fat cover and muzzle width are significantly correlated (-.176) in steers of similar weight. Thicker fat cover over the 12th rib is associated with narrower muzzles in this set of steers. The simple correlation does not approach significance.

Cannon circumference and round circumference are highly correlated, (.624) for the simple correlation and (.395) for steers of a constant live weight. As the size of the cannon increases there is an increase in the round circumference, possibly due to larger frame or due to a heavier muscled

round in the heavier boned steers.

Cannon circumference is nonsignificantly correlated with dressing percentage in steers of various weights, however, the partial correlation is highly significant (-.310) indicating heavier boned steers dressed lower. This is in agreement with the work of Weseli (1957), Boughton (1958) and Lush (1932).

In this study cannon circumference has a highly significant negative correlation (-.223) with marbling score in steers of different weights. The partial correlation, also highly significant, is (-.340). According to these correlations, the heavier boned steers possessed less intra-muscular fat. Cannon circumference is highly significantly correlated (.214) with area of loin in the simple correlation, but in steers of similar weight the correlation is near zero (.021). This is in agreement with Weseli (1957) and Boughton (1958) but disagrees with Lush (1932) who stated light boned steers possess heavier muscling.

Cannon circumference and fat cover are not significantly correlated (-.105) in steers before the effect of live weight is corrected. The partial correlation is highly significant (-.328) indicating the heavier boned steers carry less thickness of fat over their 12th rib. Weseli, (1957) and Boughton (1958) obtained similar results in their work.

Round circumference is highly significantly correlated (.175) with dressing percentage in the simple correlation, however, the partial correlation is very near zero. This correlation indicates that steers of higher dressing percentages tend to have larger round measurements when the differences in weight are not corrected. Round circumference and area of loin correlations are highly significant (.375), before the effect of weight is removed. The

partial correlation, although not as high, is significant (.177). Steers with larger round measurements have larger area of loin eyes. Boughton (1958) noted a highly significant correlation (.37) in heifers, however, the correlation in steers was not significant. The simple correlation between round circumference and fat cover is nonsignificant while the partial correlation is highly significant (-.229). This correlation indicates that the steers with larger round measurements tend to have less fat cover.

Dressing percentage is highly correlated with marbling score for both the simple and partial correlations (.227 and .206). Marbling is intramuscular fat, and finish increases dressing percentage. One would expect the steers with more marbling to have a higher dressing percentage. Dressing percent is highly significantly correlated with area of loin eye both before and after the difference in live weight is corrected.

The heavier muscled steers possess a higher dressing percentage. Weseli (1957) found this correlation nonsignificant. Dressing percentage is found to be related to fat cover as the fatter steers have a higher yield. The simple correlation is (.352) and the partial correlation is (.300). This is similar to the findings of Weseli (1957) and Boughton (1958).

The simple and partial correlations between area of loin eye and marbling score are very near zero. Marbling score and fat cover are highly significantly correlated, the simple correlation being (.254) while the partial correlation is (.234). This indicates that the fatter steers possess more marbling in both steers of various weights and steers of similar weight. In the work of Weseli (1957), the partial correlation between fat cover show a simple correlation of near zero. However, holding the live weight constant increases the correlation (-.190). Steers in this study with large loin eyes

tend to have less fat covering than steers with small loin eyes. This agrees with the work done by Weseli (1957).

The correlations reported in this study are in general agreement with unpublished work presented in Tables 9 and 10 of the Appendix.

SUMMARY

The animals used in this study consisted of 253 steers that comprised the carcass contest at the 1957 International Livestock Exposition at Chicago.

There was a range of weight from 800 to 1300 pounds and in age from 12 to 18 months in the steers.

Live body measurements taken on the steers consisted of width of eyes, width of muzzle, circumference of cannon and circumference of round. A visual muscling score was taken on each steer.

Carcass measurements consisted of fat thickness, and rib eye area. Marbling score, dressing percentage, breed and live weight are included in the data.

Simple and partial correlations were computed from these data between live animal measurements, carcass characteristics, and live animal and carcass characteristics.

Results were computed without regard to breed, however, the influence of weight factors were considered.

Differences among weight groups for width of eyes, muzzle width, cannon and round circumferences, dressing percentage, loin eye area and fat cover were significant. Dressing percentage in steers of similar weight was positively correlated with fat cover, marbling score and loin eye area and negatively correlated with muzzle and eye widths and cannon circumference.

Fat thickness in steers of similar weights showed a negative correlation with area of loin eye, cannon and round circumferences, and eye and muzzle widths. However, fat cover in this study was positively correlated with marbling score. This would indicate that as the amount of muscle and bone increases there is a decrease in the amount of fat. Cannon circumference showed a positive correlation with round circumference, width of muzzle, and width of eyes in steers of the same weight.

Steers possessing broader muzzles were also wider between the eyes in steers of similar weight.

Heavier boned steers possessed less intra-muscular fat.

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APPENDIX

Table 8. Data from the carcass steers used in this study.

Tag No.	Breed	Live Weight	Muscling score	Eye to eye[1]	Width of muzzle	Cir. of cannon[3]	Cir. of round[4]	Dressing percent	Marbling score	Rib eye area[5]	Fat cover 12th rib[6]
110	Angus	805	4	8.0	5.0	18.2	126.8	62.7	8	10.1	.5
130	"	810	4	8.6	5.3	16.9	122.4	62.5	8	10.9	1.2
128	"	815	5	8.2	5.2	16.5	124.7	64.4	8	10.1	1.7
148	"	820	4	8.4	5.1	18.0	128.2	64.4	8	11.9	1.1
200	"	825	5	8.3	4.6	18.0	118.8	62.5	10	9.3	.9
103	"	830	4	8.2	5.0	15.0	125.0	62.7	8	10.1	.7
109	"	830	3	8.8	5.3	18.0	117.5	58.2	8	9.6	.5
105	"	835	3	8.4	4.9	17.8	118.5	61.6	9	9.8	.7
147	"	835	5	7.9	4.8	18.0	119.5	65.4	10	9.2	1.2
104	"	850	4	8.4	5.2	18.8	123.9	61.8	8	12.5	1.0
149	"	850	4	8.4	5.0	18.2	128.0	64.7	8	10.5	1.1
180	"	850	4	8.1	5.1	17.0	121.4	65.2	10	10.2	1.1
146	"	855	5	8.2	5.1	19.0	118.4	64.2	9	9.6	1.2
127	"	860	4	8.3	5.3	18.5	122.7	64.8	9	12.5	1.2
102	"	865	5	8.4	5.2	17.2	127.5	65.8	10	13.7	.6
143	"	865	4	8.4	5.3	18.8	126.3	64.3	10	9.9	1.4
140	"	870	4	8.3	5.0	18.8	120.1	63.9	9	9.7	1.0
150	"	875	3	8.6	5.2	18.2	117.1	60.7	9	11.7	.5
137	"	880	5	8.7	5.0	18.7	135.0	66.1	10	12.0	.9
133	"	885	5	8.0	5.0	18.0	130.0	63.9	8	11.5	.7
164	"	885	4	8.6	5.4	18.8	129.0	64.9	10	10.1	.9
151	"	885	4	8.2	5.2	18.2	127.3	60.3	8	11.4	.9
123	"	910	5	8.5	5.1	18.2	136.4	62.7	9	11.7	1.1
138	"	910	3	8.3	5.2	18.0	123.0	66.3	9	12.7	1.2
124	"	915	4	8.4	4.9	19.0	133.0	64.9	9	11.6	1.2
363	"	895	3	8.2	4.8	18.3	133.1	65.0	9	10.8	1.4
122	"	915	5	8.7	5.3	19.2	135.2	65.5	9	9.6	1.4
113	"	915	2	8.8	5.4	19.2	124.7	61.3	9	8.5	1.6
141	"	915	5	8.0	5.1	18.0	133.7	62.3	8	11.1	.4
179	"	915	2	8.2	5.0	19.0	129.3	63.1	9	11.1	.8
112	"	920	5	8.6	5.3	18.0	132.2	64.6	9	9.9	1.1
329	"	920	3	8.2	5.1	18.0	124.4	67.1	9	11.4	1.9

Table 8 (cont.)

Tag No.	Breed	Live Weight	Muscling score	Eye to eye[1]	Width of muzzle[2]	Cir. of cannon[3]	Cir. of round[4]	Dressing percent	Marbling score	Rib eye area[5]	Fat cover 12th rib[6]
346	Angus	920	5	8.6	5.4	18.5	134.4	67.8	8	13.2	1.2
362	"	920	3	8.6	5.3	18.0	124.7	64.6	9	10.7	1.5
108	"	925	4	8.2	5.1	17.7	135.2	63.8	10	10.4	1.5
373	"	925	3	8.1	5.0	19.0	124.1	62.5	9	10.5	.9
117	"	930	4	8.4	5.4	18.4	127.0	61.5	9	11.6	1.0
121	"	935	4	8.3	5.6	19.5	131.0	64.4	8	10.7	.7
129	"	940	5	8.2	5.1	17.8	129.7	65.9	8	12.9	1.2
325	"	940	4	8.6	5.2	19.1	131.0	61.5	8	10.7	.7
106	"	950	4	8.6	4.8	17.5	135.3	63.9	10	11.0	1.2
318	"	950	3	8.1	5.1	18.2	127.2	63.6	10	12.1	1.4
335	"	950	4	8.4	5.4	18.5	130.1	66.3	10	13.9	1.2
111	"	955	4	9.0	5.3	18.2	128.2	62.7	10	11.7	1.9
152	"	955	5	8.6	5.2	19.4	128.6	66.2	9	11.6	1.4
321	"	955	4	8.3	5.3	19.3	126.6	64.5	10	10.9	1.0
311	"	955	3	8.3	5.0	19.2	132.1	62.1	9	12.8	.9
339	"	955	5	8.6	5.2	19.7	134.7	66.3	10	11.0	1.6
408	"	955	4	8.5	5.3	19.0	133.3	62.1	10	10.9	1.1
115	"	960	4	8.7	5.6	19.0	133.7	65.7	8	12.1	.7
132	"	960	5	8.7	5.4	18.5	123.3	61.5	9	11.6	1.0
198	"	965	4	8.1	5.4	18.2	132.2	65.3	9	10.2	1.1
367	"	965	3	8.2	5.3	19.9	130.0	64.5	9	12.3	1.7
374	"	965	4	8.2	5.3	20.5	134.9	63.7	9	11.5	.5
135	"	970	4	8.9	5.4	18.5	132.0	57.9	8	12.6	1.2
120	"	970	4	8.1	4.9	18.8	129.6	62.2	9	11.6	1.0
336	"	970	4	8.3	5.0	18.6	132.7	65.2	9	11.3	1.4
338	"	975	3	8.2	5.5	19.5	133.5	66.3	9	11.9	1.2
131	"	980	4	8.2	5.2	18.7	128.5	64.7	10	11.6	1.0
331	"	980	5	9.0	5.6	19.9	138.3	64.1	10	11.1	1.1
358	"	980	4	8.6	5.0	19.2	127.2	64.7	10	11.7	1.2
162	"	985	4	8.4	5.3	19.0	137.0	67.6	8	14.7	.9
328	"	985	3	8.7	5.5	19.3	138.6	62.6	10	11.9	1.5
330	"	985	2	8.7	5.3	18.3	132.2	63.5	9	9.8	1.3

Table 8 (cont.)

Tag No.	Breed	Live Weight	Muscling score	Eye to eye[1]	Width of muzzle[2]	Cir. of cannon[3]	Cir. of round[4]	Dressing percent	Marbling score	Rib eye area[5]	Fat cover 12th rib[6]
340	Angus	985	4	8.5	5.1	19.3	132.1	66.0	10	10.5	1.1
348	"	985	4	8.4	5.0	19.6	138.0	63.4	8	14.5	1.2
116	"	990	5	8.1	5.1	18.3	125.4	64.8	7	12.1	.9
185	"	990	5	8.6	5.3	19.5	130.2	66.0	10	9.6	1.4
324	"	990	5	8.0	5.0	18.5	131.0	62.2	10	10.4	1.1
372	"	990	4	8.6	5.0	19.1	131.0	65.3	9	13.0	1.2
376	"	990	5	8.8	5.3	19.7	134.7	65.8	8	11.1	1.6
166	"	995	4	8.6	5.2	19.3	128.3	64.6	10	9.7	1.7
314	"	995	5	8.0	5.4	19.1	138.4	66.5	9	12.6	1.2
134	"	1000	5	8.6	5.5	20.0	133.0	64.1	10	14.0	.6
139	"	1000	5	8.6	5.4	19.0	127.8	67.2	9	10.4	1.3
315	"	1000	3	8.6	5.4	19.7	135.5	60.6	8	12.7	.9
165	"	1005	5	8.7	5.0	19.1	135.7	65.1	9	10.2	1.2
317	"	1005	4	8.4	5.1	20.0	132.2	64.5	8	13.3	1.7
356	"	1005	4	8.5	5.0	19.3	135.3	64.3	8	9.6	1.6
352	"	1010	4	8.4	5.0	19.3	135.5	64.5	9	10.2	1.2
323	"	1015	4	8.6	5.4	20.2	131.2	63.6	10	12.2	1.5
375	"	1015	5	8.4	5.1	19.2	128.1	67.2	10	12.8	1.3
483	"	1020	4	8.6	5.3	20.1	134.7	61.0	9	12.7	.7
495	"	1020	3	8.8	5.7	20.2	135.1	60.9	8	12.0	.6
313	"	1025	4	8.3	5.4	19.5	132.1	65.6	9	12.3	.9
316	"	1025	4	8.1	4.8	20.9	132.5	65.9	10	10.6	1.4
320	"	1025	3	9.0	5.1	20.2	130.9	62.1	9	11.5	1.4
345	"	1025	3	8.7	5.0	19.3	135.2	65.3	10	12.4	.9
144	"	1030	6	8.5	5.4	18.9	147.2	75.9	8	19.6	.5
326	"	1030	4	8.5	5.3	19.7	131.3	65.0	8	11.4	1.2
355	"	1030	4	8.7	5.2	19.5	137.5	63.2	9	11.9	1.3
343	"	1040	4	8.6	5.2	19.0	130.5	63.5	10	12.0	.75
347	"	1040	5	9.2	5.3	19.5	137.0	65.0	10	12.3	1.3
489	"	1040	4	8.8	5.3	18.0	128.5	67.0	10	14.0	1.2
101	"	1045	3	8.4	5.1	18.5	132.0	67.6	7	10.8	1.1
364	"	1045	5	8.3	5.1	19.0	138.6	70.6	10	13.0	1.7

Table 8 (cont.)

Tag No.	Breed	Live Weight	Muscling score	Eye to eye[1]	Width of muzzle[2]	Cir. of cannon[3]	Cir. of round[4]	Dressing percent	Marbling score	Rib eye area[5]	Fat cover 12th rib[6]
486	Angus	1045	4	8.8	5.3	19.7	129.5	64.2	9	10.7	1.4
199	"	1050	4	9.0	5.4	18.0	128.7	65.1	9	9.2	1.2
406	"	1050	4	8.4	5.6	19.3	128.3	65.7	9	12.4	1.6
366	"	1085	5	8.9	5.1	20.1	135.1	65.1	9	11.1	1.0
354	"	1085	4	8.6	5.0	19.5	135.7	67.1	10	10.2	1.4
369	"	1090	4	9.0	5.3	19.4	134.2	65.6	10	10.1	1.3
341	"	1095	4	8.7	5.2	19.1	128.0	64.6	8	12.2	1.0
449	"	1095	4	9.0	5.5	19.9	138.1	62.0	9	10.2	1.2
453	"	1105	4	8.3	5.4	19.7	136.6	66.8	10	13.0	1.4
484	"	1105	2	9.2	5.9	20.8	135.5	62.0	10	12.1	1.3
322	"	1115	5	8.3	5.2	19.9	143.0	69.7	9	11.5	2.1
309	"	1115	5	9.1	5.4	20.2	138.8	63.0	9	13.3	1.0
153	"	1120	3	8.5	5.9	20.4	148.6	65.8	10	13.2	1.1
487	"	1120	5	8.8	5.5	20.5	135.5	66.0	10	10.7	1.0
459	"	1125	3	8.8	5.3	19.8	135.1	63.7	8	11.4	1.4
450	"	1130	4	8.3	5.3	19.7	140.0	67.0	9	12.0	1.5
454	"	1130	5	8.7	5.1	20.2	141.2	64.8	10	9.8	1.5
462	"	1135	4	9.1	5.6	20.5	138.8	65.4	9	10.4	1.5
431	"	1140	4	8.9	4.8	19.3	137.6	66.9	9	11.4	1.4
433	"	1150	5	8.9	5.3	19.9	137.3	64.7	9	12.8	1.5
448	"	1160	4	9.0	5.1	19.5	136.3	66.0	10	12.4	1.4
434	"	1160	4	9.3	5.3	20.2	132.5	64.4	9	11.7	1.0
915	"	1160	3	9.2	5.8	20.0	143.0	62.8	10	12.3	1.1
371	"	1170	3	8.4	5.2	19.1	139.3	64.5	10	13.0	.9
432	"	1170	6	9.1	5.4	20.0	143.0	65.0	10	13.2	1.0
435	"	1170	4	8.9	5.3	18.8	141.3	61.6	9	13.4	1.4
456	"	1175	5	9.2	5.4	21.3	140.0	66.8	10	14.5	.8
447	"	1190	3	8.8	5.3	20.2	140.3	63.2	9	13.1	1.5
436	"	1190	5	8.7	5.3	20.0	142.0	67.0	10	12.9	1.7
440	"	1195	5	8.6	5.3	20.5	136.8	67.5	10	13.1	1.6
395	"	1195	4	8.8	5.5	19.3	145.0	61.9	10	13.2	1.1
464	"	1200	5	8.6	5.2	20.3	148.2	65.9	9	12.5	.7
496	"	1215	5	9.3	5.2	19.8	146.5	66.9	8	13.9	.9

Table 8 (cont.)

Tag No.	Breed	Live Weight	Muscling score	Eye to eye[1]	Width of muzzle[2]	Cir. of cannon[3]	Cir. of round[4]	Dressing percent	Marbling score	Rib eye area[5]	Fat cover 12th rib[6]
458	Angus	1235	5	9.0	5.4	21.0	148.3	65.2	9	12.7	.8
161	"	1240	4	8.8	5.7	20.4	145.5	65.6	10	14.9	1.3
446	"	1400	5	9.1	5.7	22.2	147.2	65.3	10	12.5	1.2
337	"	1110	5	9.3	5.3	18.8	147.5	66.0	10	12.0	1.6
169	Hereford	815	3	8.9	5.6	19.1	122.8	62.4	10	10.2	.9
154	"	825	4	8.4	4.8	19.5	131.3	60.9	9	12.1	.7
171	"	835	4	8.2	5.3	19.2	121.4	63.4	10	11.1	.7
156	"	845	4	8.5	5.3	20.0	134.2	59.8	7	9.4	.7
172	"	870	4	8.5	5.1	19.8	132.5	61.2	8	10.1	.7
173	"	895	4	8.9	5.4	22.2	141.0	58.4	8	11.8	.5
168	"	900	5	8.6	5.4	19.0	134.2	63.9	7	10.6	.8
158	"	905	4	8.9	5.6	21.7	133.3	62.8	[illegible]	12.5	.9
177	"	915	4	8.9	5.4	20.3	139.4	63.1	8	10.8	.9
413	"	915	3	8.8	5.4	20.4	138.8	64.0	9	11.9	.7
160	"	920	4	8.7	5.5	21.9	137.1	60.0	6	12.0	.6
191	"	925	4	8.4	4.9	20.2	133.3	63.3	10	11.0	1.2
182	"	950	5	8.5	5.4	20.8	135.3	63.1	8	11.5	.7
157	"	960	3	8.9	5.2	21.1	139.5	61.6	6	10.7	.5
399	"	965	3	8.1	5.5	20.3	137.0	62.7	8	10.9	1.1
404	"	985	3	8.8	5.2	20.0	132.0	61.3	7	12.0	.8
414	"	990	3	8.4	5.6	20.5	141.3	62.9	8	11.9	.9
405	"	995	4	8.8	5.4	22.5	135.1	63.2	7	12.9	1.1
415	"	995	4	8.2	5.1	21.1	138.7	62.2	7	12.3	.6
422	"	1000	5	8.7	5.3	20.2	135.2	64.1	8	10.8	1.2
400	"	1010	5	8.6	5.4	21.1	146.1	63.2	7	10.6	1.2
310	Angus x Hereford	1015	5	8.2	5.0	20.2	138.5	65.6	9	13.1	.8
361	Hereford	1020	4	9.1	5.4	21.3	132.2	64.2	6	11.4	.7
475	"	1030	4	8.8	5.3	21.5	144.0	70.7	10	12.2	.7
181	"	1035	5	8.6	5.5	22.6	137.8	65.5	8	12.0	.9
390	"	1035	5	8.7	5.5	19.2	143.9	65.4	8	12.4	1.5
491	"	1035	5	8.7	5.2	20.2	140.0	64.0	10	10.6	1.5

Table 8 (cont.)

Tag No.	Breed	Live Weight	Muscling score	Eye to eye[1]	Width of muzzle[2]	Cir. of cannon[3]	Cir. of round[4]	Dressing percent	Marbling score	Rib eye area[5]	Fat cover 12th rib[6]
378	Hereford	1050	4	8.7	5.3	21.3	144.9	63.3	7	10.0	1.2
379	"	1050	4	8.9	5.4	22.0	140.6	62.6	9	11.6	1.2
914	"	1050	5	9.2	5.2	21.7	136.4	63.0	10	11.2	.8
155	"	1055	4	9.1	5.5	21.2	148.2	62.9	8	11.6	1.3
384	"	1055	3	8.6	5.5	21.5	133.0	62.2	7	11.0	1.1
421	"	1065	4	8.7	5.4	21.2	146.4	63.1	8	11.8	.7
380	"	1070	5	8.9	5.5	19.3	142.1	65.9	10	12.9	1.0
409	"	1070	5	8.3	5.2	19.7	138.4	65.9	8	10.1	1.2
480	"	1070	2	8.9	5.7	21.7	143.7	65.4	6	11.2	1.1
385	"	1080	3	8.8	5.5	20.5	139.0	64.7	7	11.6	1.7
472	"	1085	2	8.7	5.7	20.2	136.8	62.8	8	13.3	1.8
387	"	1090	4	9.5	5.9	21.2	137.9	61.3	10	10.5	.8
401	"	1100	5	8.7	5.4	22.9	143.8	63.7	8	12.3	.9
389	"	1100	4	9.5	5.6	21.0	136.1	64.0	10	11.1	1.5
386	"	1105	4	8.6	5.1	21.3	138.1	63.8	8	12.2	.7
473	"	1105	2	8.7	5.5	21.0	135.4	62.0	8	11.5	.9
500	"	1105	5	8.6	5.2	20.4	133.5	66.1	10	11.3	.9
360	"	1110	4	8.9	5.5	22.7	137.3	64.8	8	12.8	1.4
381	"	1110	4	8.6	5.2	20.5	136.2	65.8	7	11.7	.8
370	"	1115	4	8.4	5.6	21.0	143.7	62.3	8	11.0	1.5
159	"	1120	5	9.0	5.2	20.0	147.3	63.6	10	12.2	1.3
383	"	1120	4	9.1	5.6	21.8	142.0	60.8	7	11.6	.8
403	"	1120	5	9.0	5.6	20.2	139.1	65.2	10	12.3	1.1
407	"	1130	5	8.9	5.3	21.0	138.0	65.4	9	12.7	.9
482	"	1135	4	9.3	5.7	22.2	148.6	64.0	8	13.2	.8
170	"	1140	3	9.4	5.9	21.0	142.0	63.2	9	11.9	.9
481	"	1150	4	9.2	5.8	22.2	141.8	61.1	10	11.6	1.0
398	"	1155	4	8.7	5.4	20.6	145.4	65.8	10	11.3	1.4
178	"	1165	4	9.0	5.5	20.6	143.0	62.2	10	11.9	1.3
402	"	1165	5	9.2	5.6	22.0	140.2	62.9	8	12.2	1.2
176	"	1170	3	8.9	5.9	21.8	139.2	63.0	9	11.2	1.2

Table 8 (cont.)

Tag No.	Breed	Live Weight	Muscling score	Eye to eye[1]	Width of muzzle[2]	Cir. of cannon[3]	Cir. of round[4]	Dressing percent	Marbling score	Rib eye area[5]	Fat cover 12th rib[6]
468	Hereford	1190	2	9.3	6.0	23.5	145.7	62.1	7	12.6	1.0
391	"	1195	5	8.8	5.2	20.6	142.8	65.9	9	12.6	1.3
469	"	1205	5	8.9	5.7	21.4	146.2	63.8	9	11.7	1.1
467	"	1215	4	8.8	5.7	22.0	145.0	62.8	8	10.6	1.2
916	"	1230	5	9.4	5.5	21.0	144.8	65.1	8	12.2	1.1
465	"	1315	5	9.0	5.3	21.7	148.9	63.4	8	13.8	1.1
303	Shorthorn	855	5	7.9	5.3	18.4	131.8	62.3	9	9.9	.7
184	"	865	4	8.0	5.2	19.0	130.3	64.3	10	9.6	1.2
183	"	875	4	8.4	5.3	18.5	127.9	63.1	7	10.0	1.0
187	"	885	5	7.6	5.2	18.5	127.4	62.9	9	9.4	.9
394	"	915	3	8.0	5.0	18.2	124.1	63.8	10	9.7	1.3
302	"	925	5	8.4	5.3	18.8	129.8	64.4	8	10.9	.8
304	"	925	4	8.4	4.7	19.8	130.8	64.9	7	10.7	1.0
307	Shorthorn x Angus	940	4	8.5	5.2	18.6	131.5	65.4	8	11.8	.9
186	Shorthorn	945	3	8.1	5.4	19.2	135.1	61.9	8	13.4	.8
420	"	945	3	8.4	5.7	19.7	131.3	62.2	7	11.1	.7
145	"	960	4	8.6	5.5	18.7	132.1	62.0	10	14.1	.9
189	"	960	5	8.4	4.7	19.1	139.2	63.3	8	10.6	1.2
463	"	970	4	8.1	5.3	18.8	126.5	63.9	9	9.2	1.4
306	"	990	4	8.6	5.2	17.8	131.7	64.6	9	10.0	1.2
429	"	990	2	8.7	5.4	18.5	130.3	63.4	9	9.2	.7
188	"	1015	4	8.5	5.2	19.7	131.0	61.9	9	9.8	1.1
410	"	1015	4	8.1	5.2	19.0	134.9	63.0	8	10.8	1.2
417	"	1015	5	8.0	5.2	18.8	142.7	65.3	9	10.3	1.4
485	"	1015	4	8.8	5.1	19.7	131.1	65.0	9	9.3	1.3
412	"	1020	4	8.5	5.1	20.5	138.8	63.2	8	10.0	.9
393	"	1025	4	7.8	5.2	19.5	133.0	65.6	9	11.8	1.3
416	"	1025	5	8.1	5.2	19.4	130.3	63.6	9	11.2	1.5
460	"	1030	2	8.5	5.3	19.5	132.4	63.9	7	10.7	1.3
190	"	1055	5	8.5	5.4	19.2	139.5	64.8	10	10.6	1.1
438	"	1055	5	8.7	5.4	19.0	131.6	65.7	8	10.9	2.0

Table 8 (cont.)

Tag No.	Breed	Live Weight	Muscling score	Eye to eye[1]	Width of muzzle[2]	Cir. of cannon[3]	Cir. of round[4]	Dressing percent	Marbling score	Rib eye area[5]	Fat cover 12th rib[6]
411	Shorthorn	1085	4	8.8	5.4	18.5	135.0	65.4	10	10.3	1.5
418	"	1100	4	8.5	5.4	18.9	128.9	65.6	10	10.0	1.5
392	"	1115	5	8.6	5.3	19.5	136.4	63.1	6	11.3	.9
474	"	1130	4	8.7	5.4	18.5	137.3	64.1	10	10.4	1.2
382	"	1140	4	8.3	5.1	19.6	143.6	65.2	7	10.6	1.2
419	"	1145	4	8.3	5.3	20.5	139.1	64.1	10	9.5	1.7
901	"	1155	4	8.6	5.2	18.8	130.4	67.4	9	10.6	1.8
492	"	1180	5	8.8	5.3	19.8	140.3	63.9	9	11.2	1.2
478	"	1210	5	8.8	5.1	19.6	140.5	68.6	8	13.5	1.7
488	"	1215	5	8.2	5.4	18.4	139.0	65.4	10	10.8	2.1
470	"	1270	6	8.9	5.3	19.7	137.6	65.0	8	13.7	1.4
461	"	1275	5	9.2	5.3	21.4	143.0	65.5	9	13.4	1.3
192	Galloway	760	3	7.8	5.2	18.2	128.4	61.9	8	10.8	.8
193	Red Polled	780	1	7.8	5.1	16.8	123.6	61.7	7	12.3	.2
196	"	810	1	8.3	4.9	19.0	130.2	61.1	6	10.3	.4
197	"	830	2	7.9	4.7	16.8	128.8	59.6	6	13.1	.5
195	"	905	1	8.4	5.3	17.8	132.0	60.8	7	12.4	.6
426	"	910	3	8.0	4.8	17.5	131.5	61.6	9	10.9	.7
424	Galloway	935	4	8.1	4.8	19.5	131.7	62.2	5	12.1	.8
444	Red Polled	945	1	8.2	4.8	18.2	127.0	61.5	6	10.0	.4
194	"	955	2	8.5	5.2	17.8	130.1	62.3	8	10.8	.7
443	"	980	3	8.3	5.5	19.0	139.9	62.7	7	12.5	.8
427	"	1025	1	8.5	5.2	17.7	133.3	62.2	10	11.9	1.4
902	"	1040	1	8.3	5.4	19.7	134.8	64.8	9	12.8	.8
497	"	1070	2	8.7	5.7	19.5	134.6	61.5	9	11.3	.7
423	Galloway	1085	5	8.5	5.5	20.7	143.1	63.6	8	13.4	1.4
442	Santa Gertrudis	1085	3	8.3	5.0	19.3	133.6	60.3	7	12.4	.8
499	Red Polled	1090	1	8.6	5.0	18.7	137.4	62.2	9	12.3	.9
428	"	1095	2	8.3	5.5	18.3	137.0	63.7	7	12.4	.9
498	"	1135	1	8.2	5.2	18.2	136.2	57.0	9	13.2	.5
913	"	1160	2	9.0	5.7	19.7	135.8	64.0	9	12.9	1.1

Table 8 (concl.)

Tag No.	Breed	Live Weight	Muscling score	Eye to eye[1]	Width of muzzle[2]	Cir. of cannon[3]	Cir. of round[4]	Dressing percent	Marbling score	Rib eye area[5]	Fat cover 12th rib[6]
490	Galloway	1175	4	9.3	5.6	19.8	148.5	64.5	9	14.5	1.0
912	Red Polled	1220	3	8.7	5.6	19.5	149.0	66.8	10	12.2	.9
905	Charolis	1290	3	8.4	5.8	22.4	154.6	64.7	6	16.7	1.0
907	"	1460	4	8.9	5.8	23.0	158.5	64.8	7	13.5	.9

[1] Inches
[2] Inches
[3] Centimeter
[4] Centimeter
[5] Square Inches
[6] Inches

Table 9. Simple correlations between live animal measurements, carcass characteristics, and live animal and carcass characteristics of 1958 carcass steers. (n = 268)

	Muscling score	Eye to eye	Width of muzzle	Cir. of cannon	Cir. of round	Dressing percent	Marbling score	Rib eye area	Visual[1] fat score	Fat cover 12th rib
Live weight	-.065	.362**	.328**	.457**	.583**	.200**	.022	.284**	.219**	.336**
Muscling score		-.107	.011	-.066	-.030	.110	.100	.101	-.015	.005
Eye to eye			.333**	.394**	.301**	-.068	.004	.118	.198**	.085
Width of muzzle				.534**	.334**	-.167**	-.118	.193**	.039	-.121*
Cir. of cannon					.419**	-.258**	-.270**	.306**	-.031	-.184**
Cir. of round						.090	-.088	.279**	.149*	.101
Dressing percent							.357**	.159**	.308**	.506**
Marbling score								.048	.093	.233**
Rib eye area									.058	-.129*
Visual fat score										.405**

*Significant at .05 level

**Significant at .01 level

[1]Visual fat score on live animal

Table 10. Partial correlations between live animal measurements, carcass characteristics, and live animal and carcass characteristics independent of live weight of 1958 carcass steers. (n = 268)

	Eye to eye	Width of muzzle	Cir. of cannon	Cir. of round	Dressing percent	Marbling score	Rib eye area	Visual[1] fat score	Fat cover 12th rib
Muscling score	-.090	.035	-.041	.010	.126	.102	.125	-.001	.030
Eye to eye		.244**	.276**	.119	-.154*	-.004	.017	.131	-.055
Width of muzzle			.457**	.186*	-.251**	-.132	.111	-.035	-.275**
Cir. of cannon				.211**	-.401**	-.315**	.207**	-.151*	-.424**
Cir. of round					-.033	-.124	.145	.027	-.149
Dressing percent						.360**	.109	.277**	.475**
Marbling score							.043	.091	.242**
Rib eye area								-.004	-.261**
Visual fat score									.357**

*Significant at .05 level

**Significant at .01 level

[1]Visual fat score on live animal

RELATIONSHIPS AMONG LIVE AND CARCASS CHARACTERISTICS OF SLAUGHTER STEERS

by

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A demand for a larger amount of muscle and quality in the beef carcass has increased the problems in selecting breeding stock. At the present, slaughter grade and yield are used to evaluate the animal on foot, but these factors are subject to human error. Also, they do not indicate the edible portion of the carcass.

An on the foot evaluation of the animal would be useful in estimating the major components of the carcass, that is muscle, fat, and bone.

In conducting this study, 253 steers were subjected to live animal carcass measurements. Live animal measurements included circumference of cannon, circumference of round, width of eyes, and width of muzzle. Each steer was visually appraised for muscling. Carcass measurements included rib eye area, fat cover, marbling score, and dressing percentage.

Simple and partial correlation coefficients between the measurements of the live animal, carcass characteristics, and between the live animal and carcass characteristics were computed.

Area of loin eye, fat thickness over the 12th rib, circumference of cannon, width of eyes, round circumference and width of muzzle were found to be related to live weight. Fat thickness showed an inverse relationship to the amount of bone and muscle. A direct relationship was noted between the head measurements and cannon bone circumference.

Dressing percentage was related to fat cover, marbling score and the amount of rib eye muscling but inversely related to bone measurements. Fat cover was directly related to marbling score.

In reviewing this study and previous work, there is an apparent need for more research in both live animal and carcass evaluation in beef cattle.