CORRELATION OF LIVE ANIMAL MEASUREMENTS TO CARCASS CHARACTERISTICS

by

RICHARD MILES MCKEE

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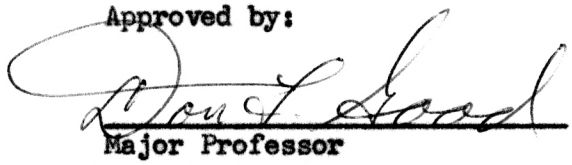
Approved by:



Major Professor

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INTRODUCTION

A term used quite freely by those involved in the production, fattening, and merchandizing of beef cattle is "meat type animal". The terms intended use is to distinguish between the animal that produces a carcass with a high percentage of red meat and the animal that produces a carcass with a larger proportion of fat trim.

At present, individuals retained for breeding herds are evaluated by visual appraisal for general beef type and performance records.

Feeder cattle grades are based on type, quality, and conformation as well as the apparent ability to make large gains economically.

Slaughter cattle are graded on the basis of type, conformation, finish, and quality. In addition, dressing percent or yield is estimated to help determine live value.

Until recently, the carcass was graded on finish, quality, and conformation, with little regard to the ratio of muscle to fat and bone. The dual grading system is an attempt to penalize those carcasses that have more than the necessary amount of fat, and should credit meaty carcasses with high cutability. The above mentioned systems of evaluation are used to better determine cattle that represent the more valuable meat type animal.

We know from repeated observations that cattle of the same weight, age, finish, and general conformation will hang carcasses that vary greatly in percentages of muscle and fat. Since we seek a heavy muscled carcass with high quality and a minimum of fat, our problem involves the production of greater numbers of cattle that will yield heavily muscled, correctly finished carcasses. We know such cattle exist in the various breeds, but are of limited numbers. These are true meat type animals and need to be identified

for beef cattle improvement.

In order to progress genetically, we must be able to distinguish between the desired and undesireable traits in cattle at all stages of production. We must be equipped to make a visual and, or, some objective appraisal of slaughter cattle and differentiate between those that will hang meaty carcasses and those that yield less meaty carcasses. It is most important that we start at the very beginning of the breeding program and identify those animals that have the traits we seek. Then, using a well planned breeding program and sound management, we can better produce the meat type animal.

This study involved the use of slaughter steers in an attempt to accurately identify those features in the live animal that portend a meaty high quality carcass. Once we achieve this, we can use this information as a tool in the production of improved beef cattle.

REVIEW OF LITERATURE

Dahl (1959) working with 253 steers exhibited in the carcass steer show at the 1957 International Livestock Exposition in Chicago, took live animal measurements and made visual appraisal scores of each steer. These scores and measurements were analyzed with certain carcass characterisitcs. Live animal measures consisted of width between the eyes, width of muzzle, circumference of cannon, and circumference of round. Muscling scores by visual appraisal were made on the live animals. Carcass measurements included fat thickness at the 12th rib, rib eye area, marbling score, dressing percentage, and live weight. Data from all breeds was pooled for analysis.

Correlations of live weight to all live animal and carcass measures except muscling score and marbling score were significant at the .01 level. Muscling score was significantly correlated to live weight at the .05 level.

Dahl (1959) found that the simple correlations (without regard to weight) for the live steer characteristics to each other were all of an absolute magnitude with the exception of muscling score to width of muzzle and to circumference of cannon. The steers scored as being heavier muscled tended to have narrower muzzles (-.126), but were significantly larger in round circumference (.184). Steers that were wider between the eyes were also wider in the muzzle (.456) and larger in circumference of both cannon (.511) and round (.473). The steers that were wider muzzled had larger circumferences of cannon (.484) and round (.387) and the larger cannons were highly significantly correlated with larger round circumference (.624).

Dahl (1959) also ran partial correlations (independent of weight) for the live animal characteristics. With weight held constant, the muscling score was still negatively correlated with width of muzzle (-.189). Steers that were wider between the eyes were wider muzzled (.328) and larger in circumference of cannon (.302). A highly significant correlation was found for circumference of round and circumference of cannon (.395). The wider muzzled steers had more circumference of cannon (.363) and a larger circumference of round (.189). It was noted that when weight was held constant, there was a decrease in the correlations although in the majority of cases the correlations were still significant.

Simple correlations for area of loin eye and width between the eyes (.230), muzzle width (.177), circumference of cannon (.214), and circumference of round (.375) were all highly significant as reported by Dahl (1959). The steers with larger loin eyes also tended to have higher muscle scores. Muscle score (.325) and circumference of round (.175) were highly significantly correlated to dressing percent. Width of muzzle was negatively correlated with

dressing percent indicating that the narrow muzzled steers dressed higher. Marbling score was negatively correlated to circumference of cannon.

When Dahl (1959) applied partial correlations to the live animal and carcass characteristics, he found that dressing percent was positively correlated to muscle score, but negatively correlated to width between the eyes, muzzle width, and circumference of cannon. This indicates that the wide broad headed steers standing on more bone will dress lower. Marbling score was negatively correlated with muzzle width, circumference of cannon, and circumference of round. Area of loin was significantly correlated with circumference of round while fat cover was negatively correlated with all live animal measures except muscle score.

Simple correlations between carcass characteristics as presented by Dahl (1959) show that dressing percent is highly significantly correlated to marbling score (.227), area of loin (.298), and fat cover (.352). Marbling score is highly significantly correlated with fat cover (.254). Partial correlations, independent of live weight, held the same highly significant correlations as found in the simple correlations. However, when weight was held constant, area of loin eye was negatively correlated to fat cover (-.190).

Weseli (1957) worked the International Livestock Exposition carcass steers in 1956 using live animal measures, visual appraisal, and carcass measures. The live steer measures were circumference of forearm, circumference of cannon, and frontal and lateral measure of cannon. Visual appraisal was for bone size and slaughter grade. At slaughter, the left metacarpus was salvaged and after removal of all extraneous material, it was measured for circumference. A frontal and lateral measurement were also taken. Loin eye area, fat thickness, and marbling score were determined from the carcass

hanging in the cooler. The analysis was run on these steers after dividing them by weight and breed. Both simple and partial correlations were used as was done by Dahl (1959).

In comparing breeds, Weseli (1957) found that there was a significant difference in live animal measures for cannon frontal and cannon circumference with Herefords having the largest. The carcasses differed significantly between breeds only for marbling score with Angus and Shorthorn being more highly marbled. When breeds were subdivided by weight, the differences 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. Carcass characteristics within breeds and among weight groups differed highly significantly for loin eye area, fat thickness, dressing percentage, cannon frontal, and cannon circumference measurements.

Using simple correlations, Weseli (1957) found the greater the live cannon circumference the lower was the visual grade (-.27). A heavy visual bone score was highly significantly negatively correlated with circumference of forearm (-.38). Circumference of forearm to live cannon circumference had a positive correlation of .42. When weight was held constant, the only highly significant correlations for live steer characteristics were circumference of forearm to live bone score (-.28) and circumference of forearm to live cannon circumference (.30).

Weseli's analysis between live steer and carcass characteristics revealed with simple correlations that live cannon circumference and circumference of forearm are positively correlated with loin eye area. These correlations were .30 and .22 respectively. All live bone measurements and visual bone appraisals were significantly correlated to the measurements of the cleaned metacarpus.

Visual slaughter grade was the only measure significantly correlated to fat thickness. The partial correlations between live steer and carcass characteristics revealed that most live bone measurements were highly significantly correlated to the carcass bone measures. Bone score was highly correlated to dressing percent and fat thickness at the 12th rib.

Simple correlations between carcass characteristics in Weseli's (1957) work showed highly significant negative relationships between loin eye area and fat thickness at the 12th rib (-.21) indicating the larger the loin eye area the less the fat cover. Carcass cannon circumference and dressing percent had a negative correlation of -.34. The larger boned animals had a lower dressing percent in this study.

Positive simple correlations significant at the .01 level were found in this study for the relationship between loin eye area and carcass cannon circumference (.22) and between fat thickness at the 12th rib and dressing percent (.44). Fat thickness was positively correlated to marbling score. When weight was held constant, the fatter steers had higher dressing percents and the larger carcass cannon circumference meant lower dressing percent and less fat.

Good et al (1961) pooled the results of Dahl (1959) and Weseli (1957) with measurements taken from the carcass contest at the 1958 International. Good reported that the steers scored as being more heavily muscled dressed higher and had larger loin eyes. Those steers that were wider between the eyes were also wider muzzled and had a larger circumference of both round and cannon. However, they had a lower dressing percent and less fat at the 12th rib. Width of muzzle showed correlations similar to those for width between the eyes with the exception that it was more highly correlated to cannon circumference. Good et al (1961) found that the larger the circumference of round

the larger were live cannon circumference and area of loin eye and the lower were marbling score and fat cover over the 12th rib. Circumference of cannon was positively correlated to area of loin eye muscle but significantly negatively correlated with dressing percent, marbling score, and fat cover. Good et al (1961) also found that a larger loin eye is associated with less fat at the 12th rib and that the heavier muscled cattle have less fat cover. All of the above analyses are partial correlations as used by Dahl (1959) and Weseli (1957).

A study of heritability was made by Dawson et al (1955) using performance records and body measurements from 58 Milking Shorthorn steers. All steers were slaughtered at approximately 900 pounds. Estimates of weight heritability obtained from the work were: birth weight, 50.6 percent; days to weaning at 500 pounds live weight, 45.1 percent; and days to final weight, 56.6 percent. The estimates for the three beef characters were: slaughter grade, 58.3 percent; carcass grade, 66.7 percent; and dressing percentage, 69.1 percent.

Height measure heritability ranged from 65.5 percent to 4.6 percent with height at withers the highest and height at flank the lowest in heritability. Width measures were quite low in heritability. Head measurements had high heritability with width between the eyes at 63.1 percent and width of muzzle at 50.0 percent. Circumference of foreflank had a heritability of 32.3 percent and shin bone 33.5 percent. Dawson et al (1955) classified the heritability percentages in the following manner: 40-70 percent, high; 20-40 percent, medium; and 0-20 percent, low.

A study of heritability estimates for scores at weaning, slaughter grade, dressing percent, and area of eye muscle was done by Knapp and Nordskob (1946) using 177 steers sired by 23 bulls. For the within sire groups, score at wean-

ing and weaning weight were correlated at .68. Final feed lot weight was correlated with slaughter grade at .64, with carcass grade at .54, and with area of eye muscle at .14. Hence, final weight is indicative of slaughter and carcass grade, but carries no indication for area of eye muscle. The observed differences between sire groups were significant for weaning score, slaughter grade, carcass grade, and area of eye muscle. Knapp and Nordskob (1946) found in their work that variations in the area of eye muscle were 69 percent heritable.

Brown et al (1953) reported on the classification of all animals in the Arkansas Agriculture Experiment Station beef herds from 1940 through 1950. The visual appraisal work was done by 25 men. The cattle were scored at two different times in the year in an attempt to evaluate them when they were in average summering condition and average wintering condition. Repeatability on scores were generally between .4 and .6 with the biggest variation in components of the total score rather than the total score.

Ternan et al (1959) worked with 98 steers over a two year period. Five feeder grades were covered by the yearling steers. A single visual feeder grade was found to be as useful a guide for feeder quality as was a detailed scoring system with points alloted for certain characteristics. Repeatability of scores from beginning of the feeding period to the end of fattening ranged from .50 to .76 with the exception of a score for feet and legs which was insignificant. Heart girth appears to be a more suitable measure of size than body weight for studies of growth and form.

A study involving the scoring of cattle at varying periods by different judges was conducted by Knapp et al (1939). He concluded that when animals were very similar, scoring by visual appraisal was subject to considerable

error and probably of little value. On the other hand, if there was a big difference in the quality of the animals being scored, visual scoring is undoubtedly the easiest way to evaluate differences in conformation.

A study using 31 yearling steers was made by Orme et al (1959a) to test the repeatability of live animal measures. The measurements were taken by three individuals and each man took two or more measures. Repeatability was either highly significant or significant for all measures except spring of rib, width of pins, and length from 13th rib to hooks. Best repeatability was for height (withers, rump, and legs), circumference (fore and hind flanks and middle), and width (round, rump, and shoulder).

Correlation coefficients were calculated for the live animal measure and the corresponding carcass measure or that area of the carcass that seemed most appropriate. All of these correlations were highly correlated to their similar carcass measurements than were the subjective live animal scores. This would indicate that in this study, measuring width was more accurate than visual appraisal of the same.

A study was made by Smith et al (1950) on the repeatability of certain methods of measuring beef cattle. Live animal and photographic measurements were used on 43 head including 10 cows, 23 yearlings, and 10 calves. High estimates of repeatability for live animal measures were found for length of body, variations .546 to .898; height of withers ranged from .888 to .906; depth of chest ranges from .784 to .914. The estimates for the photographic method were .726 to .844 for length of body, .908 to .927 for height of withers, and .807 to .908 for depth of chest. Repeatability for the round measurement (patella to patella) was lower with a range of .463 to .769.

Tallis et al (1959) took body measurements in duplicate on 8 Hereford

steers. The components of variance due to steers, investigators, steer and investigator interaction, and measurement error were estimated and compared. Those measurements with the lowest investigator interaction and error components and the highest steer components were width of chest, depth of chest, heart girth, length of body, circumference of navel, and height at hooks and withers.

Following the work on the 8 Hereford steers, Tallis et al (1959) did further studies on both steers and heifers. Calves produced from different lines of breeding showed a significant difference in circumference of navel, height at hooks, height at withers, and body length when the weight was held constant. Ratios of weight to both height and length were calculated and correlated to dressing percent, area of loin eye, and edible portion. A negative correlation for the two ratios was found when correlating to edible portion, but a positive correlation to rib eye area. Steers showed a positive correlation for the ratios and dressing percent, while heifers showed a negative correlation.

White et al (1952) working on 50 steers found that the rough loin and various segments (trimmed loin, short loin, and sirloin butt) correlated to essentially the same degree with live weight, slaughter grade, and linear and width measurements. Hence, even though the total loin or its break down represent anatomical differences, all could be used interchangeably in analysis with approximately the same results.

In a continuation of the work of White et al (1952), Green (1954) divided the carcasses into preferred cuts I (round, trimmed loin, and rib) and preferred cuts II (round, trimmed loin, rib, and cross cut). Using partial correlations, width of shoulders and depth of twist were highly correlated to preferred cuts I. Those two measures plus width of hooks were highly corre-

lated to preferred cuts II. Width of shoulders is a positive indication of dressing percent important in predicting weight of the cross cut and reasonably well correlated with depth of twist, width of crops, width of thighs, live weight, heart girth, and very highly associated with width of hooks. Excepting live weight and heart girth, these are all direct or indirect measures of muscling.

Thirty Hereford steers and 53 Hereford heifers were measured by Boughton (1958) and then the carcass data analyzed. Prior to slaughter, the cattle were visually appraised by a committee for bone size, degree of muscling, and slaughter grade. In general, heifers had higher correlations between live animal measurements than did the steers.

Among steers, live grade was significantly correlated to muscling score and in both steers and heifers, muscling appraisal was correlated to the area of loin eye. The animals with larger loin eye had less fat at the 12th rib and it was noted heifers had a larger loin eye and more fat cover at the 12th rib than steers of equal weight.

Yao et al (1953) worked with 101 beef Shorthorn and 62 Milking Shorthorn steers that were all slaughtered at 900 pounds. Carcass grade was highly correlated to circumference measures of live animals taken at foreflank, navel, and rear flank. Carcass grade was significant to length of coupling, width at shoulders, width at last rib, and width at hip. Carcass grade was negatively correlated to height at withers and height at chest floor.

Yao et al (1953) found that width and circumference measures were positively correlated with slaughter grade, carcass grade, and dressing percent and called these fleshing measurements. On the other hand, all height and length measurements were negatively correlated with slaughter grade and were

called skeletal measurements.

Kidwell et al (1959) did further studies on the steers used by Ternan (1959). The work showed that the proportions at slaughter that produce the most desireable carcass are low at the withers and hooks but wide of chest relative to heart girth. It was generally concluded that the relationship between most slaughter measures and carcass traits are low. However, the ratio height at withers / heart girth did separate the carcass grades.

Rib eye area, reported Orme (1959a) is highly correlated to live animal circumference measures of foreflank, hind flank, and middle. Thus, steers with larger body circumference had the larger loin eyes. Other measures significantly correlated to loin eye area were width of rump, live weight, and circumference of leg above the hock. The leg circumference measure, however, was of a negative magnitude which was just the opposite of that expected by Orme as he felt a thick full quarter would indicate a large loin eye. With weight held constant, the circumference of flank accounted for 81 percent of the variation of loin eye area.

Orme et al (1959a) found only two live animal measures that were significant at the .01 level with the percent of primal cuts. These measures were circumference of foreflank and circumference of middle with figures of -.46 and -.53 respectively. When percent primal cuts was correlated to the rib eye area, it showed that as rib eye area increased, the percent of primal cuts decreased. This was true with weight held constant.

Kidwell et al (1955) used 64 head of Hereford steers exhibited at the Nevada Junior Livestock Show to study live animal measures. These steers varied in age from 10-16 months and were fed from 180-240 days. The relationship between height at withers to length and depth of body was fairly high

but the relation of height to width measures was low.

The most important measures indicative of carcass quality were chest width and the ratios of height at withers to heart girth and length to heart girth. From a carcass standpoint, the most desireable proportions would be low at withers, short of body, and shallow of chest relative to heart girth. The chest should be wide irrespective of size.

Cook et al (1951) worked with 157 Milking Shorthorn steers. Those steers that were shorter in height at the withers and to the chest floor coupled with a shorter body length tended to have slightly higher slaughter and carcass grades and a higher dressing percent when compared with steers described as being more rangy. Steers that had a larger circumference of foreflank tended to make slightly higher slaughter grades. More width of shoulders in the live animal tended to go with slightly higher slaughter and carcass grades. A higher dressing percent was noted for those that showed a larger circumference of foreflank.

McMeekan (1950) found good evidence that the weight of bone in a carcass is positively correlated with the amount of muscle in that carcass. McMeekan (1950) felt that this was understandable if one considered that muscles are attached to bones which they operate. This implies that size and shape of the muscle must be dictated by the size and shape of the bones they operate. Hence, we could expect a fine boned animal to have a low percent of muscle in relation to fat when compared to a heavy boned animal of the same weight.

McMeekan (1950) stated that the shorter and thicker the bone the deeper was the muscle covering that bone. A deep cut of meat in the rear quarter is associated with a short, flat, thick bone rather than a long thin bone.

Wythe (1958) studied the relation of bone to muscle using 28 Hereford

steers. These steers represented six herds, had been fed for 215 days, and had an average chilled carcass weight of 559 pounds with a range from 426 to 715 pounds. Wythe (1958) found high correlations for weight and length of trimmed metatarsus, metacarpus, tibia, femur, and ulna-radius. This was considered good proof that bones develop proportionately both in length and weight. The above mentioned bones were then analyzed for both weight and length to the area of eye muscle and the weights of the three beef cuts: sum loin, rib, round; sum retail trimmed rib, chuck, loin; trimmed boneless cushion round. All correlations were highly significant. Correlations of weight/length ratios of certain bones were also highly significant with the three beef cuts as well as loin eye area.

Orme et al (1959b) working with the same 31 yearling steers used by Orme et al (1959a) removed the metatarsals and metacarpals from the carcasses at time of slaughter. All extraneous material was removed and the bones were then weighed and measured. These bone measures and weights were all positively and significantly correlated to live animal weight, chilled carcass weight, primal cuts weight, and estimated carcass lean.

With the carcasses hanging in the cooler, radiographs were taken from both dorsal and ventral view of the lumbar vertebrae. The lumbar vertebrae as seen in these photographs were then measured and these measurements were positively and significantly correlated to rib eye area.

Orme's et al (1959b) results indicate that both the cannon bone measurements and the radiographs of the lumbar vertebrae showed relationship to muscling. However, it is doubtful if the correlations are high enough to be useful for predictive purposes.

Hankins et al (1943) used a muscle bone ratio in studying certain carcass

characteristics. They had found this muscle bone ratio to be a highly heritable character and thought that a change in the ratio might be associated with a change in separable fat. However, they found that it was not the muscle bone ratio that altered the separable fat, but rather the length of the feeding period. There was a tendency for the finer boned animals to have a higher muscle-bone ratio. However, Hankins et al (1943) found none of their correlations high enough to be of any value.

Hankins and Buck (1938) used the muscle-bone ratio and found a significant correlation to thickness of muscling and fat at the 12th rib. No correlation was found between muscle-bone ratio and efficiency of gain.

In a study of 157 Milking Shorthorn steers, Kohli et al (1951) found that height of withers had low but positively significant correlation with length of body, birth weight, days to weaning, and final weight. Height of shoulder had a low negatively significant correlation with width of shoulders and average daily gain. Height of chest floor, a skeletal measurement also, had a significant positive correlation with birth weight and length of body and a significant negative correlation with circumference of foreflank and width of shoulder. Circumference of foreflank had a small significant positive correlation with width of shoulder and days to weaning and final weight, but a small significant negative correlation with average daily gain and efficiency. Width of shoulder had no significant correlations with any measures of performance. Length of body had a small negative correlation with average daily gain, but a small positive correlation with days to final weight and to weaning.

Lush (1932) in a study of 241 steers drew some comparisons as to desired characteristics for rate of gain versus dressing percent. For high gainability

a steer should have a large paunch girth, a narrow loin, and a long body. When dressing percent is considered, the animal should have a small paunch girth, a wide loin, and a short body. A large heart circumference is important from both standpoints, but probably more important to rate of gain. Lush (1932) found also that steers with small bony measurements but large fleshing had the highest dressing percent and the most valuable meat at the end of the feeding period. These same two measurements indicated a fatter more heavily muscled steer than one of the same skeletal dimensions. Perhaps one of the most important measures for meat quality and high dressing percent, according to Lush (1932), is a head narrow at the eyes.

A study of steers designated as compact, medium, or rangy in type was conducted by Knox and Koger (1946). A compact animal was one in which height and length were small in comparison to depth and width. The rangy steers differed from the compact steers in the proportion of height and length to depth and in size due to greater height and length. Observations were made on 350 head of Hereford steers from 1937 to 1945 for feed lot gain, slaughter grade, carcass grade, and dressing percent. The rangy steers had a significantly higher initial weight, gain, and dressing percent and the compacts showed a slight nonsignificant advantage for slaughter grade and gain expressed as a percent of initial weight. Medium type steers were ranked in the middle in all cases. There was no difference in carcass grades for any of the three types.

Knox and Koger (1946) felt that the more rapid gains of the larger cattle were due to their initial size and the associated feeding capacity rather than to body form. Realizing that rapidly gaining strains may be developed in all types of cattle, Knox and Koger (1946) felt that the development of such a

strain would be more difficult if size were reduced too greatly by restricting height and length to secure compactness.

MATERIALS AND METHODS

This study concerns live animal and carcass measurements taken on steers entered in the Quality Beef Contest at the 1959 International Livestock Exposition. The steers in the contest originated from twelve states and represented a heterogenour group as to regards breeding, kinds of feed, and methods of management. This study includes work on 124 Angus steers, 41 Hereford steers, and 45 Shorthorns.

Some of the cattle arrived at the International stalls as early as Sunday, November 22nd, and the others continued to arrive until Wednesday afternoon, November 25th. Thursday morning, November 26th, the steers were mouthed by the veterinarians employed by the International board of directors. This mouthing is an attempt to determine the age of the steers using as a guide the development of the teeth. The steers were then placed into one of three age groups: junior yearlings, 19-23 months of age; summer yearlings, 15-19 months of age; and senior calves, 14 months of age and under.

Following mouthing, the steers were weighed. Qualifying weights were set by age, the minimum being 1025 pounds for junior yearlings, 925 pounds for summer yearlings, and 800 pounds for senior calves. Any steers that failed to meet qualifying weights were dropped from the contest as had been all steers over 23 months of age. No measurements were taken on any cattle that were so dropped.

Immediately following weighing, four live animal measurements were taken: depth of jaw, circumference of muzzle, circumference of cannon, and circumference of round. Depth of jaw measurements were taken by placing one point

of a wooden calipers on the dorsal rim of the orbital fossa and the other point on the anterior ventral point of the mandible. The distance between the two points was then measured in centimeters. All circumference measurements were taken in centimeters, using a flexible steel tape. Muzzle circumference was measured porterior to the nostrils in that area which gave the smallest reading. Cannon circumference was taken midway between knee and pastern joint of the left metacarpus. Round circumference was taken by placing the end of the tape on the point of the left pin bone (tuber ischii). The tape was then passed down over the twist, under the base of the round on the left side of the cod, out at the left flank, and back to the point of origin. Note Plate I of the Appendix for a diagram of measurements.

On Friday, the steers were shown by breed and age for live animal placing. At this time, each steer was handled and scored for quality and quantity of fat. A score of 5 was considered optimum for both divisions. The minimum score given was 1 which designated a quality considered extremely hard and a quantity of a very small amount. Nine was the maximum score given. Used as a quality score, 9 designated an extremely soft, oily finish. For quantity, it designated an animal with an over abundance of finish. The composite score for finish was a total of the two scores for quality and quantity. Note Table 16 of the Appendix for fat scores.

Immediately following the live animal placing, the steers were slaughtered. The cattle hung in the coolers until Sunday morning when they were ribbed.

Following ribbing, a team of three men took loin eye tracings of each carcass. At the same time, the fat cover at the 12th rib was measured directly from the carcass. Another team of three men measured the loin eye tracings for area of eye muscle. Each man worked independently with a randomly selected group of tracings.

The judges scored each carcass for marbling using the numbers 0 to 10. A score of 10 indicated a cattle with very abundant and desirable marbling. A score of 9 or 10 was considered to be very desirable. In some cases the quantity of marbling may have been excellent but very course marbling lowered the score.

Following the International, all loin eye tracings were made available to the author at which time all loin eye areas were remeasured and the fat cover at the 12th rib was measured from the tracings.

All measures are presented in Table 15 of the Appendix.

Table 1. Live weight of the steers entered in the 1959 International Livestock Exposition Quality Beef Contest.

	Range	Average	Mean
30 Angus Jr. Yearling	1025-1340	1110	1095
15 Hereford Jr. Yearling	1050-1235	1114	1100
14 Shorthorn Jr. Yearling	1040-1270	1108	1085
59 Jr. Yearling	1025-1340	1111	1090
58 Angus Sm. Yearling	925-1175	1021	1010
19 Hereford Sm. Yearling	945-1135	1049	1050
19 Shorthorn Sm. Yearling	930-1220	1056	1035
96 Sm. Yearling	925-1220	1034	1025
36 Angus Sr. Calves	800-1080	904	900
7 Hereford Sr. Calves	840-1055	943	930
12 Shorthorn Sr. Calves	830-1060	905	875
55 Sr. Calves	800-1080	909	915

Table 2. Carcass weight of the steers entered in the 1959 International Livestock Exposition Quality Beef Contest.

	Range	Average	Mean
30 Angus Jr. Yearling	617-905	714	703
15 Hereford Jr. Yearling	610-762	688	690
14 Shorthorn Jr. Yearling	637-847	691	681
59 Jr. Yearling	610-905	702	690

Table 2 (concl.).

	Range	Average	Mean
58 Angus Sm. Yearling	539-772	643	640
19 Hereford Sm. Yearling	548-713	649	657
19 Shorthorn Sm. Yearling	559-761	653	645
96 Sm. Yearling	539-772	646	643
36 Angus Sr. Calves	470-679	556	556
7 Hereford Sr. Calves	482-629	573	576
12 Shorthorn Sr. Calves	489-652	544	531
55 Sr. Calves	470-679	556	556

The second phase of this study concerns live animal and carcass measurements taken on 33 head of Hereford steers slaughtered at Kansas State University. These steers had been on feeding trials at the end of which the steers were kept on full feed. Five steers were slaughtered every week during September and October of 1960.

Every evening preceeding the next days slaughter the steers were brought into a 3' x 8' holding pen and held all night without food or water. It was while the steers were so confined that the live animal measurements were taken.

All live animal measurements were taken in centimeters using a flexible steel tape. There were four head measurements taken: length of head, muzzle circumference, width between the eyes, and depth of jaw. Length of head was that distance between the upper most point on the poll and the end of the muzzle. Muzzle circumference was taken just posterior to the nostrils in that area which gave the smallest circumference reading. Width between the eyes was the distance between the right and left dorsal rims of the orbital fossa. Jaw depth was that distance from the dorsal rim of the orbital fossa to the anterior ventral point of the mandible.

Three body measurements were also taken at the same time: cannon circum-

ference, forearm circumference, and circumference of the round.

Cannon circumference was the midpoint between knee and pastern. Forearm circumference was taken above the knee and as close to the body as possible with the tape remaining horizontal with the floor. Round circumference started on the dorsal mid-line of the animal at the point between the hooks. The tape then passed back to the left of the tail, down over the twist, to the left of the cod, under the left flank, and back to the point of origin. Note Plate II of the Appendix for a diagram of all measures.

Forty-eight hours following slaughter, the carcasses were broken down into wholesale cuts. The fat was trimmed to ¼ inch and the bones removed.

Carcass grade and marbling score were determined by an official government grader following USDA recommendations.

Table 20 of the Appendix presents the numerical scores used in this study for marbling. Table 19 of the Appendix lists the numerical scores assigned for carcass grade. The complete list of measures is found in Table 18 of the Appendix.

CORRELATION ANALYSES

Correlation figures for the group of steers studied in Chicago were computed by age groups without regard to weight or breed.

Loin eye tracings of the Chicago steers were available for this study. All loin eye areas were remeasured and fat thickness at the 12th rib refigured from the tracings. The relationships between the measurements for loin eye area and fat thickness at the 12th rib as used in Chicago and the measurements for the same factors as refigured by the author are presented in Table 3. As these correlations were quite high, all data used in the rest of the study con-

cerning loin eye area and fat thickness will be the remeasurements done by the author.

Table 3. Relationship between contest measurements and author's measurements for loin eye area and fat thickness at the 12th rib.

		Author's loin	Author's fat thickness 12th rib.
Senior Calves			
	Contest loin	.975**	
	Contest fat thickness 12th rib		.881**
Summer Yearlings			
	Contest loin	.972**	
	Contest fat thickness 12th rib		.850**
Junior Yearlings			
	Contest loin	.979**	
	Contest fat thickness 12th rib		.869**

**Significant at .01 level

Even though all figures are highly significant, the loin eye area measurements show a higher degree of agreement than the fat measurements at the 12th rib. This can probably be credited to the fact that loin eye measurements were taken from the same tracing in contrast to the fat measurements, one of which was taken directly from the carcass and the other from the tracing.

With the exception of cannon circumference, no actual live animal measurement is correlated to body weight. This indicates that the shape of the head as measured by jaw depth and muzzle circumference is not an indication of the weight of the animal. Nor does the circumference of the round as measured in

this study give an indication of the animals weight. However, the circumference of the cannon does seem to indicate, in the case of the younger cattle, the weight of the individual. From the figures attained, it might be indicative that younger cattle have a higher correlation between cannon circumference and body weight, even though the figure for summer yearlings while lower in number is more highly significant than the other two. The larger degrees of freedom involved in the summer yearlings lowers the limits of significance. Perhaps the younger cattle show more correlation because a higher proportion of their body is bone than is the case in the older cattle. Or we could say that bone does not grow in proportion to the development of the body, or more specifically, the laying on of fat.

Table 4. Correlations between live steer weight and live animal measurements.

	Senior calves	Summer yearlings	Junior yearlings
Muzzle circumference	.256	.196	.122
Jaw depth	.212	.039	.111
Cannon circumference	.315*	.280**	.108
Round circumference	.038	.000	.191
Visual quantity of fat	.301*	.264**	.150
Visual quality of fat	.111	.236*	-.035
Total visual fat score	.230	.271**	.065

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

Summer yearlings and senior calves show a correlation between the live animal weight and the visual scores for fat. The figures for summer yearlings, although not high, are significant at the .01 level for visual quantity and

total visual fat score, and are significant at the .05 level for visual quality fat score. The correlation for senior calves for visual quantity fat and live weight is significant at the .05 level.

Correlations for live steer weights and carcass characteristics are presented in Table 5.

Table 5. Correlations between live steer weights and carcass characteristics.

	Senior calves	Summer yearlings	Junior yearlings
Dressed weight	.953**	.931**	.898**
Dressing percent	.317*	.247	.247
Fat at the 12th rib	.313*	.291**	.140
Marbling score	.079	-.169	.059
Loin eye area	.296*	.305**	.535**
Loin eye area / 100# carcass	-.399**	-.385**	-.133

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

As we would expect, automoticity shows itself in the correlations between live weight and carcass weight with all figures being highly significant. It is noted, however, that the correlation is greater for the younger cattle than for the older cattle. This is perhaps explained when we study the relationship between live weight and dressing percent. The younger calves show a greater correlation between dressing percent and live weight than do the older cattle.

Table 5 seems to indicate that in younger cattle the correlation between the fat at the 12th rib and live weight is greater than that for older cattle. However, there is no correlation between live weight and marbling.

The comparison of loin eye area / 100# carcass and live weight shows that

in younger cattle the heavier cattle have less loin eye per 100# carcass weight. The figures for senior calves and summer yearlings were -.399 and -.385 respectively. Both were significant at the .01 level. The figure for junior yearlings was also negative, but not significant.

The correlations between carcass weight and live animal measurements are presented in Table 6.

Table 6. Correlations between dressed weight and live animal measurements and observations.

	Senior calves	Summer yearlings	Junior yearlings
Muzzle circumference	.185	.144	-.018
Jaw depth	.183	.028	.040
Cannon circumference	.254	.213*	-.059
Round circumference	.053	-.008	.126
Visual quantity fat	.373**	.343**	.273*
Visual quality fat	.121	.272**	.021
Total visual fat score	.274*	.336**	.170

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

Only in summer yearlings was there an indication that cannon circumference was correlated to carcass size and that was at the .05 level.

In summer yearlings, all three visual scores for fat were significant at the .01 level. In senior calves, the visual score for quantity fat correlated with carcass weight was significant at the .01 level, while the composite total visual score was significant at the .05 level. Junior yearlings showed a significance at the .05 level only for visual quantity of fat as correlated with carcass weight.

The correlations of carcass weight with carcass characteristics are presented in Table 7.

Table 7. Correlations between dressed weight and carcass measurements.

	Senior calves	Summer yearlings	Junior yearlings
Fat at the 12th rib	.420**	.385**	.414**
Loin eye area	.313*	.322**	.524**
Loin eye area/100# carcass	-.426**	-.427**	-.237
Dressing percent	.588**	.584**	.646**

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

In all ages of cattle, the correlation between carcass weight and fat at the 12th rib was significant at the .01 level. This indicates that part of the weight of the heavier carcasses is due to a greater deposit of fat.

The correlations for loin eye area and carcass weight became increasingly greater as the cattle got older with the junior yearling steers showing a correlation of .524.

The heavier carcass in each age group was indicative of a higher dressing percent. All three age groups showed significance at the .01 level.

Correlations of all live animal measurements are given in Table 8.

Table 8. Correlations of live animal measurements.

	Jaw depth	Cannon circumference	Round circumference
Muzzle circumference			
senior calves	.596**	.670**	.312*
summer yearlings	.453**	.393**	.402**

Table 8 (concl.).

	Jaw depth	Cannon circumference	Round circumference
Muzzle circumference			
junior yearlings	.588**	.930**	.707**
Jaw depth			
senior calves		.902**	.440**
summer yearlings		.214*	.212*
junior yearlings		.615**	.506**
Cannon circumference			
senior calves			.464**
summer yearlings			.215*
junior yearlings			.700**

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

Of the 18 correlations listed for live animal measurements, all but four are significant at the .01 level. Those four are all significant at the .05 level. Correlations appear to be highest in the junior yearling steers ranging from .930 to .506. Lowest correlations are in the summer yearlings with a range from .453 to .212. It would appear that as the size of the animal increases so do all of the measurements studied in this project.

The relationship of the fat measures and marbling score are presented in Table 9.

The visual scores for fat (quantity, quality, and a total of the two) are all significant at the .01 level. As the scores for fatness were on a progressive scale, it is apparent that those animals carrying more finish are

also softer to the touch. When a comparison between the visual scores and actual fat measurements was made, the scores for visual quantity showed the most relationship with senior calves (.456). Summer yearlings were .258 and junior yearlings were .365.

Table 9. Correlations of visual fat scores, fat measurement and marbling.

	Visual quality fat	Total visual fat score	Fat 12th rib	Marbling
Visual quantity fat				
senior calves	.437**	.807**	.456**	-.097
summer yearlings	.717**	.942**	.258*	-.168
junior yearlings	.406**	.826**	.365**	.294*
Visual quality fat				
senior calves		.884**	.094	.080
summer yearlings		.910**	.204*	-.136
junior yearlings		.851**	.081	.226
Total visual fat score				
senior calves			.299	.002
summer yearlings			.252*	-.166
junior yearlings			.260*	.309*
Fat thickness 12th rib				
senior calves				.157
summer yearlings				-.030
junior yearlings				.349**

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

The correlation between visual quality and fat thickness at the 12th rib was significant at the .05 level for summer yearlings (.204). Total visual score correlated to fat at the 12th rib was significant at the .05 level for summer yearlings (.252) and junior yearlings (.260).

Junior yearlings were the only age group that showed a positive significant correlation for marbling and the various fat measures. Those correlations were visual quantity fat (.294*), visual quality fat (.226), total visual score (.309*), and fat thickness at the 12th rib (.349**). The summer yearlings showed slightly negative correlations for each factor and the senior calves varied from slightly negative to slightly positive, all of which were insignificant. Thus, it would appear from this study that only in the older cattle is the amount of fat indicative of marbling.

Table 10 shows the correlations between loin eye area, marbling, loin eye area / 100# carcass weight, and all other measurements in this project.

It is evident that live weight and dressed weight are the two best estimates of loin eye area as observed in this study. The highest correlations were found in the case of the older cattle, the junior yearlings, with highly significant readings of .535 and .524 for live weight and dressed weight respectively. Summer yearlings had correlations significant at the .01 level for the same two weights; the readings were .305 and .322. The figures for the same two weights for senior calves were only significant at the .05 level and were .296 and .313 respectively.

Fat at the 12th rib shows several significant correlations, but they vary from one age grouping to another. For senior calves, fat at the 12th rib was negatively correlated to loin eye area (-.298*) and also negatively correlated to loin eye area / 100# carcass (-.581**). For summer yearlings, the correla-

tion was -.332** for fat at the 12th rib and loin eye area / 100# carcass weight. Junior yearlings showed correlations significant at the .01 level for fat at the 12th rib to marbling and to loin eye area / 100# carcass weight. The figures were .349** and -.472** respectively.

Table 10. Correlations between loin eye area, marbling, loin eye area / 100# carcass weight, and all other measurements.

	Senior calves			Summer yearlings			Junior yearlings		
	Mrbl	Loin eye area	Loin eye /100# wt	Mrbl	Loin eye area	Loin eye /100# wt	Mrbl	Loin eye area	Loin eye /100# wt
Live wt.	.079	.296*	-.399**	-.169	.305**	-.385**	.059	.535**	-.133
Dressed wt.	.103	.313*	-.426**	-.100	.322**	-.427**	.224	.524**	-.237
Dressing %	.123	.168	-.292	.107	.169	-.284**	.401**	.233	-.287
Muzzle cir.	.138	-.015	-.143	-.003	.173	.058	-.138	.058	.091
Jaw depth	.089	.109	-.019	-.071	.136	.111	.059	.045	.024
Cannon cir.	.029	.115	-.064	-.047	.029	-.107	-.157	.008	.070
Round cir.	.193	.088	.054	-.022	.195	.179	-.089	.084	-.006
Vis. quant.	-.097	-.013	-.272	-.168	.199	-.064	.294*	.022	-.189
Vis. qual.	.080	.040	-.045	-.136	.088	-.116	.226	.019	-.010
Total vis.	.002	.019	-.171	-.166	.161	-.094	.309*	.024	-.115
Fat 12 rib	.157	-.298*	-.581**	-.030	-.059	-.332**	.349**	-.107	-.472**
Marbling		.075	-.021		-.109	-.016		.148	-.023
Loin eye area			.720**			.714**			.701**

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

Correlations for the second phase of this project, the 33 head of Hereford steers, were computed without any correction factors for weight or age. The correlations for the live animal measures are as follow in Table 11.

Table 11. Correlations between live animal measurements.

	Eye width	Jaw depth	Round cir.	Cannon cir.	Arm cir.	Head length	Live wt.
Muzzle circum.	.223	.223	.058	-.016	-.100	.165	.075
Eye width		.037	.425*	.197	-.046	-.163	-.316
Jaw depth			-.083	.109	.181	.351*	.183
Round circum.				.509**	.262	-.061	.008
Cannon circum.					.469**	-.018	.024
Arm circum.						.204	.242
Head length							.344*

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

Round circumference shows a positive correlation to width between the eyes at .425 which was significant at the .05 level. Round circumference also shows a positive correlation to the circumference of the cannon (.509), which was significant at the .01 level. The cannon circumference also shows a highly significant correlation to the circumference of the forearm (.469). It should be noted that in this study the cannon circumference correlation to the two measures which could be considered muscle measures (circumference of round and circumference of forearm) was positive and at the .01 level. Head length was correlated to jaw depth and to live weight with figures of .351 and .344 respectively. Both figures were significant at the .05 level.

The correlations between live animal measures and carcass measures that show significance are listed in Table 12.

Muzzle circumference correlation to fat and lean in the carcass shows a negative correlation to fat and a positive correlation to lean. The figure of -.352 was found for the fat correlation and .361 for the total lean weight of

the carcass. Both of these figures were significant at the .05 level. The deeper jawed cattle showed a correlation of .375 to total lean in the loin. Length of head showed a positive correlation to three measures of meatiness in the carcass. These measures and their correlations are: loin eye area .363, total lean weight .387, and total lean in the chuck .424. All three of the head measurements used in this experiment showed a positive correlation to meatiness or muscling in the carcass. All three measurements are skeletal in nature. The other live animal measure which shows a positive correlation to carcass is the circumference of the forearm. This is a muscle measurement and shows a correlation of .498 to the total lean in the loin, which is significant at the .01 level.

Table 12. Correlations between live animal measures and carcass measures.

	Loin eye area	Fat thickness 12th rib	Total lean cut	Total lean loin	Total lean chuck
Muzzle circumference	.217	-.352*	.361*	.160	.342
Jaw depth	-.042	-.006	.269	.375*	.254
Arm circumference	-.100	-.123	.198	.498**	.217
Head length	.363*	.022	.387*	.256	.424*

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

Weight plays a big part in the breakdown of the carcass and Table 13 shows the correlations for live weight and cold dressed side weight to other measures in this study. The correlation between the two weights is quite high, .928, as is expected. Live weight shows a correlation of .344 to head length, but this is the only significant correlation to any of the pre-slaughter measurements by either of the weight measures. Weight had no significant correlation

to loin eye area, dressing percent, fat thickness at the 12th rib, marbling, or carcass grade. It had been anticipated that weight would be an indication of the meatiness or fatness of the carcass and, hence, might show itself in some of the above measures, but such was not the case. Live weight, however, does express itself quite evidently in its correlation to weight of the lean in the primal cuts and to total lean, fat, and bone in the carcass.

Table 13. Correlations of live weight and cold dressed side weight to other live and carcass measurements.

	Live weight	Side weight
Muzzle circumference	.075	.020
Eye width	-.316	-.291
Jaw depth	.183	.213
Round circumference	.008	.118
Cannon circumference	.024	.124
Arm circumference	.242	.263
Head length	.344*	.281
Loin eye area	.305	.290
Live weight		.928**
Dressing percent	-.229	.124
Fat thickness 12th rib	.139	.343
Carcass grade	-.127	-.288
Marbling	-.084	-.238
Total lean weight	.773**	.705**
Total fat weight	.405**	.594**
Total bone weight	.595**	.514**
Total lean round	.623**	.511**
Total lean loin	.432*	.512**
Total lean rib	.585**	.561**
Total lean chuck	.641**	.587**

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

Table 14 shows the correlations of all measures taken after slaughter. Loin eye area was a good indicator of total lean in the carcass (.600). It also indicated the total lean in the round rib and chuck with figures of .526, .348, and .532 respectively. It was surprising that the loin eye area did not

show a significant correlation to the total lean of the loin.

Table 14. Correlation of carcass measurements.

	Dressing %	Fat 12 rib	Car. grade	Marbl	Tot. lean	Tot. fat	Tot. bone	Lean round	Lean loin	Lean rib	Lean chuck
Loin eye area	-.091	-.069	-.121	-.062	.600**	-.201	.121	.526**	.192	.348*	.532**
Dress %		.490**	-.443**	-.437*	-.194	.454**	-.297	-.297	.185	-.055	-.179
Fat 12th rib			-.249	-.223	-.130	.653**	-.072	-.223	-.003	-.098	-.124
Carcass grade				.991**	-.079	-.340	.055	.125	-.226	-.245	-.123
Marbling					-.050	-.292	.053	.162	-.206	-.216	-.096
Total lean wt.						-.095	.456**	.825**	.626**	.606**	.852**
Total fat wt.							-.035	-.174	.012	.134	-.086
Total bone wt.								.413*	.294	.237	.435*
Total lean round									.418*	.484**	.639**
Total lean loin										.304	.628**
Total lean rib											.343

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

Dressing percent showed a positive correlation to fat at the 12th rib (.490) and total fat (.454). However, the correlation for dressing percent with carcass grade (-.443) and with marbling (-.437) was a negative figure. In this test, the fatter, higher dressing cattle were the poorer grading, poorer mar-

bled cattle. Fat at the 12th rib was a good indication of total fat. The correlation was .653 which was highly significant. The highest correlation in the entire study was between carcass grade and marbling with a figure of .991.

The total weight of the bone showed a positive correlation to the total weight of the lean in the carcass. The correlation of .456 between these two was significant at the .01 level. Total bone weight also showed correlations, significant at the .05 level, to total lean of the round and total lean of the chuck. These figures were .413 and .435 respectively. It is noted that while the correlations of total bone weight to either of the fat measures are not significant, both correlations are negative.

The total lean in the carcass showed highly significant correlations with the total lean of the four primal cuts. The total lean of the four primal cuts were all interrelated in their correlations with the exception of total lean in the rib, which showed no significant correlation to either total lean of the loin or chuck.

DISCUSSION

This study is comprised of two different phases. Phase one was work done on the steers entered in the 1959 Quality Beef Contest at the International Livestock Exposition in Chicago. In some respects, these steers should show more homogeniety than a randomly selected group of slaughter steers. These steers were all selected to compete at this contest because the exhibitor felt that they excelled in those characteristics which gave indication of the superior carcass of the individual. Meatiness, trimness, amount of finish, quantity of bone, and apparent quality were all pre-selected traits.

In some respects, the group represented a great deal of heterogeneity.

Feed, management, climatic conditions, distance traveled, and even care at the show varied greatly for each individual. Because of these conditions, it would not be advisable to try to read these results into a more randomly selected group of slaughter steers. However, the results of this study should be an aid in understanding the relationships between a uniformly good group of slaughter steers.

Phase two was done at Kansas State University and involved work on 33 head of slaughter steers. These steers were all purchased from the same herd and upon arrival at the University had been randomly alloted to various test groups. These cattle had been fed on four different fattening rations, at the completion of which they were all penned together and fed identically for 30 days prior to the first slaughter period. The five steers with the highest slaughter grade were taken to slaughter each week except the last two slaughter periods when four steers were slaughtered each week.

Phase two represents a more randomly selected group of steers and should present findings which may be of value in selecting breeding cattle to produce more desirable market animals.

This work follows the work done by Good et al (1961). In so doing, a new approach to the correlations was tried using age as a dividing factor rather than breed or weight. The cattle in phase one were divided into three age groups: junior yearlings (19-23 months), summer yearlings (15-19 months), and senior calves (under 15 months). The steers in phase two were all junior yearlings.

Neither group of steers in this study shows a definite overall relationship between an increase in weight and an increase in various live animal measurements. For the Chicago steers, cannon circumference and live weight

showed a correlation of .315 (significant at the .05 level) for senior calves and a correlation of .280 (significant at the .01 level) for summer yearlings. In phase two, there was a correlation of .344 (significant at the .05 level) for head length and live weight.

From these studies, it could be concluded that all steers do not make an increase in weight by the same methods of development. Some steers make a higher percent of growth in muscle tissue development; other cattle make a higher percentage of their weight increase by the deposition of fat; some cattle make more of their gain in skeletal structure than do others; and some increase in weight is a partial combination of these factors and perhaps others.

Inheritance could account for a large part of the variance in growth pattern of the steers studied. The Chicago steers were a very heterogenious group for inheritance. The phase two steers, even though purchased from the same herd, were bred under range conditions and could represent a number of sires as well as a variation in maternal background. Feed management and environment could affect the patterns by which cattle increase their weight.

Live weight with visual scores for fat showed a positive correlation in the summer yearling steers at Chicago. The figures were .264 for visual quantity of fat, .236 for visual quality of fat, and .271 for the total visual score. (The first and last figures were significant at the .01 level and the other significant at the .05 level.)

The live animal measures in phase one (muzzle circumference, jaw depth, cannon circumference, and round circumference) all showed a significant positive correlation with each other. These figures ranged from .212 to .930 and of the 18 correlations, four were significant at the .05 level and all the others were significant at the .01 level. The steers in phase two had seven

live animal measurements, but only four significant correlations. Cannon circumference had a correlation significant at the .01 level to round circumference (.509) and to arm circumference (.469). Eye width was correlated to round circumference (.425) and jaw depth was related to head length (.351).

Cannon circumference was the only skeletal measure in both studies that related to muscle measurements (round and forearm). From this study, it would seem that cannon circumference is a good indication of size of round and forearm. Dahl (1959), Weseli (1957), and Good et al (1961) found the same results.

Live weight showed a correlation to loin eye area in the Chicago steers of .296 for senior calves, .305 for summer yearlings, and .535 for junior yearlings. (Senior calves were significant at .05 level and the other two were significant at .01 level). The phase two steers showed a correlation of .305 for loin eye area and live weight. In this study, the Chicago steers would seem to indicate that the older animals will have proportionately larger loin eyes for their weight than will the younger animals. This does not follow with previous work and may be due to selection of the individuals. Live weight failed to show a correlation for marbling score in either phase of this study. In the Chicago steers, there was a correlation of live weight to fat thickness at the 12th rib of .313 for senior calves and .291 for the summer yearlings.

Dressed weight showed a higher correlation to fat at the 12th rib for the Chicago steers than did live weight. The correlations, all highly significant, were .420 for senior calves, .385 for summer yearlings, and .414 for junior yearlings. The correlation for fat at the 12th rib jumped from .139 for live weight to .343 for dressed weight in the phase two steers. Fill may be the factor responsible for this much difference.

The three visual scores for finish used in the Chicago steers shows a

highly significant inter-relationship between all measures for all three ages of steers. These correlations ranged from .942 to .406. The visual quantity score shows a significant correlation to fat at the 12th rib. The correlations were .456 for senior calves, .258 for summer yearlings, and .365 for junior yearlings. The relationship of visual quality fat to fat at the 12th rib showed a significant correlation only for the summer yearlings (.204). The total visual fat score showed a correlation with fat at the 12th rib for summer yearlings of .252 and for junior yearlings .260. From this study, it would seem that a simple attempt to determine the amount of finish is a better indication of the amount of fat at the 12th rib than to compound the picture by trying to use quality of finish in any way.

Visual quantity of fat was correlated -.097 with marbling for senior calves, -.168 for summer yearlings, and .294 for junior yearlings. (The correlation for junior yearlings is significant at the .05 level.) Actual fat thickness at the 12th rib showed a correlation to marbling .157 for senior calves, -.030 for summer yearlings, and .349 (significant at .01 level) for junior yearlings. In the Chicago steers, it was only the older cattle that showed a positive significant correlation of fat cover with marbling. It is unclear whether this could be attributed to marbling appearing at a certain age or to some other factor. From this study, it would appear that perhaps age influences the appearance of marbling. In the phase two steers, the correlation of marbling with fat at the 12th rib is -.223. These steers would correspond to the junior yearlings in Chicago as to regards for age. These steers in phase two were lacking in carcass quality averaging only slightly higher than a modest amount of marbling. Perhaps the negative correlation could be attributed to inheritance in that the carcass would always be lightly marbled irre-

gardless of the outside fat cover.

The correlation of marbling to carcass grade in phase two is .991, a highly significant correlation, which illustrates the importance of marbling in grading.

Fat at the 12th rib showed a significant negative correlation to loin eye area for senior calves at Chicago of -.298. The correlation for summer yearlings was -.059, for junior yearlings -.107, and for the steers in phase two -.069. In all cases, then, there was an indication that the steers with larger loin eyes had less fat cover at the 12th rib.

Phase two covered more actual carcass measurements. Loin eye area was highly significantly correlated to total lean in the carcass (.600). Other factors all showing a highly significant correlation to total lean were total bone weight (.456), total lean in the round (.825), total lean in the loin (.626), total lean in the rib (.606), and total lean in the chuck (.852). The correlation of loin eye area with total lean in the round was .526, with total lean in the rib .348, and with total lean in the chuck .532. However, the loin eye area correlated with total lean in the loin was .192, which was not significant. This study indicates that the loin eye area is not always a reliable means of estimating the total lean in the loin.

Fat at the 12th rib showed a highly significant correlation with total fat of .653. This would indicate that fat at the 12th rib is a satisfactory method for determining total fat in the carcass.

Total bone was correlated with total lean in the round at .413 and with total lean in the chuck at .435. Both figures are significant. Total bone correlation with total lean in the loin was .294 and with total lean in the rib at .237. Both correlations are nonsignificant. Coupled with the correla-

tion of .456 for total bone with total lean, this study shows a definite positive relationship between bone and muscle.

The total lean in the round correlates significantly with total lean in the loin at .418, with total lean in the rib at .484, and with total lean in the chuck at .639. Total lean in the chuck is correlated with total lean in the loin at .628. This study shows, then, that total lean in the round is the best indicator of the lean in the other three primal cuts. Total lean in the chuck is the best indicator of total lean in the carcass.

Muzzle circumference had a significant negative correlation of -.352 for the phase two steers in relationship to fat at the 12th rib. The Chicago steers had correlations of .136 for senior calves, -.109 for summer yearlings, and -.174 for junior yearlings. With three of the four correlations negative and one a significant one, it might be indicative that the larger muzzled steers had less fat at the 12th rib. The phase two steers showed a significant correlation of .361 between muzzle circumference and total lean in the carcass. It would seem, then, that the larger muzzled steers would have less fat and more muscle.

Head length of the steers in phase two was correlated with total lean in the carcass at .387 and with total lean in the chuck at .424; both figures significant. Arm circumference was highly correlated with total lean in the loin at .498 and jaw depth was significantly correlated with total lean in the loin at .375.

In this study, cannon circumference was a good indicator of muscle in the round and forearm as determined by live animal measures, but held no significant relations to any carcass muscle measure. Head measures seemed to show more significant relation in this respect.

SUMMARY

This study was divided into two phases. Phase one was with 210 steers entered in the 1959 Quality Beef Contest at the Chicago International. Phase two consisted of 33 head of steers fed and slaughtered at Kansas State University.

Steers in phase one weighed from 800 to 1340 pounds and varied in age from 12 to 19 months. Steers in phase two varied in weight from 912 to 1236 pounds and were all the same age.

Live body measurements taken on the steers in phase one consisted of depth of jaw, circumference of muzzle, circumference of cannon, and circumference of round. Two visual fat appraisals were made on these steers: total quality and total quantity of finish. These two scores were then added together for a total fat score. Live measures in phase two were length of head, muzzle circumference, eye to eye width, depth of jaw, cannon circumference, forearm circumference, and round circumference.

Carcass measures in phase one were fat at the 12th rib, marbling, loin eye area, and loin eye area / 100# carcass. Measurements in phase two were fat thickness 12th rib, carcass grade, marbling, total lean weight, total fat weight, total bone weight, total lean in the round, total lean in the loin, total lean in the rib, and total lean in the chuck.

Simple correlations were computed between all factors in phase one and between all factors in phase two. Steers in phase one were divided for analysis by age groups: junior yearlings (born between January 1 and April 30 previous year), summer yearlings (born between May 1 and August 31 previous year), and senior calves (born after September 1 of previous year). All steers in phase two were junior yearlings.

Relationships between live weight and various live animal measures from both phases were, for the most part, nonsignificant indicating variations among individuals in the manner in which they increased their weight. Live animal measures in phase one were all correlated with each other. Steers in phase two showed highly significant correlations for cannon circumference with both round circumference and forearm circumference.

Visual quantity fat score held a significant relation to fat at the 12th rib. The older steers in phase one showed a relationship of fat thickness at the 12th rib to marbling score.

In phase two, loin eye area showed a highly significant correlation to total lean weight. Fat thickness at the 12th rib showed a highly significant correlation to total fat in the carcass.

Muzzle circumference was significantly correlated to total lean in the carcass in phase two.

In both phases, live cannon circumference was highly significantly correlated to live measures of muscle. In phase two, steers with more bone had more lean in the carcass. The steers with more lean and larger loin eye areas had less fat. Fat at the 12th rib was not correlated to marbling.

This study indicates that the larger boned steers will have more muscle, less fat, and that carcass grade will not be influenced by the lesser amount of fat.

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APPENDIX

EXPLANATION OF PLATE I

Plate I illustrates the live animal measures taken in phase one.

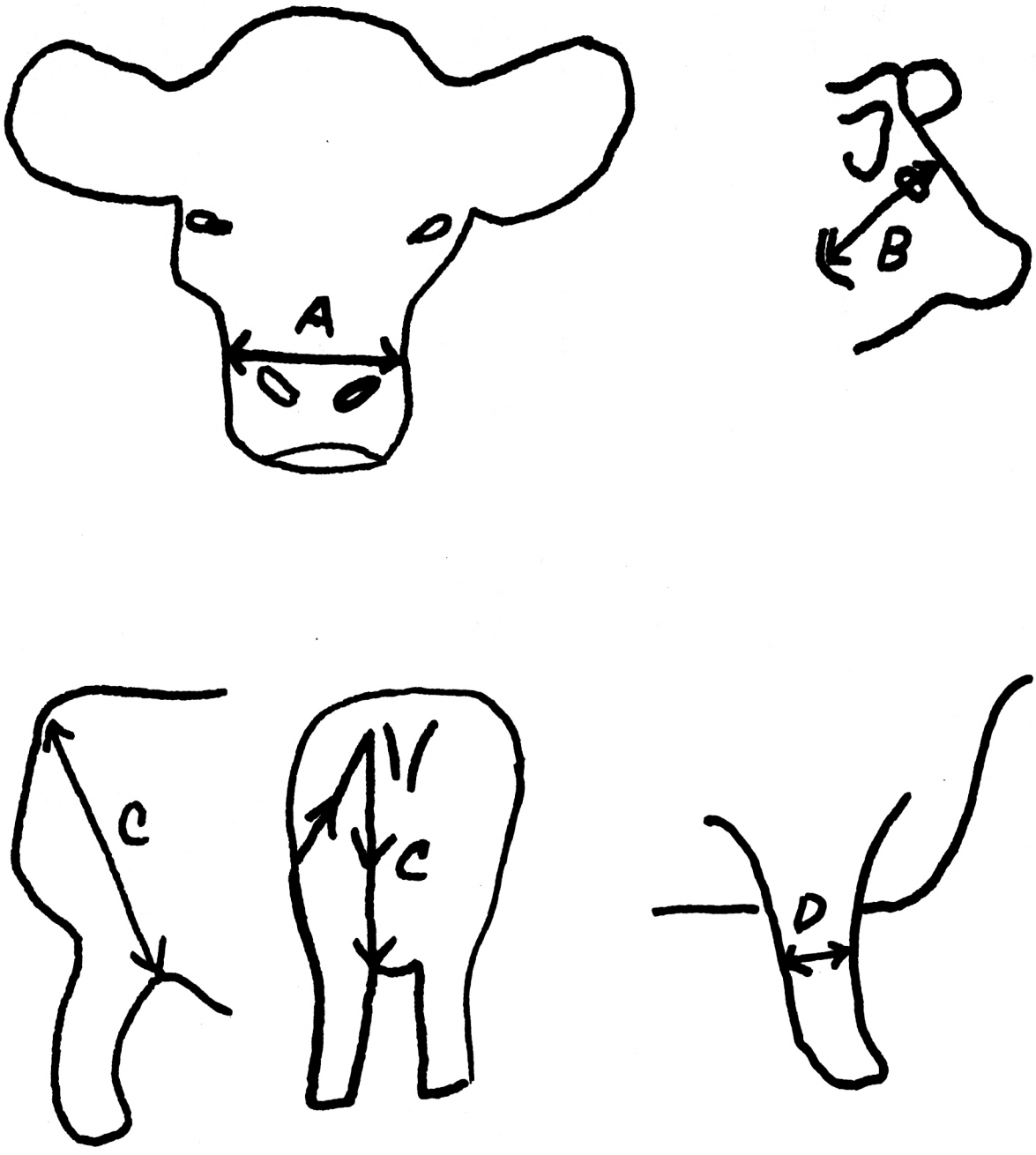
A--muzzle circumference

B--jaw depth

C--round circumference

D--cannon circumference

PLATE I



EXPLANATION OF PLATE II

Plate II illustrates the live animal measures taken in phase two.

A--- muzzle circumference

B---width between the eyes

C---depth of jaw

D---length of head

E---forearm circumference

F---cannon circumference

G---round circumference

PLATE II

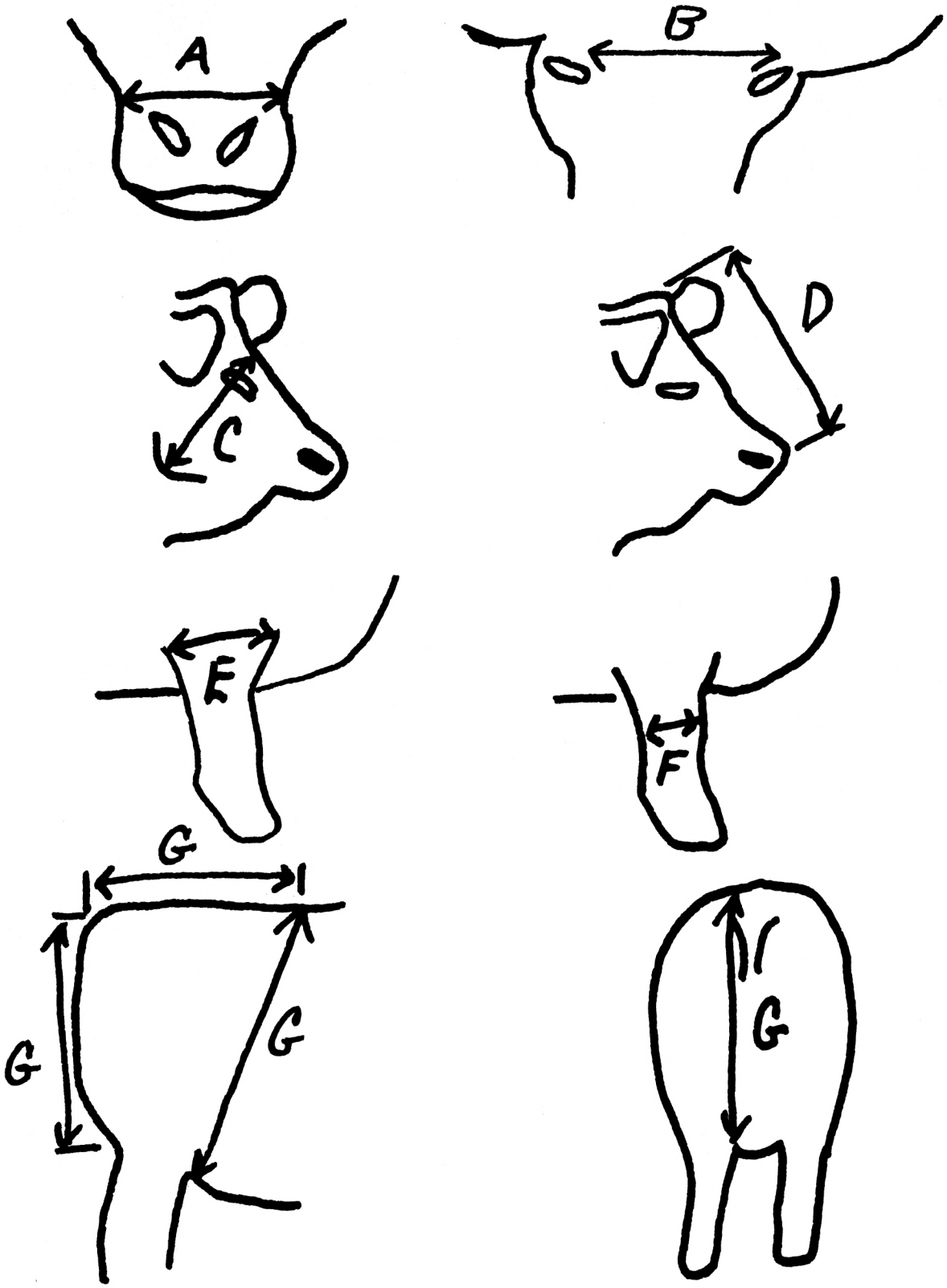


Table 15a. Junior yearling Angus measures in phase one.

Con-test no.	Weight		Dress %	Circumference			Jaw depth	Visual fat score			Fat thickness			Loin eye area		
	Live	Dress		Muzzle	Cannon	Round		quantity	quality	Total score	Contest	Author's	Marbling	Contest	Author's	/100# carcass wt.
59	1035	678	65.5	40.2	19.2	147.2	26.8	6	9	15	1.0	1.4	9	11.01	11.34	1.7
81	1025	653	63.7	47.9	20.0	141.0	25.2	6	2	8	1.4	1.5	8	10.37	10.75	1.6
84	1060	644	60.8	48.2	22.1	142.8	25.4	7	7	14	1.1	1.2	10	12.42	12.34	1.9
111	1180	767	65.0	43.8	20.3	149.6	27.0	5	5	10	1.2	1.3	8	11.64	11.87	1.5
113	1055	674	63.9	43.5	19.6	150.5	23.6	5	5	10	1.2	1.4	9	10.52	10.93	1.6
115	1070	699	65.3	44.6	19.1	142.7	25.0	9	9	18	1.7	1.6	10	13.41	13.72	2.0
117	1065	679	63.8	43.7	18.9	139.3	25.7	6	7	13	1.2	1.4	8	10.01	10.03	1.5
119	1180	763	64.7	43.5	21.3	152.0	26.8	4	6	10	0.9	1.2	8	13.28	13.57	1.8
121	1090	688	63.1	44.5	20.8	146.5	25.4	5	5	10	0.9	1.0	7	12.73	13.58	2.0
123	1135	754	66.4	45.2	20.1	147.3	26.0	8	5	13	1.3	1.3	10	12.33	12.65	1.7
125	1050	678	64.6	41.2	19.4	138.5	26.2	5	5	10	1.3	1.5	8	9.56	9.82	1.4
127	1035	652	63.0	41.7	19.8	142.9	27.2	8	2	10	1.4	1.4	10	11.20	11.23	1.7
129	1215	808	66.5	46.0	19.7	146.8	27.0	6	6	12	1.4	1.6	8	12.83	12.97	1.6
131	1110	738	66.5	44.8	19.5	150.0	27.0	9	8	17	1.9	1.6	10	11.21	11.39	1.5
133	1040	679	65.3	44.8	19.6	142.8	25.8	6	5	11	1.0	1.1	8	12.47	12.93	1.9
143	1200	753	62.8	45.8	21.0	147.0	26.0	6	6	12	1.0	1.1	8	13.25	13.43	1.8
154	1035	635	61.4	41.0	19.4	138.2	25.0	7	6	13	1.2	1.1	8	10.91	11.29	1.8
156	1340	905	67.5	49.8	20.9	156.4	27.4	9	2	11	1.6	1.7	8	12.53	12.94	1.4
158	1125	703	62.5	42.4	20.6	141.6	25.5	7	5	12	1.2	1.5	9	10.65	10.91	1.6
161	1100	682	62.0	44.3	19.9	142.3	26.1	5	5	10	1.2	1.2	9	12.89	12.87	1.9
162	1150	711	61.8	45.4	19.8	144.5	25.9	5	5	10	0.8	1.0	8	14.03	13.98	2.0
166	1120	712	63.6	45.2	19.2	138.0	25.6	6	8	14	1.4	1.6	10	11.28	11.77	1.9
168	1120	727	64.9	46.2	20.5	150.5	24.8	7	5	12	1.1	1.3	8	13.49	13.74	1.9
169	1025	700	68.3	42.3	19.4	148.4	25.6	9	7	16	1.5	1.7	9	10.62	11.00	1.6
175	1160	760	65.5	44.7	19.2	149.2	24.0	6	7	13	1.5	1.6	10	12.78	12.75	1.7
180	1075	702	65.3	39.2	18.2	141.6	24.1	9	8	17	1.4	1.5	10	10.15	10.43	1.5
181	1185	767	64.7	40.0	19.8	144.5	24.6	7	6	13	1.3	1.5	9	11.40	11.64	1.5
182	1200	776	64.7	47.3	23.2	147.7	25.8	8	6	14	1.1	1.2	10	12.33	12.32	1.6
184	1025	617	60.2	40.5	19.0	130.0	25.8	4	1	5	1.2	1.3	8	9.30	9.70	1.6
267	1090	713	65.4	41.8	19.2	142.4	27.3	7	7	14	1.2	1.6	10	12.29	12.41	1.7

Table 15b. Junior yearling Hereford measures in phase one.

Con-test no.	Weight		Dress %	Circumference			Jaw depth	Visual fat score			Fat thickness			Loin eye area		
	Live	Dress		Muzzle	Cannon	Round		quantity	quality	Total score	Con-test	Author's	Marbling	Con-test	Author's	/100# carcass wt.
120	1120	690	61.6	44.6	21.3	159.8	27.0	8	7	15	0.8	0.8	8	11.30	11.75	1.7
122	1135	706	62.2	45.3	20.2	155.2	26.7	8	7	15	1.3	1.5	9	10.91	11.48	1.6
124	1075	650	60.5	46.2	23.0	147.2	26.3	7	7	14	1.0	1.0	7	12.34	11.90	1.8
126	1080	707	65.5	44.3	23.5	153.7	25.7	8	7	15	1.4	1.6	8	9.99	10.46	1.5
128	1050	658	62.7	45.8	21.5	145.8	25.6	8	6	14	1.2	1.0	9	10.70	11.09	1.7
132	1095	660	60.3	46.7	21.5	157.4	26.6	7	7	14	0.9	0.9	7	11.25	11.66	1.8
136	1060	610	57.5	45.9	22.1	148.2	24.6	5	6	11	0.8	0.8	8	10.18	10.50	1.7
138	1090	656	60.2	47.4	21.2	152.0	25.6	5	7	12	0.9	1.0	8	10.36	10.30	1.6
144	1165	736	63.2	49.8	22.6	158.6	26.0	6	6	12	0.9	1.0	9	11.13	11.71	1.6
147	1150	718	62.4	47.2	21.8	146.2	26.0	6	6	12	1.0	1.2	8	11.72	11.58	1.6
148	1170	737	63.0	43.7	21.5	157.6	25.5	9	6	15	1.8	1.9	8	10.28	10.62	1.4
151	1235	762	61.7	47.7	22.1	157.0	25.8	6	6	12	1.3	1.5	9	12.18	12.09	1.6
178	1100	687	62.5	47.8	21.1	149.7	23.9	5	5	10	0.8	0.9	10	12.82	12.63	1.8
234	1140	691	60.6	45.0	22.8	145.2	29.2	8	6	14	0.9	0.8	7	12.52	12.79	1.9
257	1050	657	62.6	48.0	21.0	140.8	24.0	5	5	10	1.0	1.2	8	9.89	9.81	1.5

Table 15c. Junior yearling Shorthorn measures in phase one.

Con-test no.	Weight Live	Weight Dress	Dress %	Circumference Muzzle	Circumference Canon	Circumference Round	Jaw depth	Visual fat score quantity	Visual fat score quality	Visual fat score Total score	Fat thickness Contest	Fat thickness Author's	Marbling	Loin eye area Contest	Loin eye area Author's	Loin eye area /100# carcass wt.
89	1040	637	61.3	44.4	21.0	141.4	27.3	8	7	15	1.1	1.1	10	10.58	10.41	1.6
94	1075	682	63.4	47.4	20.6	150.9	24.3	5	5	10	0.9	1.0	9	11.04	11.45	1.7
118	1085	697	64.2	42.0	19.5	142.2	24.9	7	6	13	1.4	1.6	8	10.13	10.22	1.5
140	1085	672	61.9	44.8	18.8	155.7	26.8	5	5	10	1.1	1.1	7	11.29	11.32	1.7
142	1170	685	58.5	49.8	21.7	143.4	25.2	6	6	12	0.8	0.8	8	12.64	13.08	1.9
145	1270	847	66.7	47.2	21.0	147.6	26.4	6	5	11	1.1	1.5	9	13.84	13.90	1.6
146	1080	644	59.6	49.2	22.8	140.6	26.1	4	3	7	0.7	0.9	7	12.34	12.31	1.9
149	1095	706	64.5	45.0	20.1	147.3	24.4	8	7	15	1.1	1.2	9	11.89	11.84	1.7
170	1095	681	62.2	44.8	22.0	150.3	27.1	4	4	8	0.7	0.8	9	11.44	11.48	1.7
171	1075	657	61.1	45.0	19.9	147.6	26.0	5	5	10	0.9	1.1	7	9.90	9.75	1.5
172	1250	782	62.6	44.7	21.0	152.3	26.4	8	7	15	1.1	1.0	9	10.90	11.47	1.5
229	1035	640	61.8	48.3	19.9	144.3	24.2	6	6	12	1.1	1.1	7	9.09	9.56	1.5
231	1090	659	60.5	43.8	20.5	138.1	26.4	8	7	15	1.3	1.2	7	10.58	10.62	1.6
278	1070	680	63.6	45.0	21.1	139.8	25.0	6	6	12	1.2	1.3	8	10.02	9.98	1.5

Table 15d. Summer yearling Angus measures in phase one.

Con-test no.	Weight		Dress %	Circumference			Jaw depth	Visual fat score			Fat thickness			Loin eye area		
	Live	Dress		Muzzle	Cannon	Round		quantity	quality	Total score	Contest	Author's	Marbling	Contest	Author's	/100# carcass wt.
42	1070	614	60.2	40.8	21.4	147.4	25.9	5	5	10	1.1	0.9	8	11.35	11.77	1.9
43	965	606	62.8	39.4	19.5	136.6	25.0	6	5	11	1.1	1.0	8	11.51	11.57	1.9
44	1075	698	64.9	43.3	19.3	142.0	25.1	8	8	16	1.5	1.7	8	11.65	11.66	1.7
45	1035	665	64.3	41.4	20.0	131.0	26.5	9	6	15	1.4	1.4	8	9.87	10.31	1.6
54	945	597	63.2	39.3	18.8	132.9	25.2	5	5	10	1.4	1.2	9	11.35	11.31	1.9
55	960	587	61.1	40.9	18.8	147.1	26.2	4	3	7	0.8	1.2	10	11.42	11.68	2.0
56	1085	684	63.0	44.5	21.2	136.8	28.4	6	5	11	1.1	1.0	10	13.53	13.43	2.0
57	985	605	61.4	46.2	18.9	136.3	23.4	8	5	13	1.1	1.1	10	12.95	12.93	2.1
60	1030	659	64.0	40.4	19.8	140.9	27.2	5	6	11	1.1	1.4	8	10.92	10.91	1.7
62	995	639	64.2	41.3	19.8	142.6	27.5	5	5	10	1.1	1.4	8	11.01	11.18	1.7
63	925	599	64.8	38.9	18.5	124.9	23.0	4	3	7	1.4	1.4	10	10.54	11.03	1.8
64	980	633	64.6	40.8	18.9	137.3	23.5	7	6	13	1.2	1.1	10	10.72	11.04	1.7
66	970	602	62.1	40.0	20.3	140.3	25.6	4	3	7	1.4	1.6	8	9.45	9.85	1.6
67	1020	651	63.8	44.2	19.4	137.1	26.3	8	6	14	0.8	1.2	9	12.31	12.20	1.9
68	985	632	64.2	43.1	19.8	144.8	26.7	6	5	11	0.8	0.9	7	12.29	12.34	2.0
69	1010	642	63.6	46.9	18.3	141.8	24.4	7	6	13	0.9	1.0	10	12.04	12.56	2.0
70	1165	745	63.9	44.7	21.1	142.2	26.0	7	6	13	1.0	0.8	10	12.61	12.48	1.7
71	1085	707	65.2	45.6	18.7	142.8	26.7	5	4	9	1.4	1.4	10	11.82	11.66	1.6
73	1070	662	61.9	41.2	18.9	151.3	26.5	5	5	10	1.4	1.6	10	11.27	11.12	1.7
74	1010	643	63.7	42.4	20.0	144.0	27.8	5	5	10	1.0	1.1	8	12.56	12.41	1.9
75	1100	697	63.4	43.4	20.7	150.8	25.7	5	5	10	1.2	1.2	10	11.50	11.39	1.6
76	1070	667	62.3	40.5	18.6	142.4	25.6	7	7	14	1.3	1.5	10	10.12	10.04	1.5
77	1150	726	63.1	46.3	20.0	159.0	26.2	8	8	16	1.4	1.4	8	13.89	13.81	1.9
78	975	587	60.2	39.8	20.2	133.2	25.0	4	6	10	0.8	0.9	8	10.90	11.37	1.9
79	1010	629	62.3	45.2	19.9	141.9	24.1	6	5	11	1.2	1.2	9	11.83	11.80	1.9
80	1070	673	62.9	43.3	19.8	142.4	28.0	5	5	10	1.4	1.5	8	10.64	10.43	1.6
82	1010	643	63.7	40.8	19.4	146.4	24.3	5	5	10	1.2	1.4	9	9.80	10.21	1.6
86	1025	640	62.4	46.9	19.1	136.7	27.5	8	3	11	1.2	1.2	9	11.97	11.92	1.9
88	1060	663	62.5	45.1	20.2	145.6	24.6	5	6	11	1.2	1.2	8	11.23	11.63	1.8
90	965	620	64.2	42.8	18.8	137.8	27.6	5	5	10	1.6	1.6	8	10.04	9.95	1.6
91	1120	725	64.7	42.6	19.2	141.1	25.9	4	4	8	1.6	1.7	7	12.79	12.82	1.8
95	1025	636	62.0	41.8	19.8	138.8	26.0	4	6	10	1.3	1.4	9	10.98	10.92	1.7

Table 15d (concl.).

Con-test no.	Weight Live	Weight Dress	Dress %	Circumference Muzzle	Circumference Cannon	Circumference Round	Jaw depth	Visual fat score quantity	Visual fat score quality	Visual fat score Total score	Fat thickness Contest	Fat thickness Author's	Marbling	Loin eye area Contest	Loin eye area Author's	/100# carcass wt.
101	955	558	58.4	43.2	23.0	141.2	23.8	5	5	10	0.7	0.9	9	10.34	10.56	1.9
103	1000	630	63.0	44.3	19.2	140.0	24.6	6	6	12	1.3	1.5	10	11.05	10.96	1.7
105	1005	624	62.1	47.2	19.7	139.2	25.5	4	4	8	1.0	1.0	9	10.08	10.09	1.6
107	985	616	62.5	42.2	20.1	128.7	22.7	5	5	10	1.2	1.4	10	8.78	8.72	1.4
152	1175	772	65.7	43.2	19.8	153.4	26.0	7	6	13	1.7	1.6	8	12.98	13.42	1.7
269	945	602	63.7	45.6	19.1	141.1	23.8	8	6	14	1.1	1.1	8	9.03	9.55	1.6
270	1120	711	63.5	46.6	20.2	150.8	24.8	7	7	14	1.2	1.2	9	12.39	12.54	1.8
272	955	605	63.4	38.0	18.0	146.4	24.2	7	5	12	1.1	1.3	7	10.73	11.25	1.9
273	940	608	64.7	40.7	19.3	141.3	25.8	5	5	10	1.0	1.3	9	11.35	11.45	1.9
274	960	608	63.3	38.8	19.8	133.9	25.0	6	5	11	1.1	1.3	9	9.75	9.64	1.6
277	1050	684	65.1	44.5	21.6	130.6	26.0	5	4	9	1.1	1.3	10	10.61	11.04	1.6
279	1020	645	63.2	43.2	19.9	141.5	25.1	5	5	10	0.8	0.8	10	13.88	13.83	2.1
280	1035	650	62.8	43.8	20.2	138.2	25.4	5	7	12	1.1	1.0	8	11.22	11.68	1.8
281	945	602	63.7	41.1	19.3	137.8	25.7	5	5	10	1.1	1.0	10	11.43	11.45	1.9
282	1055	683	64.7	45.9	18.6	145.4	26.2	5	5	10	1.5	1.7	10	9.58	9.98	1.5
284	1030	652	63.3	47.1	21.4	142.3	24.2	8	7	15	1.1	1.3	8	9.83	10.22	1.6
285	1015	616	60.7	46.3	19.9	141.9	25.6	4	4	8	1.1	1.1	9	10.76	11.18	1.8
286	1135	705	62.1	45.5	21.2	151.3	24.2	6	5	11	1.0	1.2	10	12.60	13.04	1.8
287	995	623	62.6	44.0	18.9	153.8	23.6	5	5	10	0.8	1.0	8	11.40	11.40	1.8
289	1065	681	63.9	42.2	21.0	143.6	24.0	5	3	8	1.2	1.2	9	13.13	12.90	1.9
291	1125	697	62.0	45.5	19.7	137.7	25.5	5	5	10	1.2	1.2	9	10.45	10.50	1.5
293	965	591	60.0	46.4	21.7	154.6	24.0	3	3	6	0.8	0.7	9	10.16	10.62	1.8
294	960	576	60.0	44.8	20.7	144.9	26.5	3	3	6	0.7	0.7	9	11.72	11.63	2.0
297	930	539	58.0	40.8	19.8	138.2	26.0	4	6	10	0.9	1.0	10	10.74	11.36	2.1
298	940	563	59.9	40.1	19.3	140.9	25.1	8	5	13	0.9	0.9	10	10.80	11.20	2.0
299	1020	655	64.2	42.8	23.0	144.0	24.2	6	6	12	1.6	1.5	9	9.78	9.96	1.5

Table 15e. Summer yearling Hereford measures in phase one.

Con-test no.	Weight			Circumference				Visual fat score			Fat thickness			Loin eye area		
	Live	Dress	Dress %	Muzzle	Cannon	Round	Jaw depth	quantity	quality	Total score	Contest	Authority's	Marbling	Contest	Authority's	/100# carcass wt.
98	1065	684	64.2	47.2	21.9	149.3	25.5	8	6	14	1.0	1.0	7	12.13	12.05	1.8
163	1135	713	62.8	47.5	23.0	151.2	25.6	8	6	14	1.6	1.5	6	10.92	10.81	1.5
230	1125	690	61.3	44.3	21.6	147.2	28.4	8	7	15	1.1	1.2	8	12.03	12.45	1.8
232	1095	682	62.3	49.6	21.0	146.2	27.0	8	6	14	0.8	1.0	6	11.85	12.41	1.8
235	1080	686	63.5	43.4	22.0	146.8	27.0	5	5	10	1.0	1.1	8	10.93	10.84	1.6
241	995	624	62.7	45.0	21.1	136.2	27.3	8	6	14	1.5	1.6	9	10.87	10.82	1.7
244	1045	657	62.9	46.3	21.0	148.7	28.0	4	5	9	0.6	0.6	8	13.11	12.99	2.0
246	985	591	60.0	46.5	21.1	139.0	24.5	4	4	8	0.9	1.1	8	10.50	11.02	1.9
248	1050	659	62.8	45.2	20.9	130.4	25.5	6	5	11	0.8	1.2	8	12.33	12.24	1.9
249	990	605	61.1	45.6	21.8	141.6	29.0	5	5	10	0.7	0.7	6	10.58	10.50	1.7
253	1060	637	60.1	48.6	21.2	140.7	25.6	8	8	16	1.0	1.2	9	13.34	13.18	2.1
255	1085	670	61.8	47.4	22.4	141.8	24.0	9	7	16	1.2	1.2	6	11.65	11.62	1.7
259	995	627	63.0	44.7	20.2	146.3	25.0	8	6	14	1.0	1.0	9	11.17	11.66	1.9
261	1070	638	59.6	46.0	22.2	156.6	26.6	4	6	10	0.8	1.0	8	10.82	11.81	1.9
263	945	570	60.3	45.7	21.0	145.6	26.1	5	7	12	0.8	1.0	7	11.11	10.89	1.9
264	1135	713	62.8	46.8	20.5	150.9	27.0	8	5	13	0.9	1.2	8	12.87	13.14	1.8
276	1050	675	64.3	45.8	21.3	147.7	25.7	8	7	15	1.0	1.0	9	10.82	10.71	1.6
283	1045	651	62.9	46.4	21.1	148.2	26.5	7	5	12	1.2	1.3	2	13.66	13.29	2.0
300	980	548	55.9	44.9	21.2	139.7	26.0	5	5	10	0.7	1.1	7	11.55	11.16	2.0

Table 15f. Summer yearling Shorthorn measures in phase one.

Con-test no.	Weight		Dress %	Circumference			Jaw depth	Visual fat score			Fat thickness			Loin eye area		
	Live	Dress		Muzzle	Cannon	Round		quantity	quality	Total score	Contest	Author's	Marbling	Contest	Author's	#/100# carcass wt.
87	930	559	60.1	41.0	18.8	139.4	25.3	4	4	8	0.8	0.7	7	10.15	10.12	1.8
96	1070	655	61.2	49.3	18.2	137.6	26.0	6	5	11	1.2	1.2	6	9.24	9.60	1.5
100	1095	710	64.8	45.9	19.6	139.7	24.5	6	6	12	1.2	1.3	9	10.03	10.36	1.5
134	985	604	61.3	42.6	19.3	139.0	24.4	6	6	12	0.9	0.9	7	9.23	9.23	1.5
202	1220	761	62.4	45.5	20.0	146.9	26.5	6	5	11	1.4	1.6	8	10.56	10.90	1.4
205	965	570	59.1	41.2	19.0	136.0	25.0	5	5	10	1.2	1.3	7	9.14	9.55	1.7
225	1020	649	63.6	41.3	19.2	149.2	27.0	6	6	12	0.8	1.0	9	9.16	9.53	1.5
227	1030	619	60.1	46.0	19.4	132.3	24.9	6	7	13	1.1	1.2	7	10.34	10.27	1.7
242	1035	611	59.0	42.8	20.2	132.2	24.8	6	5	11	0.8	0.8	10	9.45	9.84	1.6
243	1035	643	62.1	47.7	20.6	142.6	26.5	5	6	11	1.3	1.3	9	10.23	10.28	1.6
245	1165	736	63.2	44.9	18.2	144.6	27.5	7	6	13	1.3	1.5	7	10.20	10.18	1.4
247	1020	625	61.3	41.9	19.7	139.1	26.0	5	5	10	0.8	1.1	10	11.18	11.60	1.9
250	1130	676	59.8	42.2	20.0	145.3	27.0	4	5	9	0.7	0.9	7	10.15	10.55	1.6
252	1070	661	61.8	44.0	20.9	139.6	26.7	6	6	12	0.6	0.9	7	11.09	11.09	1.7
254	1055	630	59.7	43.2	20.2	140.6	24.7	5	5	10	1.1	1.0	7	8.94	9.30	1.5
256	1010	645	63.9	44.0	19.0	131.1	25.0	6	7	13	1.3	1.3	10	10.34	10.73	1.7
258	1120	693	61.9	44.6	19.6	145.2	23.5	4	4	8	1.1	1.5	9	10.84	11.22	1.6
260	1025	637	62.1	47.4	21.0	142.8	26.0	5	4	9	0.8	0.8	6	10.87	10.77	1.7
262	1090	722	66.2	43.4	20.2	153.5	24.2	6	6	12	1.2	1.3	9	11.39	11.40	1.6

Table 15g. Senior calf Angus measures in phase one.

Con-test no.	Weight: Live	Weight: Dress	Dress %	Circumference: Muzzle	Circumference: Cannon	Circumference: Round	Jaw depth	Visual fat score: quantity	Visual fat score: quality	Visual fat score: Total score	Fat thickness: Con-test	Fat thickness: Author's	Marbling	Con-test	Author's	/100# carcass wt.
4	835	524	62.8	39.0	17.3	128.4	26.8	4	4	8	0.9	1.0	9	10.83	10.83	2.1
6	915	577	63.1	43.2	20.5	141.0	25.4	5	5	10	1.1	1.1	8	10.46	10.43	1.8
7	825	527	63.9	42.0	18.3	125.8	25.6	4	4	8	1.3	1.3	7	9.82	10.21	1.9
8	1020	630	61.8	43.4	19.6	137.1	24.6	5	5	10	0.8	1.0	10	11.91	11.78	1.9
9	810	489	60.4	40.2	19.4	123.0	25.1	5	4	9	0.9	0.9	8	9.98	9.86	2.0
10	985	602	61.1	41.0	20.0	141.0	26.5	5	5	10	1.5	1.5	9	10.55	10.41	1.7
11	925	596	64.4	41.8	18.8	146.2	25.2	4	5	9	1.0	0.9	10	11.21	11.73	2.0
12	930	559	60.1	40.8	18.1	134.7	23.2	4	5	9	1.1	1.1	10	9.62	9.54	1.7
13	1080	663	61.4	42.7	19.7	143.3	25.3	6	5	11	0.8	1.1	9	11.58	11.44	1.7
14	980	627	64.0	41.3	18.7	136.2	27.0	4	4	8	1.1	1.1	7	11.58	12.05	1.9
15	910	540	59.3	45.4	22.2	135.2	24.6	4	4	8	0.9	1.0	8	10.03	10.42	1.9
16	1045	667	63.8	41.7	19.4	144.5	23.8	5	5	10	1.3	1.3	7	11.35	11.43	1.7
17	855	512	59.9	38.0	18.7	132.4	24.6	5	5	10	0.9	1.2	8	8.14	8.48	1.7
20	825	508	61.6	40.3	18.3	126.4	23.7	4	4	8	0.9	0.9	9	9.84	8.53	1.7
21	925	575	62.2	43.6	19.3	134.2	26.5	6	5	11	1.1	1.2	7	9.73	10.04	1.7
22	900	527	58.6	38.9	18.2	129.4	25.3	4	4	8	0.7	1.0	8	8.51	8.80	1.7
23	890	571	64.2	39.2	17.7	132.2	27.0	6	6	12	1.1	1.2	10	10.75	11.26	2.0
24	865	556	64.3	39.2	18.6	133.2	23.7	5	5	10	0.9	1.2	10	9.63	10.00	1.8
26	930	569	61.2	42.0	20.0	140.6	26.1	5	4	9	1.2	1.3	8	9.90	9.98	1.8
27	960	592	61.7	44.9	18.8	140.3	25.6	5	5	10	1.0	0.8	10	11.43	11.94	2.0
28	1030	639	62.0	48.5	21.3	140.2	25.1	5	4	9	0.8	0.8	9	12.10	11.97	1.9
29	850	539	63.4	39.8	17.8	132.1	26.6	5	4	9	0.8	0.7	8	11.48	11.50	2.1
31	835	502	60.1	48.2	19.7	128.6	26.2	5	4	9	1.4	1.3	8	9.65	9.61	1.9
32	835	498	59.6	39.3	20.7	130.3	26.7	4	4	8	0.8	0.8	9	9.64	9.51	1.9
33	950	556	58.5	48.0	19.2	132.6	26.0	5	4	9	1.1	1.1	9	9.78	10.14	1.8
34	835	504	60.4	41.2	18.9	127.4	23.9	4	5	9	1.0	1.1	8	10.06	10.43	2.1
36	1075	679	63.2	43.2	20.7	147.3	25.5	5	5	10	1.1	1.1	7	13.10	12.83	1.9
37	820	507	61.8	38.0	18.0	136.5	25.2	4	4	8	0.8	1.0	10	9.81	10.11	2.0
41	915	574	62.7	40.0	19.3	129.0	26.0	4	5	9	1.2	1.5	9	11.01	11.00	1.9
46	870	532	61.1	37.9	18.3	117.0	24.2	5	5	10	1.5	1.4	10	9.84	9.80	1.8
47	960	600	62.5	41.8	18.5	134.2	25.5	5	5	10	1.5	1.3	8	9.26	9.16	1.5

Table 15g (concl.).

Con-test no.	Weight Live	Weight Dress	Dress %	Circumference Muzzle	Circumference Cannon	Circumference Round	Jaw depth	Visual fat score quantity	Visual fat score quality	Visual fat score Total score	Fat thickness Con-test	Fat thickness Author's	Fat thickness Marbling	Loin eye area Con-test	Loin eye area Author's	Loin eye area /100# carcass wt.
48	800	471	58.9	41.4	18.9	127.0	25.0	4	5	9	0.2	0.2	5	11.57	12.02	2.6
49	815	471	57.8	39.3	18.3	130.7	24.6	5	5	10	0.8	1.0	10	14.01	13.95	3.0
52	815	470	57.7	39.4	19.5	121.4	23.5	4	4	8	0.7	0.5	7	12.14	12.49	2.7
53	920	586	63.7	42.8	18.7	136.6	26.8	5	4	9	0.8	1.0	9	14.28	14.75	2.5
85	810	487	60.1	42.0	18.9	138.8	24.5	4	4	8	0.7	0.7	9	8.37	8.40	1.7

Table 15h. Senior calf Hereford measures in phase one.

Con-test no.	Weight Live	Weight Dress	Dress %	Circumference Muzzle	Circumference Cannon	Circumference Round	Jaw depth	Visual fat score quantity	Visual fat score quality	Visual fat score Total score	Fat thickness Con-test	Fat thickness Author's	Fat thickness Marbling	Loin eye area Con-test	Loin eye area Author's	Loin eye area /100# carcass wt.
3	930	576	61.9	49.3	22.0	132.4	27.6	5	5	10	1.2	1.1	8	9.78	10.21	1.8
5	945	564	59.7	47.0	24.0	135.1	26.8	4	4	8	0.6	0.7	8	11.42	11.73	2.1
51	840	482	57.4	45.0	20.2	132.0	26.1	4	5	9	0.5	0.5	6	10.44	10.43	2.2
204	925	580	62.7	46.9	21.9	139.2	27.0	6	6	12	1.1	1.2	7	9.19	9.68	1.7
209	980	617	63.0	42.5	21.8	148.4	24.6	6	6	12	1.2	1.3	7	10.47	10.43	1.7
226	925	564	61.0	44.2	20.3	135.7	23.9	5	5	10	1.0	1.1	8	11.46	11.44	2.0
251	1055	629	59.6	47.0	23.0	144.6	25.2	5	5	10	0.6	0.6	8	12.69	12.74	2.0

Table 15i. Senior calf Shorthorn measures in phase one.

Con-test no.	Weight Live	Dress	Dress %	Circumference Muz-zle	Can-non	Round	Jaw depth	Visual fat score quan-tity	qual-ity	Total score	Fat thickness Con-test	Au-thor's	Mar-bling	Loin eye area Con-test	Au-thor's	/100# car-cass wt.
201	920	548	59.6	43.8	17.3	135.9	21.5	5	6	11	0.9	1.1	8	8.53	8.46	1.5
206	850	494	58.1	40.2	19.3	129.4	23.3	4	5	9	0.5	0.5	8	11.97	11.93	2.4
208	830	522	62.9	38.4	18.4	130.8	24.7	6	5	11	1.2	1.3	7	7.67	8.18	1.6
210	870	540	62.1	41.2	18.7	132.8	24.1	6	6	12	1.1	1.1	7	9.52	9.75	1.8
211	860	505	58.7	41.8	19.2	127.9	34.3	5	6	11	0.7	0.9	8	11.76	11.68	2.3
213	1000	601	60.1	46.9	19.7	136.4	26.4	4	1	5	1.1	1.3	8	8.98	8.99	1.5
217	1060	652	61.5	43.7	20.2	141.2	28.2	5	5	10	1.1	1.3	9	9.24	9.64	1.5
221	860	504	58.6	41.0	19.4	136.2	25.6	4	4	8	0.7	0.6	9	10.34	10.87	2.2
223	960	565	58.9	40.4	19.2	139.6	25.4	4	6	10	0.6	0.6	9	9.52	10.01	1.8
233	830	489	58.9	39.7	17.8	130.0	24.1	4	4	8	0.7	0.7	7	9.35	9.74	2.0
236	945	597	63.2	42.0	19.8	145.1	25.9	6	6	12	0.9	0.9	9	11.58	11.12	1.9
239	880	513	58.3	42.4	19.4	126.6	25.2	3	6	9	0.7	0.7	10	9.66	10.02	2.0

Table 16. Scores for visual fat in phase one.

	Visual quantity finish	Visual quality finish
1	Completely lacking	Completely soft
2	Lacking	Soft
3	Moderately lacking	Moderately soft
4	Slightly lacking	Slightly soft
5	Correct amount	Correct trimness
6	Slightly over	Slightly hard
7	Moderately over	Moderately hard
8	Over	Hard
9	Completely over	Completely hard

Table 17a. Correlations for senior calves in phase one.

	Dressed weight	Dressing %	Muzzle circum.	Jaw depth	Cannon circum.	Round circum.	Visual quantity	Visual quality	Total fat	Contest fat 12th rib	Author's fat 12th rib	Marbling	Contest loin eye area	Author's loin eye area	Loin eye area /100# carcass weight
Live weight	.953**	.317*	.256	.212	.315*	.038	.301*	.111	.230	.278*	.313*	.079	.304*	.296*	-.399**
Dressed weight		.588**	.185	.183	.254	.053	.373**	.121	.274*	.390**	.420**	.103	.323*	.313*	-.426**
Dressing %			-.104	.010	-.045	.070	.376**	.077	.246	.489**	.491**	.123	.177	.168	-.292
Muzzle circum.				.596**	.670**	.312*	.190	.300*	.296*	.149	.136	.138	-.043	-.015	-.143
Jaw depth					.902**	.440**	.100	.228	.202	.115	.137	.089	.092	.109	-.019
Cannon circum.						.464**	.100	.237	.208	.083	.085	.029	.109	.115	-.064
Round circum.							.048	.083	.079	.039	-.068	.193	.105	.088	.054
Visual quantity								.437**	.807**	.443**	.456**	-.097	-.009	-.013	-.272*
Visual quality									.884**	.081	.094	.080	.017	.040	-.045
Total visual score										.284*	.299*	.002	.007	.019	-.171
Contest fat									.881**	.094	-.257	-.274*	-.536**		
Author's fat										.157	-.281*	-.298*	-.581**		
Marbling											.100	.075	-.021		
Contest loin												.975**	.690**		
Author's loin													.720**		

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

Table 17b. Correlations for summer yearlings in phase one.

	Dressed weight	Dressing %	Muzzle circum.	Jaw depth	Cannon circum.	Round circum.	Visual quantity	Visual quality	Total fat	Contest fat 12th rib	Author's fat 12th rib	Marbling	Contest loin eye area	Author's loin eye area	Loin eye area /100# carcass weight
Live weight	.931**	.247*	.196	.039	.280**	.000	.264**	.236*	.271**	.277**	.291**	-.169	.301**	.305**	-.385**
Dressed weight		.584**	.144	.028	.213*	-.008	.343**	.272**	.336**	.393**	.385**	-.100	.325**	.322**	-.427**
Dressing %			-.052	-.014	-.050	-.020	.321**	.190	.283**	.427**	.375**	.107	.184	.169	-.284**
Muzzle circum.				.453**	.393**	.402**	.017	-.014	.003	-.115	-.109	-.003	.156	.173	.058
Jaw depth					.214*	.212*	.081	.087	.090	-.022	.050	-.071	.107	.136	.111
Cannon circum.						.215*	-.005	.028	-.016	.048	.083	-.047	.003	.029	-.107
Round circum.							-.128	-.109	-.129	-.140	-.181	-.022	.157	.195	.179
Visual quantity								.717**	.942**	.268**	.258*	-.168	.216*	.199	-.064
Visual quality									.910**	.192	.204*	-.136	.088	.088	-.116
Total visual score										.283*	.252*	-.166	.171	.161	-.094
Contest fat								.852**	-.040	-.047	-.046				-.333**
Author's fat									-.030	-.063	-.059				-.332**
Marbling										-.140	-.109				-.016
Contest loin											.972**				.684**
Author's loin															.714*

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

Table 17c. Correlations for junior yearlings in phase one.

	Dressed weight	Dressing %	Muzzle circum.	Jaw depth	Cannon circum.	Round circum.	Visual quantity	Visual quality	Total fat	Contest fat 12th rib	Author's fat 12th rib	Marbling	Contest loin eye area	Author's loin eye area	Loin eye area /100# carcass weight
Live weight	.898**	.247	.122	.111	.108	.191	.150	-.035	.065	.085	.140	.059	.525**	.535**	-.133
Dressed weight		.646**	-.018	.040	-.059	.126	.273*	.021	.170	.329*	.414**	.224	.500**	.524**	-.237
Dressing %			-.257*	-.105	-.319	-.047	.351**	.138	.287	.576**	.668**	.401**	.198	.233	-.287
Muzzle circum.				.588**	.930**	.707**	-.083	-.214	-.179	-.194	-.124	-.138	.067	.058	.091
Jaw depth					.615**	.506**	-.028	-.199	-.139	-.039	.021	.059	.060	.045	.024
Cannon circum.						.700**	-.030	-.172	-.123	-.245	-.168	-.157	.019	.008	.070
Round circum.							.153	-.044	.061	-.077	-.042	-.089	.087	.084	-.006
Visual quantity								.406**	.826**	.582**	.365**	.294*	-.006	.022	-.189
Visual quality									.851**	.150	.081	.226	.019	.019	-.010
Total visual score										.427**	.260*	.309*	.008	.024	-.115
Contest fat								.869**	.358**	-.160	-.137		-.426**		
Author's fat									.349**	-.120	-.107		-.472**		
Marbling										.162	.148		-.023		
Contest loin											.979**		.697**		
Author's loin													.701**		

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

Table 18. All measures for steers in phase two.

Steer no.	Muzzle circum.	Width between eyes	Jaw depth	Round circum.	Cannon circum.	Forearm circum.	Head length	Loin eye area	Live wt.	Dressing %	Fat thickness 12th rib	Carcass grade	Marbling	Side weight	Total lean weight	Total fat weight	Total bone weight	Total lean round	Total lean loin	Total lean rib	Total lean chuck
3	44.6	23.4	25.5	134.9	20.4	42.4	44.9	10.21	1030	65.78	1.55	6	7	333.5	192.55	104.35	38.00	48.90	27.70	14.15	61.10
4	46.5	19.9	25.2	136.4	21.5	43.3	44.9	12.43	1112	63.84	1.12	6	7	350.0	201.90	98.45	45.85	56.20	25.90	17.10	53.05
6	45.5	21.3	26.0	138.5	22.0	47.8	46.9	13.25	1098	62.48	.68	6	7	337.0	215.15	64.25	56.30	55.80	30.35	15.30	71.55
15	44.4	23.7	25.4	142.0	22.6	47.1	43.3	10.15	912	65.13	.73	6	7	294.0	171.50	77.50	38.55	49.15	27.70	12.30	52.75
16	46.2	22.8	23.8	141.6	23.0	47.2	46.6	11.65	1008	63.59	.75	6	7	314.0	195.65	71.90	44.70	55.40	27.05	13.40	64.70
18	45.6	21.4	25.8	143.3	21.8	47.5	45.7	11.40	1030	66.21	.72	3	4	335.0	200.20	84.05	48.45	53.50	29.50	17.50	64.50
19	46.2	23.6	24.2	134.8	21.7	42.8	42.9	11.80	970	61.24	.46	8	9	291.0	186.35	58.45	43.80	53.90	24.75	14.00	57.90
20	46.0	21.3	26.2	128.7	19.9	44.6	45.4	11.66	944	65.30	.86	4	5	298.0	195.65	56.65	42.30	51.20	27.05	14.05	57.50
29	47.3	22.3	25.6	143.5	20.4	42.4	44.5	12.55	950	65.05	.80	7	8	302.0	193.85	59.50	47.25	54.90	27.15	14.40	60.90
30	45.8	21.6	23.8	139.6	21.2	42.7	45.2	12.90	1084	62.45	.73	6	7	330.0	211.80	68.15	46.05	57.30	27.15	21.20	63.85
31	45.3	21.2	25.6	137.8	21.8	43.2	45.8	9.61	988	62.96	1.05	5	6	305.0	170.15	86.70	43.75	43.75	23.75	13.10	57.30
32	43.1	20.7	25.7	135.4	20.0	42.6	45.8	10.85	1056	60.60	.70	6	7	312.0	194.75	65.95	52.35	56.95	25.55	14.85	57.50
33	46.8	24.0	25.6	148.1	21.2	42.1	48.8	13.72	1060	62.74	.78	7	8	331.0	207.25	71.40	48.70	54.85	24.45	14.05	63.35
34	46.0	22.8	24.8	143.2	22.7	44.2	46.6	11.08	998	63.72	.65	5	6	311.0	193.70	71.45	47.10	50.90	26.35	15.40	57.45
36	46.0	24.9	25.6	144.0	21.7	41.2	44.2	11.15	1052	63.78	.86	5	6	330.0	194.65	79.25	52.45	50.80	24.95	18.85	58.25
37	47.2	22.8	24.7	136.2	22.0	43.6	44.1	10.98	1056	64.02	.83	5	6	328.0	193.45	87.65	47.20	54.70	25.60	14.35	60.30
39	46.1	22.6	24.9	134.7	21.8	43.2	45.9	11.91	992	65.12	.85	7	8	315.0	197.30	72.05	44.70	53.30	26.70	13.70	62.10
44	46.1	20.6	26.2	126.3	21.1	43.5	46.4	12.50	1010	62.28	.66	6	7	310.0	201.05	57.85	46.30	53.80	25.55	13.95	65.10
45	43.2	20.3	25.7	133.3	22.4	43.7	46.2	11.65	1042	63.05	1.02	6	7	323.0	201.85	67.58	52.65	60.10	26.50	14.30	65.30
47	41.7	19.5	24.2	136.2	20.0	45.0	45.6	11.14	1058	63.98	1.08	4	5	331.0	181.25	98.60	49.70	47.90	24.55	12.20	58.95
54	47.5	18.5	26.3	139.5	21.9	48.0	46.4	11.39	1236	62.30	.78	7	8	375.0	230.75	89.90	56.00	62.45	27.25	17.80	74.60
69	48.3	22.4	25.2	142.5	21.0	42.5	44.3	8.66	914	61.92	.50	9	9	273.0	181.75	39.15	48.90	49.85	24.20	11.95	54.10
72	47.3	22.2	26.6	143.0	22.8	47.0	48.3	11.01	1162	63.68	.88	6	7	365.0	222.40	81.10	59.70	56.85	35.00	15.80	75.30
75	48.1	19.8	26.6	130.3	20.9	41.9	45.6	13.60	1042	64.20	.76	4	5	330.5	218.30	62.55	48.85	54.65	28.10	16.15	75.40
80	45.9	22.3	23.6	135.3	20.8	42.8	43.8	12.43	1050	64.19	.68	6	7	329.0	206.75	84.05	45.60	59.40	25.90	15.90	70.50
89	46.5	24.5	26.4	141.8	21.2	44.3	43.6	11.85	1092	63.64	.76	6	7	341.0	219.95	75.15	45.45	58.55	30.60	15.90	71.60
91	45.7	18.4	25.2	133.3	21.2	45.4	47.6	13.75	1080	63.56	.98	4	5	335.0	223.20	64.50	46.30	60.70	29.45	15.90	72.35
103	43.7	19.9	26.2	138.2	24.4	44.1	44.7	10.73	1021	66.80	.86	5	6	327.5	187.85	93.75	44.00	49.50	26.15	14.90	56.50
108	47.0	25.0	27.0	140.5	22.4	43.7	47.4	10.68	1058	62.94	.68	5	6	333.0	199.55	86.30	47.80	52.65	27.30	15.50	64.50
110	43.8	20.2	24.7	146.7	21.0	43.1	43.8	10.84	1026	66.27	1.03	5	6	336.0	195.90	83.15	47.90	54.50	27.30	15.50	55.80
111	45.3	20.8	24.8	149.6	24.7	44.2	43.2	11.10	1038	65.32	1.22	6	7	338.0	190.10	91.15	57.85	53.45	25.95	13.80	59.30
135	45.5	25.0	26.2	149.5	24.7	48.5	45.8	10.93	980	64.18	.88	6	7	310.0	187.60	81.40	43.50	51.80	25.95	15.10	54.15
139	44.4	23.7	25.4	142.0	22.6	47.1	43.3	10.15	1078	63.17	.55	5	6	333.0	210.25	70.65	48.20	58.20	28.55	16.60	63.00

Table 19. USDA carcass grades for phase two cattle.

1	High prime
2	Average prime
3	Low prime
4	High choice
5	Average choice
6	Low choice
7	High good
8	Average good
9	Low good

Table 20. USDA marbling scores for phase two.

1	Extremely abundant
2	Very abundant
3	Abundant
4	Moderately abundant
5	Slightly abundant
6	Moderate
7	Modest
8	Small
9	Slight
10	Traces

Table 21. Correlations for steers in phase two.

	Eye width	Jaw depth	Round circum.	Cannon circum.	Arm circum.	Head length	Loin eye area	Live weight	Dressing %	Fat thickness 12th rib	Carcass grade	Marbling	Side weight	Total lean weight	Total fat weight	Total bone weight	Total lean round	Total lean loin	Total lean rib	Total lean chuck
Muzzle circum.	.223	.223	.058	-.016	-.100	.165	.217	.075	-.184	-.352*	.330	.304	.020	.361*	-.341	.100	.193	.160	.182	.342
Eye width		.037	.425*	.197	-.046	-.163	-.261	-.316	-.051	-.262	.257	.267	-.291	-.242	-.062	-.288	-.238	-.019	-.050	-.222
Jaw depth			-.083	.109	.181	.351*	-.042	.183	.021	-.006	-.156	-.160	.213	.269	-.042	.197	.017	.375*	.050	.254
Round circum.				.509**	.262	-.061	-.261	.008	.176	-.003	.178	.174	.118	-.124	.201	.233	-.074	.065	.083	-.220
Cannon circum.					.469**	-.018	-.232	.024	.210	.002	.032	.052	.124	-.117	.264	.158	-.062	.100	-.001	-.113
Arm circum.						.204	-.100	.242	.082	-.123	-.182	-.170	.263	.198	.136	.161	.188	.498**	.011	.217
Head length							.363*	.344*	-.244	.022	-.126	-.114	.281	.387*	-.064	.289	.141	.256	.035	.424*
Loin eye area								.305	-.091	-.069	-.121	-.062	.290	.600**	-.201	.121	.526**	.192	.348*	.532**
Live weight									-.229	.139	-.127	-.084	.928**	.773**	.405*	.595**	.623**	.432*	.585**	.641**
Dressing %										.490**	-.443**	-.437*	.124	-.194	.454**	-.297	-.297	.185	-.005	-.179
Fat 12th rib											-.223	.343	-.130	.653**	-.072	-.223	-.003	-.098	-.124	
Carcass grade												.991**	-.288	-.079	-.340	.055	.125	-.226	-.245	-.123
Marbling													-.238	-.050	-.292	.053	.162	-.206	-.216	-.096
Side weight														.705**	.594**	.514**	.511**	.512**	.561**	.587**
Total lean weight															-.095	.456**	.825**	.626**	.606**	.852**
Total fat weight																-.035	-.174	.012	.134	-.086
Total bone weight																	.413*	.294	.237	.435*
Total lean round																		.418*	.484**	.639**
Total lean loin																			.304	.628**
Total lean rib																				.343

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

CORRELATION OF LIVE ANIMAL MEASUREMENTS TO CARCASS CHARACTERISTICS

by

RICHARD MILES MCKEE

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The emphasis in today's dressed beef market is for a carcass of excellent quality which has a high percentage of red meat. Present slaughter grades are still largely based on the same standards used for the last several decades.

This study explored some of the live animal characteristics and their relationship to the carcass in search of some measure for better pre-slaughter evaluation of cattle. It should be hoped information of this type obtained from slaughter cattle would be useful in implementing a breeding program designed to produce meaty carcasses.

This study was divided into two phases. Phase one concerned measurements of 210 fat steers at the International Livestock Exposition in Chicago. Phase two was measurements of 33 head of slaughter cattle at Kansas State University. Steers in both phases were divided into four month age brackets for correlation analyses.

Live animal measures on steers in phase one were muzzle circumference, depth of jaw, circumference of round, cannon circumference, and live weight. A visual appraisal of the quantity and quality of finish was also made on these steers. Carcass measures on these steers included dressed weight, fat thickness at the 12th rib, marbling, and loin eye area.

Live animal measures in phase two were weight, muzzle circumference, head length, width between the eyes, depth of jaw, cannon circumference, forearm circumference, and round circumference. Carcass data in phase two included fat thickness at the 12th rib, carcass grade, marbling, total lean weight, total bone weight, total fat weight, total lean in the round, total lean in the loin, total lean in the chuck, and total lean in the rib.

Live animal measures were significantly correlated to each other, but not to live weight. In both phases cannon circumference had a positive signifi-

cant correlation to measures of muscle, forearm circumference, and, or, round circumference.

In phase one, the visual quantity fat score had a positive significant correlation to fat at the 12th rib. These correlations were .456 for senior calves, .258 for summer yearlings, and .365 for junior yearlings. Only in the older cattle of phase one was there a correlation between fat at the 12th rib, and marbling.

Muzzle circumference was correlated to total lean weight in phase two (.361).

Steers in phase two with larger loin eyes had less total fat, less fat at the 12th rib, more total lean, and more total bone. Steers in phase one with larger loin eyes had less fat at the 12th rib.