RELATIONSHIPS AMONG LIVE AND CARCASS CHARACTERISTICS OF SLAUGHTER STEERS

by

DOUGLAS JOHN WESELI

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INTRODUCTION

Body conformation is one of the most important factors in selecting animals for breeding and production purposes. A maximum of high quality meat per animal, that can be produced economically should be the objective of a contemporary beef production program. The composition of beef carcasses have been found to be variable since the proportion of lean meat in beef carcasses of similar weight and age may be quite different. Measurements taken on various parts of the animal's body furnish an objective description of body conformation. The ability of cattle to produce meat could be estimated with these measurements if relationships between body measurements and musceling actually existed.

One of the major problems in measuring merit in beef cattle has been to devise an on foot evaluation that would be useful in determining the amount of muscle in the beef carcass and the quality of the meat. At present, slaughter grade and yield are used to evaluate the animal on foot, but these factors are subject to human error and do not indicate the area of eye muscle, the amount of outside fat and the proportion of edible meat in the carcass.

From the standpoint of the packer as well as the consumer, the most desirable carcass is one that has good conformation, enough fat for palatability and "ripening quality" and a large proportion of lean meat. The producer can produce this kind of an animal if he is provided with guidance in selecting for the meat type. Carcass grade is determined by conformation, quality and finish. After a steer is fat enough to attain a desired grade, additional finish is undesirable because the extra fat must be trimmed off and it is uneconomical for the producer to feed beyond this point. Many show steers have been criticized for being over finished and some feed lot steers are also fed until they are wasty and over finished. The important thing is to be able to determine the animal that is correctly finished and that has an abundance of muscling which is of high quality.

The thought behind this study is that the ratio of lean meat or muscle to bone and/or forearm circumference might offer an index of carcass merit that would be useful in the selection of superior market animals and breeding stock; particularly of herd sires.

REVIEW OF LITERATURE

According to Hankins, *et al.*(1943), the muscle-bone ratio is a rather definitely inherited character. With this fact in mind, selecting for bulls with a high transmitting ability of this characteristic, one could decidedly increase the muscle-bone ratio of a group of progeny.

Hankins, *et al.* (1943) ran a correlation study within beef Shorthorn type and within the dual-purpose Shorthorn type for the relationship between the muscle-bone ratio and various production factors, live animal measurements, and other carcass characteristics. An objection might be raised to this ratio in question that a high percent of muscle and a low percentage of bone might result in a reduction in the percentage of separable fat in a carcass. For the two types of cattle the correlations were determined between muscle-bone ratio and percentage of separable fat, and in neither instance was the value significant. This would indicate that the muscle-bone ratio can be increased without materially affecting the ability of an animal to fatten. Therefore, if it is desired to increase or decrease the fatness, the feeding of steers over a longer or shorter period of time would be the controlling factor.

It should be expected that the smaller the bone, the higher the muscle-bone ratio. Hankins, et al. (1943) found none of their correlations to be high enough to be of any value. Indications 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 are 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 with carcass measurements were, in general, higher than those with 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.

Height at withers, which is almost entirely a skeletal measurement, was found to be significantly correlated with length of body, circumference of fore-flank, width of shoulders, average daily gain and final age of marketing. Kohli, et al. (1951) also pointed out that there is a slight indication that the shorter the legs of a steer, the better his daily gain.

Height at floor of chest, also a skeletal measurement, had a significant positive correlation with birth weight and length of body; 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 a small significant positive correlation with width of shoulders, days to weaning and days to final weight, but had a small significant negative correlation with average daily gain and feed efficiency. The above results are similar to those found by Lush (1932) but differs from that found by Black, _et al._ (1938) who did not find significance of fore flank (heart girth) to be correlated appreciably with rate of efficiency of gain. This difference may be due to the difference in breeding and age of the steers.

Width of the shoulder which is a measure of both structure and fleshing had no significant correlation with performance of the steers. However, Black, _et al._ (1938) did show a slight positive correlation between width of shoulder and feed efficiency and daily gain.

Kohli _et al._ (1951) found that the length of the body, which is largely a skeletal measure, had a small negative correlation with average daily gain and a small positive correlation with days until weaning and days until final weight was reached. Black and Knapp (1936) who obtained different results, found efficiency of gain to be highly correlated with length of body as well as with height of withers.

Days to weaning was highly correlated with days to final weight. This seems only logical since the earlier the animal reaches 500 pounds (weaning weight), the earlier he will be expected to reach slaughter weight. It was also shown that calves with higher birth weights tended to reach weaning weights more rapidly than those with lower birth weights. From the standpoint of performance, circumference of the fore-flank seems to be one of the better measurements to use in selecting breeding stock. Kohli, et al. (1951) showed that cattle with a high daily gain tended to be more efficient utilizers of feed. Steers which are shorter in height and in length of body and smaller in circumference of fore-flank were slightly superior in feed efficiency. Generally, length of body tended to be positively associated with height measurements but not with circumference of fore-flank. However, Knapp et al. (1939) concluded that though there seems to be less heritability in the measures of quality of product than in the measure of growth, there is ample opportunity to select for these characteristics.

Kohli et al. (1951) stated that steers tended to vary independently with regard to 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 measurement studied for use in the selection of breeding stock so far as relation to the measures of performance are concerned. Kohli et al.(1951) pointed out that steers with a high daily gain usually have a high feed efficiency. From this study, Kohli et al. (1951) showed that different rations did not affect significantly the height at the withers, height at floor of chest, or efficiency of gain. However, he stated that the more compact steers tended to have higher average daily gains and to be more efficient in their feed utilization.

Stonaker *et al.* (1950) showed that small type steers compared to conventional type steers had significantly smaller rates of gain and slaughter weights. Significant differences have not been found in days on feed, digestible nutrients per pound of gain, percent of wholesale cuts, or percent of separable lean, fat, and bone as measured in the 9-10-11th rib cut.

Yao *et al.* (1953) using 101 beef Shorthorn and 62 Milking Shorthorn steers that were sired by 18 and 10 sires respectively and nursed to a weaning weight of 500 pounds and fed individually until they reached 900 pounds were subjected to 19 live animal measurements prior to slaughter. The live animal measurements taken were height of withers, height of floor of chest, height of rear flank, depth of chest, length of rump, length of coupling, length of nose, width between the eyes, width of muzzle, circumference of fore-flank, circumference at navel, circumference of rear flank, circumference of shin bone, width of shoulder, width of chest, width of paunch, with at loin, and width at hips.

All width and circumference measurements were positively correlated with slaughter grade, carcass grade and dressing percentage. All height and length measurements were negatively correlated with slaughter grade. Birth weight had positive correlations with most of the height and length measurements but negative correlations with the width measurements. A higher birth weight tended to go with less days to weaning, less days to final weight, but it also tended to go with a greater daily gain and higher efficiency in feed utilization than a lower birth weight.

Results obtained by Dawson *et al.* (1955) were similar to those of Yao's in the fact that higher birth weights was highly correlated with weaning weights and final weights. Yao is also in accord with Kohli et al. (1951) that the greater the daily gains of an animal, the less time required and the smaller the amount of feed needed to reach the final slaughter weight. Yao, et al. (1953) suggested that the scores on live animals graded on foot before slaughter could be used to predict the carcass grades and to a lesser extent the dressing percentages which can only be obtained after slaughter. Using carcass grade would be a more precise method of estimating dressing percent than using slaughter grades as a somewhat higher correlation existed between carcass grade and dressing percentage, but it would, of course, be of little value since if the animals are killed, dressing percentage could be obtained directly.

Height at withers was highly correlated with other height measurements and is the best single measurement to represent height. Depth of chest was not correlated with height at floor of chest or height of rear flank. There was no correlation between the length of rump and length of coupling. All head measurements were correlated with one another. There was no correlation between circumference of fore-flank and circumference of rear flank. The circumference of the shin bone is significantly correlated with height at either flank.

Yao et al. (1953) stated that steers with a heavier birth weight tended to have poorer slaughter grade, carcass grade and dressing percentage than ones with a lighter birth weight. On the contrary, a steer with a longer period from birth to weaning and to final weight tended to have a higher dressing percentage than one with a shorter nursing or feeding period.

Yao *et al.* (1953) pointed out that the heavier the birth weights the narrower the width of the chest. Birth weight was positively correlated with height at the floor of chest, length of body and circumference of shin bone. The small negative correlation between growth rate and head measurements indicate a slight tendency for animals with smaller heads to have faster growth rates than those with larger heads. This is not at all conclusive since the correlations are small and many of them not significant. The negative correlation between growth rate and circumference measurements also showed that those animals with a smaller circumference would have a better growth rate (feed efficiency and average daily gain) than those with a larger circumference. Efficiency was also negatively correlated with dressing percentage, thus a faster growing steer would dress out less. Slaughter grade was negatively correlated with all height, length and head measurements. Carcass grade was shown by Yao *et al.* (1953), Cook *et al.* (1951), and Knapp and Nordskob (1946) to be negatively correlated with height measurements.

Yao *et al.* (1953) found that all height measurements were positively correlated with length measurements though not all of them were significant. Thus, as a group, the height measurements could be regarded as one group of measurements which denote the size of the animal. Height measurements were all negatively correlated with beef characteristics; thus, they could be referred to as the non-meat production measurements or skeletal measurements; this is in agreement with Knapp and Nordskob (1946) and Cook *et al.* (1951). Width measurements were found to be positively correlated with circumference measurements and could be regarded as another group of measurements which indicate the thickness and heaviness of the beast and could be referred to as fleshing measurements.

When the relation between birth weight and other measurements is considered, it is highly correlated with skeletal characteristics. Birth weight according to Yao et al. (1953) was positively correlated with height of chest floor, length of body, and circumference of shin bone, but negatively correlated with width measurements. Birth weight was also shown to be negatively correlated with width and circumference measurements.

Yao et al. (1953) developed the following indices for the evaluation of beef characteristics. In these formulas, body measurements with positive simple correlations were used as numerators and those with negative correlations as denominators.

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

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

$$\text{Index of dressing} = \underline{\text{width at shoulders} \times \text{circumference of fore-flank}}$$

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

$$\text{Index for beef characteristics} = \frac{\text{width} \times \text{circumference}}{\text{height} \times \text{length}}$$

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 (1932) also found a high correlation between body measurement ratios and slaughter grade, dressing percentage, and fatness of steers when the ratios were expressed as in the above formula. Knapp et al. (1939) suggested that the ratio of the heart girth and height at withers could be regarded as an expression of the amount of meat in the animal. According to Black et al. (1938) and Lush (1932), breed differences and age of cattle may play an important part in the correlation values of work of this sort.

Knox and Koger (1946), working with 350 grade Hereford steers from 1937 to 1945, ran studies dealing with gain, finished grade, carcass grade and dressing percentage and their relationship as compared to compact, medium and rangy steers.

The rangy steers had a significantly higher initial weight, gain and dressing percentage. The compact had a small non-significant advantage in grade when finished and in gain expressed in percent of initial weight. The medium type was intermediate in both cases. There was no differences between the three types in average carcass grades. There was a slight, but non-significant tendency for the compact cattle to rank higher on percentage gain and fat grade.

In this trial, the rangy steers had an average weight advantage over the compact steers at the beginning of the feeding period, which is noteworthy, but not at all surprising. Since height and length contribute to size, when these factors are reduced, weight will decrease if other factors remain unchanged. The consistency with which the rangy steers outweighed and out-gained the steers of other types suggests that gain made in the feed lot may be correlated with weight of the feeder steers. Knox and Koger (1946) suggest that the greater gains made by the rangy steers in the feed lot is due to capacity rather than to the form of the individuals.

Dressing percentage was another factor showing a consistent and significant difference, with rangy type being much higher in dressing percentage than compact type cattle. This is rather surprising, since it is generally supposed that the compact type would have a slightly higher yield because of less bone and hide to body weight. The difference in dressing percentage was contributed to higher condition or less paunchiness of the rangy steers. In this study by Knox and Koger (1946), the cattle were fed the same rations and managed under similar conditions, thus, finish should have been identical between the two types of steers when based on a large grouping. A compact animal has been described as one in which height and length are small in comparison to depth and width and a rangy animal is one where the reverse condition exists.

Green (1954) reported that the correlation between live weight and dressing percentage was quite low. He also found 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 study, 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 that area, included relatively few other parts that would probably contribute much to 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 overly finished could also be used as a determination of muscling since this area is composed primarily of muscle tissue.

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 well be due to general quantitative muscling. Width through the thighs is also an indicator of muscling.

Green _et al._ (1955) stated that according to judging standards, width of body in the dorsal areas 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. Other times, especially in show animals, uniformity is secured less by basic structural uniformity (as it might literally appear on the surface) 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 really counts as far as furnishing meat is concerned and less attention be paid to uniformity of lines and other probably esthetic values. However, type and production must go hand in hand for maximum efficiency.

Green _et al._ (1955) found that such measurements as pin to poll and shoulder points to hooks was of little value in predicting the value of preferred cuts. He also suggested that more study of body measurements might lead to newer views in show ring standards.

McMeekan (1950) stated that there is a strong positive correlation between the weight of bone in each animal and the weight of muscle tissue. It is impossible to get a carcass with a wealth of fleshing without having associated with that flesh a heavy weight of bone. The reason for this association is obvious if one thinks about it from a biological point of view. 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. On an average, fine boned animals will kill out with a smaller percentage of lean meat and a larger percentage of fat at the same weight as will a stronger, thicker boned animal.

As regards to the one structure, McMeekan 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 hind quarter is associated with short, flat, thick bone rather than long, thin bone.

Smith et al. (1950), using 43 animals, analyzed to determine the accuracy and the repeatability of live-animal and photographic measurements of beef cattle. Generally, high estimates of repeatability were obtained for the body measurements studied. These included, length of body, height at withers, depth of chest, and patella to patella (live animal measurements). Estimations for body length for the group varied from .546 to .898 for live animal measurements and .726 to .848 for photographic measurements. Repeatability for height at withers ranged from .888 to .906 for live animal measurements and .908 to .927 for photographic measurements. For depth of chest, estimates of repeatability varied from .784 to .914 for live animal measurements and .807 to .908 for photographic measurements. Repeatability for the round measurements (patella to patella) was lower than those of the other items studied with a range of .463 to .769; size of the animal did not seem to have much influence upon the accuracy of the measurements. Photographic measurements gave slightly higher degrees of repeatability than did live animal measurements. Differences between measurements taken by different men and differences due to the time of day were too small to be significant.

This review suggests that there exists a dire need for continued research in this field. New methods and techniques need to be developed to secure more accurate results and thus, a more practical application of results should follow.

MATERIALS AND METHODS

The animals used in this study consisted of 73 Angus steers, 43 Hereford steers and 37 Shorthorn steers which were exhibited at the 1956 International Livestock Exposition held in Chicago. The group of 153 steers comprised the carcass contest held in conjunction with the International. The age range of the group of steers was from 12 to 18 months and the weight varied from 800 to 1300 pounds.

The steers were bred and fed by individuals from varied localities with the intent of entering them in the carcass contest.

On November 22, four body measurements were taken of these steers immediately after leaving the scales for show ring classification. A flexible steel tape placed around the forearm on a horizontal plane at the junction of the forearm and the brisket gave the circumference of the forearm. The circumference of the left metacarpus was taken mid-way between the knee and pastern joint. At this same position a sliding vernier calipers was used in determining a frontal and lateral measurement of the cannon. At the time of weighing a visual estimation of bone size and a visual grade was placed on each steer by a committee of three appraisers. The average score of the committee was used for analyses.

The score cards that were used in recording the visual grades were broken into three divisions for each grade. For example, high primes were listed as 2, medium primes as 4, low primes as 6, and high choice as 8. The visual estimation of bone were recorded in similar fashion with the numerical number 2 representing the steers that were classified as very fine boned. As the steers increased in ruggedness of bone, they were designated with a higher numerical value. The numerical range for bone estimation was from 2 to 14.

On November 23, the group of steers were shown in hand and placed numerically according to conformation, finish and quality. These steers were classed according to age and breed, making a total of twelve classes. After being placed on foot, the steers were moved to Armour and Company for slaughter on Saturday, November 24th. At the time of slaughter, the left metacarpus was salvaged and transported to Kansas State College where it was freed of all excess tissue, and circumference, lateral and frontal measurements were taken of the clean metacarpus in similar fashion to the live measurement of the same region.

After the carcass had hung in the cooler for 48 hours, the left side of the carcass was ribbed between the 12th and 13th ribs. At this time a tracing of the longessimus-dorsi muscle was made using 9x12 aquebee acetate sheeting. From this tracing the area was determined with the aid of a planimeter which gave the area of the tracing in square inches.

A marbling score was also taken along with a measurement of fat thickness over the 12th rib.

The complete data on the group of carcass steers from the 1956 carcass contest as presented in the Appendix, shows the following information on each steer; visual grade and bone appraisal, loin eye area, fat thickness over the 12th rib, also given are the circumference, frontal and lateral measurements of the left metacarpus. Breed, weight, age, dressing percentage, marbling score, and live measurement of the forearm and metacarpus were also included in the data.

From the data, analyses of variance and correlations were computed between live body measurements and carcass characteristics. The procedure was followed as outlined by Snedecor (1950).

RESULTS

Differences in Live and Carcass Characteristics Due to Breed and Weight

Since the steers ranged in weight from 800 to 1,300 pounds, the data were arbitrarily divided into three weight groups within each breed for preliminary analyses to determine whether weight should be considered in correlation analyses of characteristics other than weight. The ranges in weights within weight groups for each breed are listed in Table 1.

Means of live animal characteristics by breeds and weight groups are presented in Table 1. Mean squares from the analyses of variance to test differences among the means are shown in Table 2. Differences among breed means were significant for cannon frontal measurement and circumference of cannon, the Herefords having the largest measurements. Differences among

EXPLANATION OF PLATE I

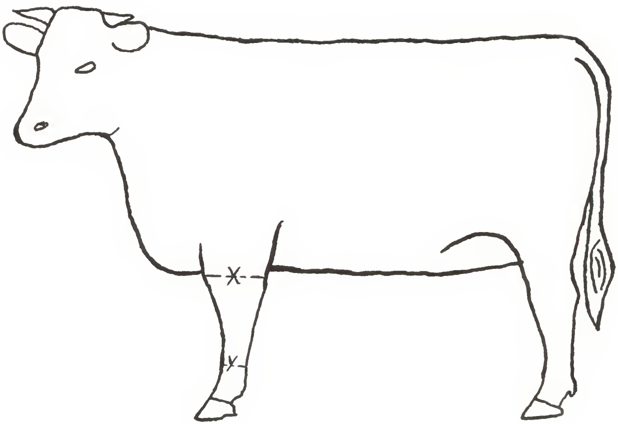
Plate I shows sliding vernier calioers and steel tape used in taking live body measurements. The position of the measurement is also shown.

PLATE I

EXPLANATION OF PLATE II

Plate II shows the position at which the live body measurements were taken as designed by X and Y.

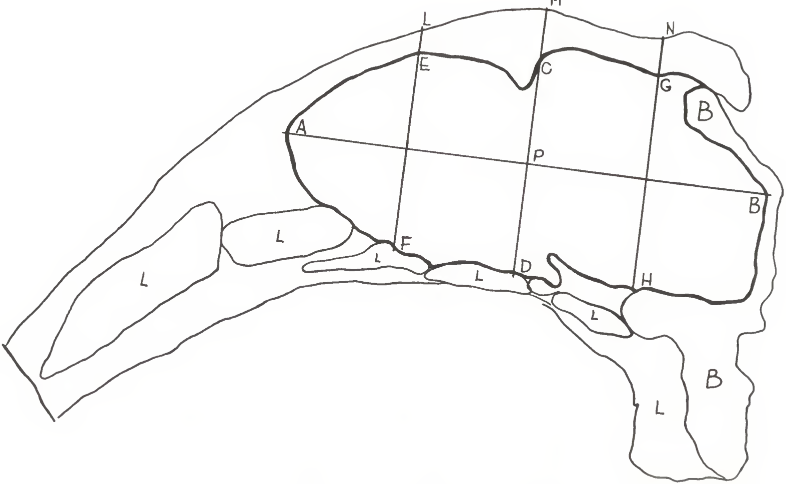
PLATE II



EXPLANATION OF PLATE III

Illustration of the twelfth rib tracing and location of the points used in taking the measurements. The letters L and B outside the eye muscle represent lean and bone. The unlabeled area outside the eye muscle is fat. The heavy line around the eye muscle was followed with the plainemeter to obtain the area.

PLATE III



weight groups within breeds were significant for visual bone score and circumference of forearm and highly significant for cannon frontal measurement, cannon lateral measurement, cannon circumference, and visual grade.

Means of carcass characteristics by breeds and weight groups are presented in Table 3. Mean squares from the analyses of variance to test differences among the means are shown in Table 4. The breeds differed significantly only in marbling score, Shorthorns and Angus having more marbling than the Herefords. Differences among weight groups within breeds were highly significant for loin eye area, fat thickness, dressing percentage, cannon frontal measurement, and cannon circumference. Differences among weight groups within breeds for marbling score and cannon lateral measurement were not significant.

Table 1. Means of live animal characteristics by breeds and weight range.

Breeds No.	Weight group	Visual bone score	Cir. of fore-arm	Cannon (C.M.) Frontal meas.	Lateral meas.	Cir.	Visual grade
Angus 26	1100-1280#	6.77	48.19	5.09	6.47	19.19	5.85
" 25	1000-1085#	7.08	47.44	5.08	6.47	18.94	6.56
" 23	800-990	7.87	45.89	4.83	6.21	18.50	9.74
Total 74		7.22	47.22	5.01	6.39	18.89	7.30
Hereford 12	1110-1300	5.08	49.38	5.57	6.80	21.00	4.00
" 16	1000-1090	6.06	49.75	5.45	6.81	20.63	5.63
" 15	855- 980	6.33	48.00	5.29	6.60	20.30	6.80
Total 43		5.88	49.03	5.43	6.73	20.62	5.58
Shorthorn 12	1110-1280	6.42	48.08	5.13	6.56	19.58	4.33
" 12	1020-1100	6.25	47.13	5.07	6.40	19.33	5.33
" 12	815-1000	7.75	42.04	4.83	6.20	18.08	6.67
Total 36		6.81	45.37	5.01	6.39	19.00	5.44

Table 2. Mean squares from analyses of variance of live animal characteristics.

Source of variation	d.f.	Visual bone score	Circumference of forearm (cm.)	Cannon frontal measurement (cm.)	Cannon lateral measurement (cm.)	Cir. of cannon (cm.)	Visual grade
Breed	2	24.23	59.18	2.73*	1.88	44.24*	60.60
Wt/breeds	6	7.15*	22.88*	.36**	.39**	4.12**	48.45**
Within	144	2.89	8.57	.08	.07	1.18	4.46

* Significant at .05 level

** Significant at .01 level

Table 3. Means of carcass characteristics by breeds and weight range.

Breed	No.	Weight groups	Loin eye area (sq.in.)	Fat thickness	Marbling score	Dressing %	Cannon Meas. (Cm.) Frontal	Lateral	Cir.
Angus	26	1100-1280	12.17	1.12	8.92	65.14	4.02	2.45	10.77
"	25	1000-1085	11.55	1.08	8.52	64.14	3.97	2.43	10.62
"	23	800- 990	11.40	.88	8.96	64.24	3.90	2.36	10.45
Total	74		11.72	1.03	8.80	64.52	3.96	2.42	10.62
Hereford	12	1110-1300	12.07	1.10	8.17	64.73	4.37	2.53	11.43
"	16	1000-1090	11.79	1.00	8.31	64.16	4.13	2.46	11.02
"	15	855- 980	11.10	.79	7.73	62.44	4.15	2.47	11.05
Total	43		11.63	.95	8.07	63.72	4.20	2.49	11.15
Shorthorn	12	1110-1280	11.10	1.29	8.75	65.11	4.04	2.51	10.82
"	12	1020-1100	10.19	1.09	9.08	64.37	3.99	2.47	10.75
"	12	815-1000	9.86	.89	8.67	63.38	3.65	2.38	10.03
Total	36		10.38	1.09	8.83	64.28	3.89	2.45	10.53

Table 4. Mean squares from analyses of variance of carcass characteristics.

	df	Loin eye area	Fat thickness	Marbling score	Dressing %	Cannon Meas. (cm.) Frontal	Lateral	Cir.
Breed	2	18.44	.19	8.46*	8.76	1.12	.07	4.84
Wt./breeds	6	4.17**	.41**	1.14	12.26**	.29**	.04	1.21**
Within	144	1.34	.06	.74	2.33	.05	.03	.24

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

Correlation Analyses

Since analyses of variance indicated breed differences in carcass frontal measurement, live cannon circumference, and marbling score, correlations involving any of these characteristics were computed within each of the breeds. Chi square tests for homogeneity of the correlation coefficients were made and homogenous correlation coefficients were combined into pooled intra-breed correlation coefficients. In cases of non-homogeneity, the within breed correlations were not pooled and are listed separately. Correlations involving characteristics, neither of which significantly differed among breeds, were computed without regard to breed.

As shown in the analyses of variance, all of the live animal characteristics and most of the carcass measurements differed among weight groups within breeds. Furthermore, most of the simple correlations between live weight and other characteristics, listed in Table 5, were highly significant. Accordingly, in addition to simple correlations between characteristics, partial correlation between characteristics independent of weight were computed.

A simple correlation indicates the relationship between two characteristics when the wide range in weight encountered in this study was not considered. A partial correlation indicates the relationship between two characteristics independent of live weight. Stated another way, a partial correlation indicates the relationship between two characteristics among steers of similar weight.

Table 5. Simple correlations between live weight and other characteristics.

Measurement	Correlation
Bone score	-.36**
Live cannon frontal	.47**
Live lateral cannon meas.	.42**
Live cannon cir.	.47**
Circumference of forearm	.36**
Visual grade	-.48**
Loin eye area	.32**
Fat thickness	.49**
Marbling	.09
Dressing %	.39**
Carcass cannon frontal meas.	.38**
Carcass cannon lateral meas.	.24**
Carcass cannon cir.	.38**

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

<u>Correlations Between Live Steer Characteristics</u>. Simple correlations between live steer characteristics are presented in Table 6. With exception of the correlation between live cannon circumference and live bone score, all are highly significant and range in absolute magnitude from .27 to .42. Steers scored as having large bones tended to have larger circumferences of forearm and higher visual grades than did steers scored as having finer bones. Circumference of forearm was positively correlated with live cannon circumference, large circumference of forearm being associated with large live cannon circumference. The negative correlation between circumference of forearm and visual grade indicates large forearms tended to be associated with high visual grading steers. Large live cannon circumferences were also associated with high visual grades.

Table 6. Simple correlations between live steer characteristics.

	Live cannon cir.	Cir. of forearm	Visual grade
Live bone score	-.04	-.38**	-31.**
Cir. of forearm	.42**		-.27 **
Live cannon cir.			-.27 **

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

Partial correlations between live steer measurements independent of live weight are presented in Table 7. Live bone score with circumference of forearm and live cannon circumference with circumference of forearm are the only highly significant correlations. Steers scored as having large bones or having large live cannon circumferences tended to have large forearms independent of live weight. A marked decrease in significant correlations was realized when weight was held constant as may be seen by comparing Tables 6 and 7.

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

	Live cannon cir.	Cir. of forearm	Visual grade
Live bone score	.16	-28.**	-.16
Cir. of forearm	.30**		-.12
Live cannon cir.			-.06

* 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 listed in Table 8. The majority of the simple correlations between live steer characteristics and carcass characteristics are significant. Live cannon circumference is positively correlated with loin eye area and carcass cannon circumference, revealing that the larger boned animals tended to have larger loin eyes and greater circumference of cannon when weight was not held constant. The correlations between live cannon circumference and dressing percent and fat thickness were non-significant. Circumference of forearm is positively correlated with dressing percent, loin eye area, and carcass cannon circumference but not significantly correlated with fat thickness. The live cannon frontal measurement is highly correlated (.44) with the carcass cannon frontal measurement. Bone score is negatively correlated with loin eye area, carcass cannon frontal, carcass cannon lateral, and carcass cannon circumference measurements, indicating that rugged bone scores were associated with large loin eyes, and large carcass cannon measurements. Bone score is not significantly correlated with dressing percent or fat thickness. Visual grade is negatively correlated with both carcass cannon circumference and fat thickness. Thus the steers possessing the larger cannon circumference and higher degree of finish were graded higher on foot than the finer boned steers and those having a lesser degree of condition. Dressing percentage and loin eye area are not significantly correlated with visual grade. Live cannon lateral and carcass cannon lateral measurements are positively correlated.

Table 8. Simple correlations between live steer and carcass characteristics.

	Dressing %	Loin eye area	Carcass Cannon			Fat thickness
			Frontal	Lateral	Cir.	
Live cannon cir.	-.01	.30**			.43**	.03
Cir. of forearm	.16*	.22**			.35**	.06
Cannon frontal meas.			.44**			
Bone score	.09	-.20*	-.51**	-.20*	-.49**	.00
Visual grade	-.12	-.05			-.26**	-.36**
Cannon lateral meas.				.30**		

* Significant at .05 level

** Significant at .01 level

Partial correlations between live steer measurements and carcass characteristics independent of weight are presented in Table 9. The partial correlation between live cannon circumference and carcass cannon circumference is highly significant. However, among steers of similar weight, the correlation between live cannon circumference and area of the loin eye is non-significant. The partial correlation between circumference of forearm and carcass cannon circumference is highly significant. However, circumference of forearm is not significantly correlated with dressing percentage, area of loin eye or fat thickness. As one would expect, the partial correlation between the live cannon frontal measurement and the carcass frontal measurement is highly significant.

Simple correlation between bone score and dressing percent and fat thickness are non-significant. However, the partial correlation independent of weight between bone score and dressing percentage (.27) is highly significant and indicates that among similar weight steers those appraised as having large bones tended to have low dressing percentages. Also the partial correlation independent of weight between bone score and fat thickness (.22) is significant and indicates that among similar weight steers, those judged to have larger bones tended to have less fat. Although simple correlations between bone score and loin eye area and carcass cannon lateral are significant, the partial correlations involving these traits are non-significant, indicating that among steers of similar weight, bone score is not related to loin eye area or carcass cannon lateral measurements. The partial correlation independent of weight between bone score and carcass cannon lateral measurement (-.43) is highly significant.

None of the partial correlations independent of weight between visual grade and carcass characteristics are significant. Simple correlations between visual grade and carcass cannon circumference and fat thickness are highly significant.

The partial correlations independent of weight between live cannon lateral measurement and carcass cannon measurement (.22) is significant but lower than the simple correlation (.30).

Table 9. Partial correlations between live steer and carcass characteristics independent of live weight.

	Dressing %	Loin eye area	Carcass cannon Frontal	Carcass cannon Lateral	Carcass cannon Cir.	Fat thickness
Live cannon cir.		.18			.31**	
Cir. of forearm	.02	.12			.24**	-.14
Cannon frontal meas.			.32**			
Bone score	.27**	-.10	-.43**	-.13	-.33**	.22*
Visual grade	.08	.12			-.09	-.17
Cannon lateral meas.				.22*		

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

Simple correlations between live cannon circumference measurements and fat thickness and dressing percentage within each breed are listed in Table 10. Breed differences among these simple correlations exist; hence, individual within breed correlations were not pooled but are listed separately. Within the Shorthorn breed, the live cannon circumference measurement is correlated with dressing percentage (.47) and with fat thickness measurements (.51), both correlations being significant. Within the Angus and Hereford breeds, correlations between the live cannon circumference measurements and dressing percentage and fat thickness are not significant.

Table 10. Simple correlation between live cannon circumference and dressing percent and fat thickness within each breed.

	Live Cannon Circumference		
	Angus	Hereford	Shorthorn
Dressing %	.10	-.09	.47**
Fat Thickness	.05	.00	.51**

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

Partial correlations independent of live weight between live cannon circumference measurements and dressing percentages and fat thickness within each breed are presented in Table 11. Partial correlations within the Angus and Shorthorn breeds between live cannon circumference and either dressing percentage or thickness of fat are not significant. As previously stated, the simple correlations between these characteristics in the Shorthorn breed are highly significant. Surprisingly, the partial correlations (-.37) between live cannon circumference measurement and dressing percent is significant within the Hereford breed and the correlation (-.36) involving degrees of fat thickness approaches significance. Neither simple correlation is significant. The partial correlations indicate that among Hereford steers of similar weight those with larger live cannon circumferences tended to have lower dressing percentages and thinner fat covering.

Table 11. Partial correlations between live cannon circumference and dressing percent and fat thickness independent of weight within each breed.

	Live Cannon Circumference		
	Angus	Hereford	Shorthorn
Dressing %	-.01	-.37*	.13
Fat Thickness	-.11	-.36	.12

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

Correlations Between Carcass Characteristics. Simple correlations between carcass characteristics are presented in Table 12. Dressing percentage is significantly correlated (-.34) with carcass cannon circumference but is not significantly correlated with marbling score. The correlations between loin eye area and fat thickness (-.21) and carcass cannon circumference (.22) are highly significant. The steers with large loin eyes tended to carry less outside fat. Large cannon circumference tended to be associated with large loin eye area. Loin eye area was not significantly related with either dressing percentage or marbling. The correlation between fat thickness and dressing percentage (.44) is highly significant and indicates that highly finished steers tended to have high dressing percentages. No significant relationship existed between thickness of fat and the circumference of the carcass cannon. The significant correlation between fat thickness and marbling score (.17) indicates that deeper fat covering was slightly associated with higher marbling score.

Table 12. Simple correlations between carcass characteristics.

	Fat thickness	Dressing %	Carcass cannon cir.	Marbling score
Dressing %			-.34**	.02
Loin eye area	-.21**	.08	.22**	.03
Fat Thickness		.44**	-.03	.17*

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

Partial correlations between carcass characteristics independent of live weight are presented in Table 13. Holding weight constant increases the correlation between carcass cannon circumference and dressing percentage. The highly significant partial correlation between carcass cannon circumference and dressing percentage (-.57) indicates that large cannon circumference was associated with low dressing percentage. Dressing percentage is not significantly related with marbling score.

Holding the live weight constant increases the correlation between loin eye area and fat thickness, the partial correlation being (-.44) and the simple correlation being (-.21). Both correlations are highly significant. Steers 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 are non-significant. Thus, among cattle of similar weights, loin eye area was not significantly correlated with carcass cannon circumference whereas when differences in weight are not considered the simple correlation between loin eye area and carcass cannon circumference (.22) is highly significant.

Table 13. Partial correlations between carcass characteristics independent of live weight.

	Fat thickness	Dressing %	Carcass cannon cir.	Marbling score
Dressing %			-.57**	-.02
Loin eye area	-.44**	-.05	.11	.00
Fat thickness		.31**	-.27**	.14

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

Holding live weight constant decreases the correlation between fat thickness and dressing percentage, the partial correlation being (.31) and the simple correlation (.44). Fatter steers tended to have higher dressing percentages. The highly significant partial correlation between fat thickness and carcass cannon circumference (-.27) shows that among steers of similar weight the fatter individuals had slightly larger cannon circumferences. The simple correlation between fat thickness and carcass cannon circumference is not significant. Among steers of similar live weight, fatness and marbling score are not significantly related. The simple correlation between the two characteristics where a wide range in live weight existed is significant.

DISCUSSION

The fact that the steers in this research study were a select group in several respects must be taken into consideration in interpreting the results and arriving at conclusions. One must consider that this group of cattle were selected for entry into the carcass show and probably were more similar in type and degree of finish than an unselected group would be. Most of the steers fell into the choice and prime grades with only a few grading good. The steers were from various localities and were from highly different breeding programs. They were fed many various rations under many diversified full feeding programs.

Even though some correlations may show statistical significance, they may be of little value or use in selection on a practical basis. The relationships between characteristics may be quite different in this set of selected steers than they would be in an unselected set of steers.

Marbling is probably the largest single factor that is considered in carcass quality. The breeds differed significantly with the Angus and Shorthorn having a higher marbling score than the Herefords. Differences among weight groups within breeds for marbling score were not significant. Marbling scores were not significantly related with finish among steers of similar weight. Those analyses suggest that steers do not have to be heavy or have deep fat covering in order to have ample quality marbling.

The variation in size of loin eyes was quite pronounced and differed among weight groups. This was also true of fat thickness, dressing percentage, cannon frontal, and cannon circumference. Fat thickness would be expected to increase with weight since it stands to reason that the degree of outside finish would increase in a direct proportion with weight. Weight also affected dressing percentage with the heavier, higher finished steers possessing the higher dressing percentages. Both cannon frontal and circumference measurements increased significantly with weight. One would expect a greater amount of bone with the heavier cattle.

A large cannon circumference was found to be associated with a large forearm measurement even among steers of similar weight. This finding is in accord with McMeekan (1950) who suggested that shorter, thicker boned steers tended to be heavier muscled.

A negative simple correlation between circumference of forearm and visual grade indicates that large forearms tended to be associated with high visual grading steers. However, among steers of similar weight, the correlation was not statistically significant.

The majority of the simple correlations between live steer characteristics and carcass characteristics are significant. Live cannon circumference was positively correlated with loin eye area and carcass cannon circumference, revealing that larger boned animals tended to have larger loin eyes and greater circumference of cannon when weight was not held constant. This relationship should exist, since as the steer increases in size and weight there should be a decided increase in size of bone and amount of muscling. However, when weight was taken into consideration, the correlation between live cannon circumference and carcass cannon circumference (.31) was highly significant with weight held constant. Thus, a live cannon circumference measurement was an indicator of bone but not as good an indicator as expected. The live cannon frontal and lateral measurements were highly significantly correlated with their respective carcass cannon and frontal measurements. These correlations were also lower than expected but do indicate that live steer cannon measurements were slightly related with cannon bone measurements.

Bone scores were not significantly correlated with loin eye area or carcass cannon lateral measurement when weight was considered. However, bone score and dressing percentage were correlated (-.27) indicating that steers scored as being coarsed boned tended to have lower dressing percentages. Also, among steers of similar weights, those possessing higher bone scores tended to have less fat. This is in agreement with McMeekan (1950) who pointed out that the shorter and thicker the bone, the greater the depth or thickness of muscling lying over that bone. McMeekan stated that on an average, fine boned animals kill out with a smaller percentage of lean meat and a larger percentage of fat at the same weight than stronger, thicker boned individuals.

Even though simple correlations between visual grade and carcass characteristics were significant, none of the partial correlations independent of weight were significant.

The partial correlation between carcass cannon circumference and dressing percentage, (-.57), indicates that large boned steers dressed lower than light boned steers which is in agreement with McMeekan (1950) and Yao (1953). Carcass cannon circumference was not significantly correlated with loin eye area among steers of similar weight. The simple correlation between the two characteristics is highly significant (.22), but is a consequence of weight differences among the steers having both larger bone and larger loin eyes. The partial correlation between carcass cannon circumference and fat thickness, (.27), indicates that larger boned steers had less fat covering. Since a carcass is composed mainly of bone, muscle and fat, an increase in either bone or muscle should be accompanied by a decrease in fat.

Partial correlations between marbling score and dressing percentage, loin eye area, and fat thickness were not significant. Since marbling score was not significantly correlated with dressing percentage, the non-significant correlation between marbling score and fat thickness should be expected. A logical reason to expect loin eye area to be correlated with marbling score is not apparent.

Among steers of similar weights the correlation between dressing percentage and fat thickness, (.31), agrees with Black et al. (1938) and Lush (1932). Dressing percentage was not significantly correlated with loin eye area and there appears to be no logical reason why a significant correlation should exist.

Large loin eye area were associated with shallow fat thickness, the partial correlation being (-.44) as previously stated, an increase in amount of muscling should be accompanied by a decrease in fat covering among steers of similar weights.

SUMMARY

The animals used in this study consisted of 153 steers that comprised the carcass contest at the 1956 International Livestock Exposition at Chicago.

The steers ranged in weight from 800 to 1300 pounds and in age from 12 to 18 months.

Live body measurements were taken of the steers consisting of the forearm circumference, cannon circumference, and a lateral and frontal measurement of the cannon. A visual grade and bone estimation was taken of each individual.

Carcass measurements consisted of carcass cannon frontal, lateral, and circumference measurements. Breed, weight, age, dressing percentage, marbling scores, fat thickness, and loin eye area was also included in the data.

From this data analyses of variance and correlations were computed between live body measurements, between carcass characteristics, and between live and carcass characteristics.

Weight and breed were influencing factors that were considered when computing the results.

Differences among weight groups within breeds for marbling score were not significant. Marbling scores were not significantly related with finish among steers of similar weights. Suggesting that steers need not have a deep fat covering to have sufficient marbling.

The variation in size of the loin eye, fat thickness at 12th rib, dressing percentage, cannon frontal and cannon circumference differed among weight groups. A large cannon circumference was found to be associated with a large forearm measurement among steers of similar weight. This research suggests that shorter, thicker boned steers tended to be heavier muscled.

Steers possessing heavy bone had significantly lower dressing percentages than lighter boned steers. Fat thickness also showed a significant decrease as size of bone increased. Large loin eyes were significantly correlated with [illegible] in a negative manner. Thus, as muscling qualities increased fat thickness decreased.

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APPENDIX

Table 14. Live animal and carcass measurements and characteristics.

Tag No.	Breed	Bone score	Live wt.	Loin eye area	Fat thickness	Marbling score	Dressing %	Live Animal Cannon Frontal	Live Animal Cannon Lateral	Live Animal Cannon Cir.	Cir. of fore-arm	Carcass Cannon Frontal	Carcass Cannon Lateral	Carcass Cannon Cir.	Visual grade
822	A	05	1280	12.70	0.90	08	63.9	5.22	7.00	21.0	52.0	4.20	2.55	11.40	08
815	A	05	1250	16.22	1.07	09	65.5	5.50	6.70	21.0	53.0	4.32	2.58	11.40	04
915	A	06	1205	10.32	1.33	08	64.2	5.50	6.70	19.5	51.0	4.50	3.50	11.80	06
816	A	07	1195	10.75	1.27	09	63.4	4.72	6.25	19.0	47.0	4.00	2.40	10.70	06
806	A	06	1145	11.79	1.03	09	64.8	4.90	6.55	20.0	49.0	3.80	2.34	10.50	06
824	A	07	1140	11.92	1.77	09	68.0	5.40	6.30	19.5	51.0	3.60	2.30	09.90	04
803	A	06	1135	12.35	0.97	09	64.4	4.90	6.40	16.0	41.0	3.55	2.32	09.60	08
963	A	04	1135	12.40	0.40	09	64.0	4.90	6.60	19.0	53.0	4.50	2.65	11.60	08
807	A	05	1135	11.10	1.40	09	63.5	5.02	6.63	19.5	47.0	4.00	2.40	11.00	02
825	A	07	1130	11.89	1.23	09	65.5	5.25	6.70	20.0	46.0	3.89	2.42	10.40	06
812	A	09	1125	11.75	1.07	09	63.5	4.95	6.35	16.0	45.0	4.25	2.50	11.40	06
801	A	09	1125	11.50	1.53	10	65.8	5.00	6.40	20.0	46.0	3.90	2.32	10.50	04
802	A	08	1125	13.53	1.10	10	61.9	5.23	6.73	20.5	48.0	4.20	2.40	11.00	02
831	A	06	1120	11.19	1.43	09	66.6	5.35	6.35	20.0	50.0	4.10	2.40	10.80	08
909	A	08	1115	10.55	0.97	09	64.9	5.20	6.40	19.0	46.0	4.00	2.30	10.50	06
908	A	05	1115	11.87	1.07	07	64.9	5.05	6.35	19.0	48.0	4.00	2.40	10.80	06
918	A	07	1115	12.01	1.20	09	63.4	5.25	6.60	20.0	47.0	4.10	2.40	10.80	04
820	A	09	1115	11.54	1.27	09	65.9	4.75	6.00	18.0	42.0	4.00	2.40	10.60	06
904	A	04	1115	12.38	0.90	07	66.5	5.05	6.35	19.5	51.0	4.12	2.43	11.00	04
919	A	09	1110	12.15	0.93	09	65.7	4.80	6.30	18.5	50.0	3.73	2.51	10.35	08
819	A	07	1110	12.45	1.40	09	65.4	5.05	6.50	19.0	45.0	3.80	2.20	10.40	06
906	A	06	1110	11.04	1.13	08	63.3	5.20	6.90	20.0	49.0	4.12	2.42	10.90	08
923	A	07	1105	12.59	0.90	10	68.1	4.80	6.25	18.5	48.0	3.94	2.29	10.60	08
833	A	08	1105	12.32	0.90	10	65.3	4.90	6.50	19.0	48.0	3.76	2.41	10.30	06
941	A	08	1105	12.98	0.97	08	66.6	5.35	6.40	19.5	52.0	4.20	2.50	11.20	08
813	A	08	1100	15.10	1.00	09	68.6	5.15	6.08	18.0	48.0	4.00	2.42	10.60	04
805	A	05	1085	13.43	0.93	09	63.6	5.20	6.70	19.5	48.5	3.90	2.50	10.70	04
914	A	06	1085	11.78	1.13	07	65.9	5.50	6.65	20.0	51.0	3.98	2.40	10.70	10

Table 14. (Cont')

Tag No.	Breed	Bone score	Live wt.	Loin eye area	Fat thickness	Marbling score	Dressing %	Live animal Cannon Frontal	Live animal Cannon Lateral	Live animal Cannon Cir.	Cir. of forearm	Carcass Cannon Frontal	Carcass Cannon Lateral	Carcass Cannon Cir.	Visual grade
837	A	06	1085	12.62	1.07	08	62.5	4.90	6.45	21.0	51.0	3.89	2.31	10.40	08
811	A	05	1075	10.85	1.13	08	63.3	5.58	6.40	18.0	50.0	4.10	2.40	10.70	02
907	A	07	1075	12.01	0.87	07	64.5	5.00	6.70	19.0	49.0	3.80	2.20	10.40	08
943	A	04	1075	11.10	1.37	09	62.8	5.25	6.20	19.5	46.5	4.42	2.52	11.85	06
804	A	06	1065	12.86	1.23	09	62.8	5.15	6.59	18.0	46.0	4.11	2.49	10.70	04
917	A	07	1065	11.75	0.93	09	64.8	4.60	6.45	19.0	48.0	3.60	2.28	09.68	08
828	A	09	1055	10.25	1.73	10	67.7	4.75	6.40	18.5	44.5	3.66	2.28	10.20	10
818	A	07	1050	13.85	1.03	10	65.1	5.90	6.55	19.5	49.0	4.38	2.68	11.50	04
814	A	07	1050	12.45	1.03	09	65.0	4.95	6.58	16.5	48.0	3.98	2.49	10.60	06
942	A	07	1050	11.58	0.93	09	65.6	5.00	6.55	19.5	45.0	4.20	2.51	11.21	08
901	A	08	1040	09.57	1.23	08	65.9	4.92	6.65	20.0	42.0	3.80	2.45	10.40	04
823	A	09	1035	11.94	1.20	08	65.4	5.00	6.30	18.5	46.0	4.10	2.30	10.80	06
810	A	11	1035	09.84	1.27	09	63.9	4.90	6.55	16.0	42.0	3.80	2.31	10.00	04
821	A	06	1030	12.39	0.93	06	64.7	5.00	6.65	19.0	47.0	4.05	2.40	10.80	08
939	A	09	1030	09.85	1.03	09	63.6	5.20	6.40	19.0	51.0	4.05	2.40	10.60	06
826	A	05	1025	09.81	1.00	10	60.5	4.92	6.50	19.0	45.0	3.80	2.55	10.50	08
979	A	08	1025	12.01	0.93	08	63.1	4.80	6.60	19.0	52.0	3.90	2.30	10.40	04
980	A	07	1010	10.03	1.10	08	64.6	5.30	6.60	20.0	51.0	3.98	3.45	11.60	06
827	A	08	1010	12.00	0.90	09	64.6	4.90	6.05	19.5	47.0	3.89	2.13	10.00	06
817	A	07	1005	12.35	0.80	07	62.5	4.75	6.10	18.5	41.5	3.85	2.26	10.10	10
922	A	09	1000	10.28	1.20	09	64.0	4.70	6.20	18.5	46.0	3.99	2.27	10.50	12
839	A	09	1000	11.65	1.03	09	64.2	5.60	6.20	18.5	49.0	4.12	2.50	11.00	06
928	A	05	1000	12.50	0.90	09	62.9	5.30	6.65	20.0	50.0	3.78	2.35	10.15	06
829	A	11	0990	09.57	1.33	09	65.8	4.70	6.30	18.0	41.0	4.41	2.48	11.30	10
913	A	07	0990	12.10	0.97	09	62.3	4.60	5.80	19.0	48.0	3.60	2.28	09.68	10
910	A	07	0985	12.89	0.73	10	64.4	4.75	6.40	19.0	44.0	3.60	2.30	09.90	10
830	A	07	0980	11.28	1.07	08	64.1	4.85	6.30	18.5	44.0	3.98	2.40	10.70	10
911	A	06	0980	12.34	1.17	09	67.0	5.40	6.30	21.0	49.0	3.85	2.35	10.60	10
835	A	08	0970	13.73	0.50	09	65.0	4.90	6.70	19.5	50.0	4.00	2.50	11.00	08
912	A	07	0965	11.81	0.97	10	64.1	5.40	6.60	19.0	44.0	3.70	2.20	10.00	12
836	A	08	0965	11.90	0.57	09	64.8	4.90	6.60	20.0	48.0	3.99	2.50	10.60	20
838	A	07	0950	10.25	0.67	10	64.7	4.50	6.10	18.5	48.0	3.64	2.23	09.75	08

Table 14. (Cont')

Tag No.	Breed	Bone score	Live wt.	Loin eye area	Fat thickness	Marbling score	Dressing %	Live animal Cannon Frontal	Live animal Cannon Lateral	Live animal Cir.	Cir. of fore-arm	Carcass Cannon Frontal	Carcass Cannon Lateral	Carcass Cir.	Visual grade
924	A	10	0950	10.85	1.00	08	64.1	4.85	6.15	18.5	45.5	3.95	2.28	10.50	10
903	A	08	0945	11.46	1.13	10	66.2	4.65	6.00	17.5	41.0	3.80	2.25	10.00	08
931	A	10	0920	12.84	0.80	09	64.3	4.80	6.05	17.5	46.0	3.85	2.25	10.20	06
916	A	07	0915	12.50	0.63	10	66.2	5.05	6.40	19.0	43.0	4.05	2.25	10.50	12
927	A	07	0905	10.95	0.73	08	62.9	5.00	6.70	20.0	54.0	4.15	2.40	11.00	08
893	A	07	0900	11.11	1.03	08	63.8	4.80	6.20	18.5	40.6	3.70	2.50	10.18	06
929	A	06	0900	09.99	1.07	09	63.9	5.50	6.20	18.5	45.0	4.20	2.50	11.20	06
930	A	07	0900	12.95	0.67	07	63.9	4.95	6.10	18.5	45.0	3.90	2.40	11.00	10
899	A	09	0900	09.35	1.17	10	65.7	4.60	6.10	18.0	52.0	3.90	2.21	10.40	06
926	A	07	0880	12.91	0.40	08	63.7	4.85	6.25	18.5	41.0	4.15	2.40	11.00	12
925	A	07	0845	09.47	1.13	10	63.9	4.50	5.60	16.5	45.0	4.00	2.23	10.40	12
938	A	12	0845	10.16	0.70	09	62.7	4.20	6.00	17.0	44.0	3.40	2.40	09.50	12
965	A	08	0830	10.61	1.03	08	60.0	4.60	6.00	17.0	48.0	3.93	2.60	10.54	10
856	A	08	0800	11.21	0.70	09	64.0	4.80	5.90	18.0	44.0	3.89	2.34	10.40	08
857	H	04	1300	12.25	1.23	07	64.2	5.80	6.80	22.0	49.0	4.42	2.52	11.90	06
845	H	04	1290	12.11	1.27	08	64.3	5.85	7.20	21.5	52.0	4.60	2.50	11.90	04
872	H	05	1240	13.25	0.93	10	65.9	5.80	7.10	22.0	49.0	4.60	2.60	11.80	02
935	H	07	1175	11.35	1.30	08	64.4	5.55	6.35	20.0	52.5	4.25	2.65	11.35	04
855	H	05	1170	11.46	1.33	08	65.9	5.25	6.70	20.5	48.0	4.08	2.45	10.80	04
858	H	05	1160	11.55	0.73	08	61.4	5.60	7.05	21.0	45.0	4.21	2.50	11.00	06
866	H	04	1150	13.00	1.13	08	65.3	5.40	6.30	22.0	50.0	4.35	2.50	11.40	04
861	H	05	1140	11.25	0.87	09	65.7	5.30	6.60	21.0	52.0	4.30	2.60	11.30	04
869	H	05	1135	11.21	1.53	08	65.6	5.60	6.85	20.5	45.0	4.35	2.50	11.50	02
847	H	05	1130	12.98	0.97	08	63.9	5.60	6.80	20.0	47.0	4.41	2.49	11.40	04
947	H	04	1120	11.86	1.13	08	63.5	5.90	7.10	22.0	54.0	4.60	2.60	11.80	04
859	H	08	1110	12.60	0.77	08	66.7	5.20	6.80	19.5	49.0	4.21	2.50	11.00	04
840	H	08	1090	12.00	1.33	07	64.1	5.40	6.70	20.5	54.0	3.81	2.40	10.50	06
851	H	05	1090	10.36	0.87	08	64.6	5.30	6.50	20.5	52.0	4.26	2.61	11.51	04
968	H	03	1090	10.59	1.57	08	63.9	5.70	6.60	21.0	49.0	4.30	2.30	11.00	06

Table 14 (Cont'.)

Tag No.	Breed	Bone score	Live wt.	Loin eye area	Fat thickness	Marbling score	Dressing %	Live animal Cannon Frontal	Live animal Cannon Lateral	Live animal Cannon Cir.	Cir. of fore-arm	Carcass Cannon Frontal	Carcass Cannon Lateral	Carcass Cannon Cir.	Visual grade
934	H	05	1090	13.51	0.83	08	63.3	6.00	7.15	21.5	49.0	4.25	2.62	12.10	06
841	H	06	1080	12.37	0.83	08	64.2	5.40	7.20	20.5	50.0	4.40	2.60	11.50	12
852	H	08	1080	13.25	0.63	08	64.4	5.35	6.65	20.0	52.0	4.21	2.58	11.35	06
953	H	11	1070	12.40	1.20	10	65.9	5.00	6.40	18.5	48.0	3.90	2.43	10.40	04
870	H	07	1060	09.99	1.03	09	64.2	5.40	6.80	20.5	48.0	4.40	2.50	11.50	02
952	H	03	1060	14.00	1.10	09	62.6	5.90	7.00	22.0	45.0	4.40	2.40	11.50	04
842	H	07	1045	10.55	0.77	08	62.3	5.30	7.00	20.5	49.0	4.28	2.41	11.00	04
844	H	05	1045	10.83	1.03	09	63.4	5.30	6.80	20.5	52.0	3.80	2.30	10.20	06
945	H	03	1045	11.65	1.10	09	64.0	5.40	7.10	21.0	50.0	4.10	2.40	10.90	04
843	H	05	1025	11.55	1.00	08	66.1	5.40	6.90	21.0	50.0	4.20	2.50	11.00	06
850	H	05	1025	12.75	0.83	08	62.5	5.80	7.00	22.0	49.0	4.25	2.60	11.50	06
967	H	05	1020	11.59	0.73	07	64.4	5.40	6.90	21.0	51.0	4.15	2.47	11.00	08
932	H	11	1000	11.31	1.10	09	66.7	5.20	6.30	19.0	48.0	3.30	2.30	09.40	06
848	H	06	0980	13.00	0.60	09	61.8	5.50	6.80	25.0	50.0	4.25	2.50	11.20	04
944	H	05	0975	10.04	1.13	07	62.8	5.30	6.70	21.0	49.0	4.30	2.60	11.30	04
951	H	04	0970	10.80	0.60	08	60.4	5.80	7.00	21.5	50.0	4.05	2.45	10.60	06
961	H	04	0970	11.55	0.80	07	62.9	5.40	5.60	22.0	53.0	4.50	2.60	11.50	06
879	H	05	0960	12.38	0.70	06	64.5	5.20	6.90	21.0	51.0	4.18	2.60	11.20	06
853	H	07	0955	11.29	0.90	08	64.5	5.70	6.50	20.5	50.0	4.30	2.40	11.50	06
863	H	07	0955	10.45	1.10	09	63.1	4.85	6.40	19.0	45.0	3.89	2.40	10.40	06
864	H	08	0950	10.49	0.87	07	61.4	5.60	6.20	19.0	43.0	3.80	2.40	10.80	12
881	H	04	0940	11.75	0.67	08	61.9	5.40	6.80	20.0	48.0	4.45	2.45	11.50	08
940	H	08	0915	13.55	0.67	07	62.7	5.00	6.40	19.0	45.0	4.06	2.46	10.90	06
862	H	09	0900	09.60	1.03	08	63.0	5.05	6.80	18.5	48.0	3.90	2.45	10.65	08
860	H	08	0890	09.59	0.93	09	62.3	5.00	6.75	19.0	45.0	4.20	2.50	11.20	08
865	H	06	0865	12.65	0.60	07	64.5	5.40	6.70	20.0	46.0	4.10	2.50	11.00	06
871	H	08	0860	09.55	0.73	08	62.6	4.90	6.60	19.0	48.0	4.40	2.50	11.50	10
854	H	06	0855	10.46	0.47	08	58.2	5.20	6.85	20.0	49.0	3.90	2.30	10.50	06
969	S	04	1280	12.45	1.50	09	66.3	5.40	7.10	21.0	51.0	4.30	2.50	11.30	04
970	S	06	1230	12.60	1.17	10	64.4	5.80	6.60	21.0	52.0	4.30	2.55	11.60	04
877	S	05	1175	10.65	1.13	10	66.9	4.90	6.50	19.5	49.0	4.00	2.58	10.70	02

Table 14 (Concl.)

Tag No.	Breed	Bone score	Live wt.	Loin eye area	Fat thick-ness	Marb-ling score	Dressing %	Live animal Cannon Frontal	Live animal Cannon Lateral	Live animal Cannon Cir.	Cir. of fore-arm	Carcass Cannon Frontal	Carcass Cannon Lateral	Carcass Cannon Cir.	Visual grade
886	S	07	1165	09.64	1.67	08	65.7	5.00	6.40	20.0	47.0	3.90	2.48	10.44	04
950	S	03	1160	10.55	1.00	09	65.1	4.80	7.30	19.5	50.5	4.40	2.50	11.60	02
880	S	09	1145	11.30	1.07	08	64.0	5.00	6.30	18.5	45.0	3.94	2.50	10.55	06
884	S	06	1140	11.65	1.33	08	65.4	5.20	6.20	19.0	51.0	3.89	2.31	10.30	06
868	S	06	1140	08.95	1.33	08	66.0	5.00	6.40	19.0	44.5	3.98	2.49	10.70	04
846	S	08	1130	10.15	1.13	09	62.6	5.00	6.40	20.0	45.0	3.85	2.50	10.50	06
888	S	07	1125	12.40	1.23	10	62.0	5.30	6.60	19.5	44.0	4.20	2.60	11.10	04
887	S	07	1120	10.20	1.70	08	67.9	4.90	6.50	20.0	52.0	3.90	2.45	10.45	04
954	S	09	1110	12.60	1.20	08	65.0	5.20	6.40	18.0	46.0	3.80	2.60	10.60	06
874	S	07	1100	10.00	1.57	10	65.3	5.60	6.70	18.5	47.0	3.78	2.43	10.30	04
971	S	05	1095	10.25	0.77	10	64.3	4.90	6.20	18.5	49.0	3.91	2.39	10.60	04
889	S	05	1085	11.50	1.07	10	64.0	5.30	6.80	20.0	47.0	4.30	2.40	11.30	06
972	S	06	1080	11.30	1.03	10	63.9	5.10	6.60	19.0	49.0	4.00	2.40	10.60	06
890	S	05	1075	09.50	1.23	10	63.5	5.20	6.50	19.0	45.0	4.20	2.50	11.20	04
960	S	09	1070	08.92	1.80	10	66.8	4.90	6.20	21.0	52.0	3.92	2.49	10.35	06
832	S	08	1060	10.66	1.00	07	62.6	4.65	6.15	18.5	43.0	3.72	2.46	10.50	06
883	S	06	1050	11.10	1.13	09	65.1	4.80	5.90	19.0	49.0	3.85	2.25	10.00	04
955	S	07	1030	10.25	0.97	09	65.1	5.10	6.30	19.0	47.0	4.16	2.38	10.90	06
933	S	06	1025	09.30	0.63	08	64.8	5.30	6.60	20.5	45.0	4.00	2.65	11.00	06
962	S	06	1020	09.70	1.10	08	63.3	4.80	6.10	19.0	47.0	3.80	2.55	10.85	06
867	S	05	1020	09.80	0.83	08	63.7	5.15	6.80	20.0	45.5	4.25	2.75	11.40	06
885	S	05	1000	09.00	1.29	09	66.0	5.20	6.10	19.0	48.0	4.00	2.40	10.50	04
949	S	08	0990	11.49	0.97	08	63.9	4.90	6.30	18.5	51.0	3.89	2.14	10.02	06
957	S	09	0990	09.20	1.00	09	64.3	4.60	6.50	18.0	45.0	3.50	2.50	10.00	06
876	S	07	0965	09.50	0.90	08	62.6	5.10	6.10	18.5	41.0	3.80	2.40	10.30	06
882	S	07	0955	10.45	0.97	09	65.8	4.90	6.20	19.0	47.0	3.55	2.41	10.00	06
956	S	07	0955	10.85	0.93	10	65.1	4.50	6.25	17.5	48.5	3.55	2.35	09.90	08
878	S	08	0955	09.45	1.17	10	64.5	4.80	6.30	18.0	42.0	3.70	2.50	10.20	06
959	S	12	0890	09.90	0.57	09	61.4	4.50	6.00	17.0	43.0	3.60	2.50	10.30	08
875	S	09	0880	09.05	0.83	08	63.5	5.00	5.80	17.5	44.0	3.50	2.50	10.00	08
948	S	07	0880	09.50	1.00	08	62.0	5.32	6.41	18.0	47.0	3.35	2.25	09.10	06
891	S	07	0865	11.02	0.50	08	61.5	4.70	6.20	18.0	45.0	3.73	2.29	10.10	10
958	S	07	0815	08.95	0.57	08	59.9	4.45	6.20	18.0	43.0	3.60	2.35	09.90	06

RELATIONSHIPS AMONG LIVE AND CARCASS CHARACTERISTICS OF SLAUGHTER STEERS

by

DOUGLAS JOHN WESELI

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AN ABSTRACT OF A THESIS

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One of the major problems in measuring merit in beef cattle has been to devise an on foot evaluation that would be useful in determining the amount of muscle in the beef carcass and the quality of the meat. At present, slaughter grade and yield are used to evaluate the animal on foot, but these factors are subject to human error and do not indicate the area of eye muscle, the amount of outside fat and the proportion of edible meat in the carcass.

There has been only a limited amount of research done in this field and the results have varied in many respects.

In conducting this experiment, 153 steers were subjected to live body measurements and carcass evaluations. Measurements of the cannon and forearm were taken of the live steer and carcass data contained information such as the loin eye area, dressing percentage, fat thickness over the 12th rib, amount of marbling and measurements of the carcass cannon. From this data analyses of variance and correlations were computed among live body measurements, carcass characteristics and between live and carcass characteristics.

Differences among weight groups within breeds were not significant for marbling score. Marbling scores were not significantly related with finish among steers of similar weights. Thus steers need not have a deep fat covering to have sufficient marbling.

The variation in size of the loin eye, fat thickness over the 12th rib, dressing percentage, cannon frontal and cannon circumference differed among weight groups. A large cannon circumference was found to be associated with a large forearm measurement among steers of similar weight. This research suggests that shorter, thicker boned steers tended to be heavier muscled.

As expected, steers possessing heavy bone had lower dressing percentages than finer or lighter boned steers. Fat thickness over the 12th rib tended to decrease in depth as size of bone increased. Loin eye area and fat thickness presented an inverse relationship.