RELATIONSHIPS OF MUSCLE, FAT, BONE AND SOME PHYSICAL MEASUREMENTS TO BEEF CARCASS CUTABILITY

by

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INTRODUCTION

The proportion of muscle, fat and bone in a beef carcass determines the yield of edible meat and these proportions are of importance to the producer, processor, retailer and consumer. Consumers prefer beef cuts with a high proportion of lean meat in relation to fat and bone. Except for special trade, fat covering in excess of one-fourth inch is usually trimmed by the retailer. This fat trim must be taken into consideration when the retailer buys beef because the fat that is trimmed costs the same per pound as lean meat. The price received for the trimmed cut must therefore absorb the amount of loss by trim. Visual estimation of slaughter steers involves an estimate of lean meat yield and percent of live weight that can be sold.

According to Kropf and Graf (33), production of boneless, kitchen-ready meat cuts, especially those handled in frozen state seem destined to increase markedly. Few data exist on cutting yields.

One of the problems in determining the value of slaughter cattle has been to devise an accurate measure of "lean meat" yield and quality. Slaughter grade or carcass grade has been used but is subject to limitations of human judgment and gives no evaluation of cutability.

Live animal measurements have been used as well as some carcass measurements in attempts to arrive at some practical and reliable method of predicting carcass yield of the edible portion.

This study was conducted in an effort to evaluate cutability of beef by studying the relationship of muscle, fat and bone as well as various carcass measurements and components upon the yield of trimmed retail cuts.

REVIEW OF LITERATURE

Loin eye area has been used as an indicator of lean meat yield of a carcass. Many studies have centered around its use to determine the influence of loin eye area on carcass yield.

Cole et al. (17) found a higher relationship between separable lean of the carcass, or of a particular cut and carcass weight, than between these items and loin eye area in a study to determine measures of total carcass lean. The separable lean of the round appeared to be a much better estimation of total carcass lean than loin eye area. With the effects of carcass weight and breed eliminated, the separable lean of the round, chuck and foreshank were associated with 90, 87 and 66 percent of the variation in total separable lean of the carcass respectively. Regression equation showed that the total carcass lean increased 2.94 pounds and 20.43 pounds for each pound increase in separable lean of the round and foreshank, respectively. Loin eye area was associated with only 18 percent of the variation in total separable carcass lean and accounted for 5 - 30 percent of the variation in separable lean of a particular wholesale cut. The highest relationship existed between separable lean of the 9-10-11 rib section and loin eye area (.55). Separable lean of a particular wholesale cut was more indicative of carcass leanness or muscling than either loin eye area or various carcass measurements. Correlation coefficients between total separable carcass lean and the various wholesale cuts were: round (.95), chuck (.93), foreshank (.81), sirloin (.80), rib (.79), and 9-10-11 rib cut (.74).

Murphy et al. (37) reported the most useful measure for predicting yield of retail cuts from beef carcasses, and live cattle is the partially boneless or boneless trimmed retail cuts from the round, loin, rib and chuck. An equation was formulated for predicting yield of retail cuts from beef carcasses as follows: retail cuts from the round, loin, rib and chuck = 51.34 minus 5.784 (fat thickness over rib eye, in.) minus .0093 (carcass weight, lbs.) minus .462 (kidney fat, % of carcass) plus .740 (area of rib eye, sq. in.). Each .3 inch increase in average fat thickness over the 12th rib was found to reduce yield of retail cuts by 2.6 percent.

Boughton (4) found the correlation between the area of the longissimus dorsi muscle and percent of untrimmed cuts to be (.11) for steers and (.08) for heifers. Significant negative correlations of (-.44) in steers and (-.28) for heifers were noted between percent of commercial round and fat thickness over the 12th rib. Area of the longissimus dorsi muscle was negatively correlated (-.07) with percent commercial round in steers and positively correlated (.17) in heifers. Percent of loin was significantly correlated (.45) with loin eye area in steers but was negative and non-significant (-.03) in heifers.

Cole et al. (16) working with 51 steers representing six breeds ranging in carcass grade from high utility to low prime, measured areas of the longissimus dorsi muscle at the 5th and 12th rib and last lumbar vertebra. Simple correlation coefficients between total separable carcass lean and loin eye area at these locations and the average of these three were: (.589), (.578), (.390), and (.681), respectively. The average of these three measurements times carcass length and correlated with total separable carcass lean was (.728). Multiple area measurements in combination with carcass length was associated with 53 percent of the variation int total separable carcass lean. By combining carcass length with loin eye area measurement, a definite improvement in estimating separable lean was demonstrated over any one loin eye area measurement or an average of the three loin eye area measurements.

Kline and Hazel (32) found little increase in accuracy for predicting lean cuts from measuring loin eye areas in more than one place on pork carcasses.

Dunn (19) studied the relationship of loin eye area and other carcass characteristics to trimmed wholesale cuts and fat trim in 48 Hereford steer carcasses. The round, loin, rib, and chuck were trimmed to one-fourth inch of fat and reported as percent of the carcass. Loin eye area was adjusted by dividing by carcass weight and multiplying by 100. The trimmed chuck (.87), untrimmed chuck (.83), trimmed round (.76) and untrimmed round (.52) were more highly significantly correlated with total trimmed wholesale cuts than loin eye area ratio (.42) or actual loin eye area (.19). The untrimmed chuck and round accounted for 27 and 76 percent of the variation in total trimmed wholesale cuts while loin eye area accounted for only 18 percent. These results indicated that loin eye area was not a good indicator of total pounds of untrimmed or trimmed loin per 100 pounds of carcass. The trimmed chuck was found to be the best indicator of total trimmed wholesale cuts. The trimmed round was found to be the best indicator of the trimmed round, loin, and rib.

Butler (7) found that eye muscle development was not directly proportional to weight increase with weight exerting a negative influence. The fast growing steers tended to have more fat and less eye muscle in a time-constant test.

Goll *et al.* (23) found no evidence from their study that loin eye area was closely related to items representing over-all carcass value.

Pearson *et al.* (40) investigated the fat-lean ratio in a cross section of rough loin at the last rib as a possible measure of leanness in pork carcasses. A correlation coefficient of approximately (-.60) between fat-lean ratio and several measures of carcass cut-out indicated the relationship may be high enough to be useful when it was impossible to obtain cut-out information. However, area of lean at the 10th or last rib was only slightly less reliable than ratio of fat to lean for estimating cut-out values.

A coring device was used to procure samples of fat and lean tissue from pork carcasses by Aunan et al. (1). A 5th and 6th rib sample offered the best index of lean tissue when percentage figures were used. It did not hold true for estimating fat content. A high degree of association existed between lean content of sample and percent of the five primal cuts. Ratio of fat to lean tissue in the 5th and 6th rib samples was highly associated with ratio of fat to lean tissue of the carcass.

Lush (34) found the percent fat of the wholesale rib cut of the beef carcass to be a more accurate indicator of degree of fatness of the entire animal than any of the other indicators studied.

Hankins and Howe (26) found the separable fat content of the 9-10-11 rib cut to be a good index of the ether-extract content of the 9-10-11 rib cut from a study of carcasses from 197 cattle. The cattle were divided into a group of steers, a group of heifers and a combination group of steers and heifers. The separable fat of the 9-10-11 rib cut was only slightly less valuable than ether-extract as an index of separable fat of the dressed carcass and of the ether-extract of the edible portion of the dressed carcass. The correlation between percent separable lean in the 9-10-11 rib cut and that of the carcass was highest in steers, lowest for heifers and intermediate for steers and heifers as a group. The usefulness of this technique appeared questionable in heifers. The relation between separable fat of the carcass and ether-extract of the edible portion was very similar. Percent ether-extract of the edible portion of the 9-10-11 rib cut was highly correlated with that of the carcass. The chuck was found to be most closely related to the 9-10-11 rib cut with respect to ether-extract of the edible portion of the carcass.

Hopper (29) reported from his study on 92 cattle that the physical and chemical composition of the whole and edible portion of wholesale and 9-10-11 rib cuts was highly correlated with physical and chemical composition of empty body, carcass, and edible portion of the carcass. This was especially true of fat percentage.

Crown et al. (18) reported that with respect to cooking loss and separable fat, lean and bone, the 12th rib cut could be used to predict the carcass yield and meat quality of beef.

Chatfield (14) found a close relationship between content of fat for any wholesale cut determined by ether-extract and fat of the carcass.

Woodward et al. (46) noted from their study a very similar correlation (.67) between area of eye muscle and weight of eye muscle to a correlation (.63) between thickness of fat at the 12th rib and weight of fat in the 9-10-11 rib cut.

Kennick and England (31) took two pair of probe samples for each rib cut as a method of estimating percentage of protein and fat in the edible portion of steer carcasses. One pair was taken between the 8th and 9th ribs and one between the 10th and 11th ribs. One probe was taken through the deepest portion of the longissimus dorsi muscle (eye probe) and the other through the center of seam fat separating the longissimus dorsi and longissimus costarum muscles from the obliquus abdominis externus and latissimus dorsi muscles perpendicular to the rib (side probe). Multiple correlations between weight of fat in the two side probes and warm carcass weight with percent fat and percent protein in the 9-10-11 rib cuts were (.781) and (.735), respectively. Weight of fat in the probe was found to be more highly correlated with the chemical composition of the 9-10-11 boneless rib cut than was fat or lean in the probe expressed in percentage. Weight of the carcass not only influenced weight of fat in the probes but was highly significantly correlated with percent of fat (.64) and protein (.65) in the boneless 9-10-11 rib cut.

Magee et al. (36) made a study of 62 yearling Hereford and Angus steers fed alike for 180 days and found that gain had a larger direct effect on carcass grade than age, final weight, or loin eye area. The correlation coefficient between loin eye area and carcass grade was small (-.0016). The correlation between loin eye area and carcass grade was (.20). Carcass grade was more highly correlated with final weight (.52) than any other variable.

Dunn (19) and Boughton (4) found carcass grade was highly correlated with marbling score (.97) indicating the influence of marbling in determining carcass grade under present U.S.D.A. standards. Other characteristics significantly correlated with carcass grade were: conformation grade (.55), carcass weight (.45), and live weight (.42). Carcass grade was negatively significantly correlated with total trimmed round (-.35). As carcass grade increased, pounds of trimmed and untrimmed round and total trimmed wholesale cuts per 100 pounds of carcass weight decreased.

Goll et al. (24) noted from their study that yield of round and chuck decreased while loin and rib increased as grade increased. It appeared that with increase in grade there was generally an increase in finish which was deposited in the loin and rib. The yield of the chuck also increased while the round decreased as carcass weight increased indicating deposit of fat in the chuck. Pierce (41) noted that amount of finish influenced the yield of most cuts considerably more than conformation.

Wheat and Holland (45) obtained information on 688 Hereford steers and heifers concerning the relationship between slaughter and carcass grade. The average correlation between slaughter grade and carcass conformation grade ranged from (.23) to (.51). Average correlations between slaughter grade and (before ribbing) carcass grade, were highly significant (.28) to (.55). Average correlations between slaughter grade and (after ribbing) carcass grade ranged from (.07) to (.39). All except two correlations were highly significant with only (.07 being not significant. Average correlations between carcass grade after ribbing and degree of marbling was (.89).

Results of a study by Kropf <u>et al</u>. (33) on beef carcasses selected to fit the middle or the choice, good, or commercial and standard grades in steer, heifer and cow classifications and in 400-500, 600-700 and 800-900 pound carcass weights indicated that boneless beef yield and percent of bone decreased and fat percentage increased as grade increased. Boneless beef to bone ratio increased in higher grades primarily since bone decreased markedly in higher grades. Boneless beef to bone ratio was lower in steers, similar in cows and heifers. Boneless beef yield decreased in 800-900 pound carcasses. Percent fat increased and percent bone decreased as carcass weight increased. Light weight carcasses (400-500 pounds) showed a lower boneless beef to bone ratio.

Clifton (15) made a study of the relationship between carcass measurements and carcass grades. He reported correlations between carcass grade and the following carcass measurements: width of fat at the 12th rib (.77), average width of fat at the 12th rib (.72), hot carcass weight (.65), and rib eye area (.10).

Butler et al. (9) studied 59 Hereford and 90 Brahman Hereford crossbred steers from Hereford dams raised under the same management systems and self fed in dry lot. The crossbreds weighed 40 pounds more at slaughter, 55 pounds more in the carcass and dressed 62.6 percent. The Herefords dressed 59.9 percent. There was little difference in carcass grade or in yields of wholesale cuts although the crossbreds had greater body and leg length.

Woodward et al. (46) found a correlation between slaughter and carcass grade of (.44) indicating inaccurate estimate of carcass quality in a study on 210 Hereford steers. Carcass grade was a better estimate of fat than lean as was slaughter grade due to the fact that grade increased as fat increases.

Backus et al. (2) found that thickness of fat over the 12th rib was correlated with carcass grade but approached zero when correlated with all other live animal and carcass measurements in a study of 293 steers.

Hankins et al. (27) made a study of muscle-bone ratio in 135 steers, 55 of which were beef Shorthorn and 80 were dual-purpose Shorthorn. Significant differences were observed between types which accounted for approximately 15.6 percent of the total variance in muscle to bone ratio. There were significant differences between sires within each type accounting for approximately 22 percent of the total variance in the ratio of muscle to bone. No significant correlation was found within types between muscle-bone ratio and percent separable fat in the carcass. No significant correlation was found between live animal measurements and muscle-bone ratio, indicating that selections could not be made on the basis of conformation evaluated by such measurements. Highly significant correlations were found with "leg bones" expressed as percent of live weight (-.32) and the average thickness of muscle and fat over the rib (.30).

Orme et al. (39) noted that live animal weight, chilled carcass weight, primal cut weight and estimated carcass lean (using the 9-10-11 rib cut) were significant in almost all instances and positively related to weight and linear measurements of the fore and hind cannon bones. Results indicated that both cannon bone measurements and radiographs of the lumbar vertebra were related to muscling, however, the relationships were not high enough to be useful for predictive purposes.

Hankins (25) and Hirzel (28) reported that in normal development of lambs, skeletal growth ceased first, muscle growth next and the final stage consisted mainly of fat deposition. Hankins (25) study of physical composition data on 64 lambs and chemical composition data on 42 lambs indicated that muscle and bone content of the rib cut was closely correlated with fat, muscle and bone content of the dressed carcass. The rib was followed by the leg in muscle correlation of the carcass.

Wythe et al. (44) and Texas workers (20) found bone weights and bone weight: length ratios of the metacarpus, metatarsus, tibia, femur and radius-ulna to be highly correlated with combined weights of the loin, rib, round and rump; the sum of the "retail trimmed" chuck, rib, loin and "retail trimmed" boneless cushion round with rump; and area of rib eye.

Woodward et al. (46) reported amount of lean to be significantly correlated with amount of bone and tendon in their study.

Cole et al. (17) found bone weight of the carcass to be highly significantly correlated (.75) with total separable carcass lean.

Butler and Wythe (10) conducted a study comparing cutting methods and their effect on carcass yield. Carcasses cut by the standard method were compared to the "retail trimmed" method in which each wholesale cut was trimmed of fat to one-fourth of an inch. The average percent of loin, rib and round with rump on was 47.82 percent by the standard method of cutting as compared to 37.25 percent for the "retail trimmed" method. Highly significant differences in percent of various cuts of the carcass were observed when measured by the "retail trimmed" method, whereas little or no significant difference was noted by the standard cutting method.

In a study to determine variations in measurements and weights of wholesale cuts from left and right sides of beef carcasses, Butler et al. (8) and Goll et al. (23) found little difference except a slightly heavier average weight of left hindquarter and left kidney knob caused by leaving the hanging tender attached to the left side.

The U.S.D.A. Marketing Service (3) in its report on studies of beef grades and carcass yields, listed two main factors affecting value; quality of lean meat and quantity of the carcass weight which could be sold as trimmed retail cuts. Quality referred to the juiciness, tenderness, and flavor on the basis of marbling, firmness, color, and texture of the lean, all in relation to maturity of the animal from which the carcass was derived. U.S.D.A. technicians found that carcasses of the same grade and weight could vary widely in yield of trimmed retail cuts due to wide variation in amount of fat deposition. A method of recognizing differences in yield could be predicted quite accurately by using four factors: 1. Thickness of fat over the eye muscle at the 12th rib, 2. size of rib eye muscle at the 12th rib, 3. amount of kidney and pelvic fat and 4. carcass weight.

Estimating the amount of fat appears to be the most difficult in determining carcass yield. Various methods have been employed to determine amount of fat. Dunn (19) used the same fat probes as outlined by Bray and Merkel (5) to determine their relationship to total fat trim. The shortloin probe was found to be highly significantly correlated with total fat trim (.63) and total trimmed wholesale cuts (-.54).

Price _et al._ (42) in reporting the use of ultrasonic measurement, indicated some promise for measuring fat thickness, although the relationship had been lower in measuring fat thickness in beef than for swine. Results of the ultrasonic method of measuring depth of lean in cattle had not been promising.

The antipyrine technique of determining body fat content was employed by Breidenstein _et al._ (6). The results were extremely inconsistent. The carcass fat content was estimated by specific gravity of the wholesale rib cut, physical separation of the whole rib and determination of ether-extract of separable lean and fat of the wholesale rib. Little relationship appeared to exist between subjective valuation of marbling and specific gravity of rib eye muscle, whereas, ether-extract of the rib eye muscle indicated a positive relationship with marbling.

Callow (11) classified carcasses of cattle and sheep into two groups: those containing under 18 percent fatty tissue and those containing more. Carcasses from animals in the fattening stage were in the over 18 percent group. Changes in percent of fatty tissues, muscular tissues, bone, tendons, etc. in carcasses during fattening were the same for cattle, sheep and pigs and could be expressed by the same curves and equations. The ratio between weight of muscle tissue and bone increased with fattening. During fattening, fatty tissue was laid down more rapidly in the subcutaneous depots than in intermuscular depots.

Callow (13) found no significant correlation between dressing percent and percent of muscular tissue on a live weight basis. Lush (34) found little or no evidence of relation between dressing percent and percent bone in dressed meat when degree of fatness was constant. Hopper (29) reported dressing percent was not reliable indication of fatness expressed either as fat or ether-extract of the carcass.

Callow (13) reported that young animals fatten more slowly than older ones and deposit less fat and more lean meat. With steers thirty months of age, 71.5 percent of the increase in weight is fat and 4.45 percent protein. Cows fattened more slowly than old steers and deposit nearly twice as much protein in their carcasses as do steers.

Texas workers (20) described desirable conformation as emphasizing superior muscling. Indicators of superior muscling were thickness of shoulder, width and shape of back and loin, thickness of rump and round with good bone development. The front legs should be set wide and show muscle in forearm and arm. A bulging round was desired but unless it was long and deep the bulge would not insure a high percentage of round steaks.

Fichte (21) reported the picturesque, low set, blocky, straight lined steer may be shunned in the future with a trend toward large, lean, muscular animals with a greater length of leg and body than now accepted. This steer will weigh not less than 450 pounds as a weaning calf at 7 months and close to 1,000 pounds at 16 months of age when marketed. His carcass should yield

48 percent or more of the preferred trimmed cuts (loin, rib, round) and have 2 or more square inches of rib eye muscle per 100 pounds of carcass.

MATERIALS AND METHODS

Thirty-eight Hereford steers from a nutrition trial studying the effect of various levels of roughage and pelleting vs non-pelleting at Kansas State University, are included in this study. The average slaughter weight of the steers was 1046 pounds with a range from 912 to 1236 pounds.

Five steers were slaughtered each week over an eight week period with the more highly finished steers selected first. The steers to be slaughtered were placed in the University meat laboratory holding pens the evening before slaughter and held without feed and water for 14 to 16 hours.

Slaughter weight to the nearest pound was recorded for each steer at the start of each slaughter day in order to avoid variation due to further shrink. The steers were slaughtered in the University meat laboratory in accordance with normal slaughtering procedure.

Hot dressed weight of each side was recorded to the nearest pound immediately after slaughter just prior to shrouding. The carcasses were placed in the cooler and held at a cooler temperature of 38-40 degrees F.

Chilled weight of each side of the carcass was recorded to the nearest pound after 48 hours. The right side was ribbed between the twelfth and thirteenth rib and tracings made of the cross sectional area of the longissimus dorsi muscle and fat cover. Area of the longissimus dorsi muscle was determined with a compensating polar planimeter. Area of the longissimus dorsi muscle was converted to a loin eye area ratio by dividing the area by carcass weight and multiplying by 100. Fat depth over the twelfth rib was measured at four sites. Three of the measurements were obtained in accordance with the procedure described by Naumann (38). These measurements were averaged and recorded to the nearest 0.05 inch. The other measurement was obtained as used by the U.S.D.A. which is the fat thickness measured at a point two-thirds of the length of the longissimus dorsi muscle from the chine. This measurement was also recorded to the nearest 0.05 inch.

The carcasses were evaluated by a committee of three meat laboratory personnel. Conformation grade, marbling score and carcass grade to the nearest one-third grade as well as a visual estimate of percent fat, bone and edible portion were reported for each carcass. No further information was collected from the left side of each carcass.

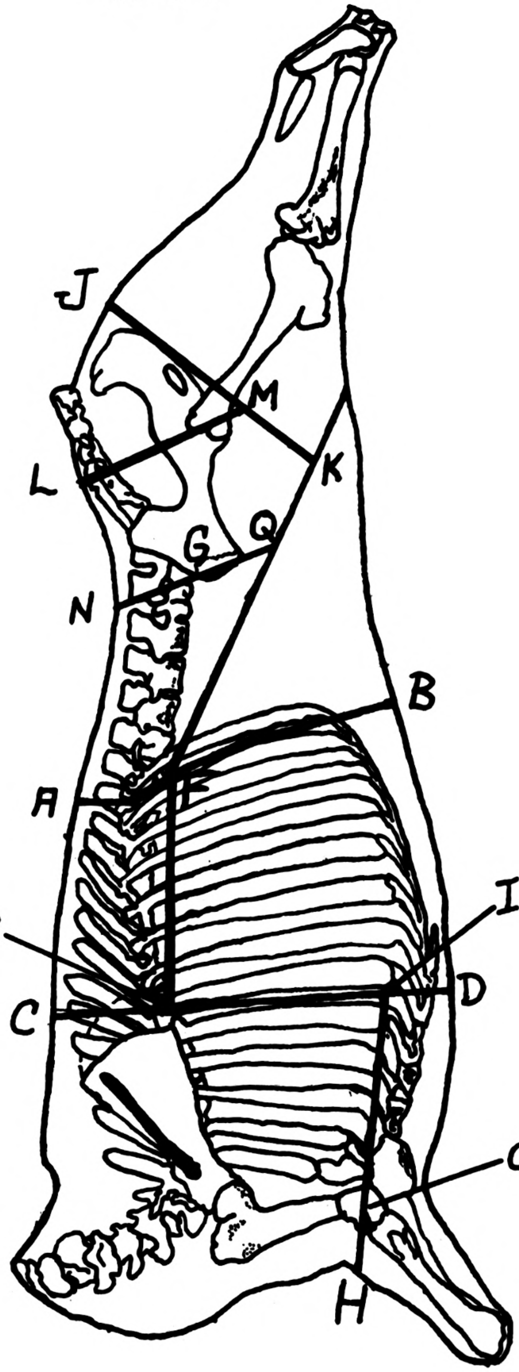
After aging at 38-40 degrees F. for 10-12 days, the right side of each carcass was weighed and weight recorded to the nearest pound prior to quartering between the twelfth and thirteenth rib. Fore and hindquarter weights were recorded to the nearest pound.

The carcasses were cut into wholesale cuts according to Mackintosh (35) in Plate I. The rib and plate were removed by cutting between the fifth and sixth ribs (C-D). The rib was separated from the plate by cutting parallel to the backbone 8 inches from the backbone (E-F). The shank was removed by cutting parallel to the underline and just dorsal to the prominance (O) (lateral condyle of the humerus) on the lower extremity of the humerus. The brisket was removed by cutting through the breast bone on the same line as the shank, (H-I). The flank was removed by cutting from a point immediately ventral to the aitch bone and following the natural separation to the thick muscle of the flank, then in a straight line to a point (F) 1 1/2 inches below the longissimus dorsi muscle.

EXPLANATION OF PLATE I

Carcass side of beef illustrating the wholesale cuts made in this study.

PLATE I



A New York Style round was removed by cutting parallel to and immediately ventral to the aitch bone (JK). The rump was removed from the loin by cutting parallel to the thirteenth rib one-half inch anterior to the aitch bone (LM).

Wholesale cuts in this study include: round (cut New York Style plus rump), loin, 8 inch rib, flank, plate, chuck, brisket and shank. Each wholesale cut and the kidney knob was weighed to the nearest one-fourth pound and reported as percent of chilled carcass weight.

Five fat probe measurements were made as described by Bray and Merkel, (5) and recorded to the nearest 0.05 inch. They were recorded as round, sirloin, shortloin, rib and chuck fat depth probes. The locations of the probes are shown in Plate II.

Each untrimmed wholesale cut was weighed to the nearest one-fourth pound and weight was recorded. The weight of each wholesale cut was also recorded as percent of chilled carcass weight.

The retail cuts, bone, fat and lean trim were weighed to the nearest one-tenth pound. The weight of each of the aforementioned was recorded as percent of the wholesale cut from which they came.

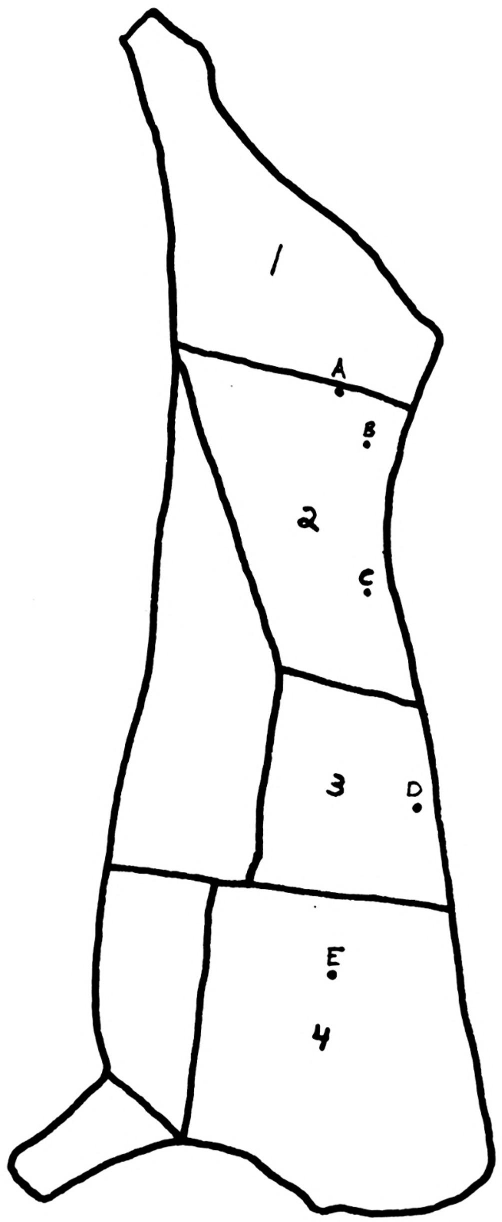
Boned and trimmed retail cuts from the round, loin, rib and chuck were recorded as percent of each of the respective wholesale cuts. The boned and trimmed retail cuts plus the lean trim from each of the aforementioned wholesale cuts were recorded as a total percent lean from each wholesale cut.

The wholesale cuts were completely boned and cut into retail cuts. All external fat covering plus seam fat was trimmed to one-fourth inch. Lean trim contained 25 percent or less fat. Trimmed retail cuts, fat trim,

EXPLANATION OF PLATE II

Illustration of carcass side of beef with wholesale cuts numbered and approximate fat probe locations lettered that were used in this study. Numbers 1, 2, 3 and 4 represent the round, loin, rib and chuck with shank on respectively. Point A represents the location of the round probe. The round probe was made on the cut surface of the sirloin from which the round was removed. One leg of the T-square was placed against and parallel to the sacral-caudal vertebrae and at point where the other leg of the T-square bisected the external fat surface, the depth of fat to the superficial muscle was determined perpendicular to the external surface. Point B was the point of the sirloin probe. The point on the sirloin was measured five inches from and perpendicular to the sacral vertebrae between the second and third sacral vertebrae. C is the approximate location of the shortloin probe. The shortloin probe was made 3 1/2 lumbar vertebrae from the lumbar-sacral junction and four inches from and perpendicular to the lumbar vertebrae. The rib probe location is shown by D. The point on the rib was measured 4 inches from and perpendicular to the thoracic vertebrae midway between the loin and chuck cut surface. The chuck probe (E) was made at a point one-half of the distance from the brisket side to the most dorsal point over and parallel to the third rib.

PLATE II



bone and lean trim of each wholesale cut were weighed and recorded to the nearest 0.1 pound.

The percent total fat trim (including kidney knob), total bone, total lean trim and total lean (retail cuts plus lean trim) of the chilled carcass weight were calculated and recorded.

Simple and multiple correlations as outlined by Snedecor (43) were used in the statistical analysis of the data in this study. Simple correlations were made between 38 different fat measurements, wholesale cut percentages, fat and lean percentages, loin eye area and loin eye area ratio. Loin eye data included loin eye area in square inches, depth of fat over the 12th rib (average of three measurements), depth of fat over the 12th rib (one measurement taken at a point two-thirds the distance of the diameter of the loin eye) and loin eye area per hundred pounds of carcass weight.

Ten multiple correlations were made to observe correlations between various carcass measurements and weight percentages with percent fat and lean.

All weights were converted to percent in order to correct for variation in carcass weights.

The data were placed on cards and the calculations were made by using an IBM 650 Digital Computer. In the statistical analysis all coefficients were recorded to four digits, but were rounded to two places in the subsequent results and discussion in accordance with the rule suggested by Kelly (30).

RESULTS AND DISCUSSION

This study was conducted in an effort to find an accurate, yet simple and practical method of predicting cutability of a beef carcass by studying the interrelationships of muscle, fat, bone and certain carcass measurements. Simple and multiple correlation coefficients were calculated for various fat probes, fat trim from each wholesale cut, lean from the major wholesale cuts, total carcass lean, fat and bone. The simple correlation coefficients are presented in the appendix, (Table 10).

Loin eye area has been used as an indicator of carcass leanness with much emphasis being placed upon it. This study involved the use of loin eye area and loin eye area per hundred pounds of carcass weight, (hereafter referred to as loin eye area ratio). Highly significant correlations were noted between loin eye area ratio and total lean from the round (.45) and chuck (.41). Significant correlations were noted with total lean from the loin (.39) and rib (.34). A highly significant correlation (.56) was observed between loin eye area ratio and combined total lean from the round, loin, rib and chuck. Significant correlations were found between loin eye area ratio, untrimmed chuck (.34) and untrimmed brisket (-.32). A very low negative correlation (-.04) was found between loin eye area ratio and untrimmed loin which was very similar to the result (-.06) noted by Dunn (19).

The loin eye area was found to be highly significantly correlated (.42) with total carcass lean which was similar to the correlation (.43) noted by Cole et al. (17).

Loin eye area was significantly (.39) and the loin eye area ratio highly significantly (.56) correlated with total combined lean of the round, loin, rib and chuck. The loin eye area was significantly (.35)

Table 1. Simple correlation coefficients of loin eye area, loin eye area ratio, total carcass lean and total carcass fat trim with lean from round, loin, rib, chuck and untrimmed wholesale cuts.

	Loin Eye Area	Loin Eye Area Ratio	Total Lean	Total Carcass Fat Trim
Total Lean from Round	.17	.45**	.78**	-.76**
Total Lean from Loin	.19	.39*	.43**	-.40*
Total Lean from Rib	.45**	.34*	.30	-.18
Total Lean from Chuck	.35*	.41**	.77**	-.69**
Total Lean from RLRC[1]	.39*	.56**	.91**	-.84**
Untrimmed Round	.02	.28	.37*	-.38*
Untrimmed Loin	-.17	-.04	-.14	.09
Untrimmed Rib	.44**	.27	-.05	.05
Untrimmed Chuck	.27	.34*	.48**	-.48
Untrimmed Shank	-.20	-.09	.20	-.28
Untrimmed Brisket	-.20	-.32*	-.45**	.43**
Untrimmed Flank	-.08	-.28	-.44**	.43**
Untrimmed Plate	.15	.13	.14	-.11
Loin Eye Area		.82**	.42*	-.23
Loin Eye Area Ratio	.82**		.59**	-.45**

*Significant at .05 level.

**Significant at .01 level.

[1]RLRC = Round, loin, rib and chuck

and loin eye area ratio highly significantly (.41) correlated with lean of the chuck.

Loin eye area ratio was a better indicator of total carcass lean (.59) than was loin eye area (.42). Dunn (19) found a highly significant correlation (.42) between loin eye area ratio and total trimmed wholesale cuts.

Loin eye area was highly significantly correlated with total lean of the rib (.45) and the untrimmed rib (.44). This might be expected since the longissimus dorsi muscle comprises most of the rib lean. Highly significant correlations were observed between total carcass lean and lean from the round (.78), chuck (.77) and loin (.43). Total carcass lean was highly signifcantly correlated (.91) with total lean from the round, loin, rib and chuck.

The lean from the round was found to be the best indicator of total carcass lean with a highly significant correlation of (.78) followed closely by lean from the chuck (.77). Cole _et al._ (17) separated beef carcasses into lean, fat and bone and found the separable lean of the round to be the best indicator of total carcass lean with a highly significant correlation of (.95). Dunn (19) found the trimmed chuck to be the best indicator of total trimmed wholesale cuts (.87) followed by the trimmed round (.76). This difference could probably be attributed to the fact that Dunn trimmed the wholesale cuts of external fat only. Goll _et al._ (24) reported that yield of chuck increased while the round decreased as carcass weight increased indicating deposition of fat in the chuck.

Highly significant negative correlations were noted between total carcass fat and separable lean from the round (-.76) and chuck (-.69). A highly significant negative correlation (-.84) was found between total carcass fat and combined separable lean from the round, loin, rib and chuck.

The lean from the round and chuck accounted for 61 and 59 percent, respectively, of the variation in total carcass lean while loin eye area and loin eye area ratio accounted for 18 and 35 percent, respectively. In the study by Cole et al. (17) the separable lean of the round and chuck accounted for 90 and 86 percent, respectively, of the variation in the carcass lean and loin eye area accounted for 18 percent of the variation. Dunn (19) found the trimmed chuck and round accounted for 76 and 58 percent, respectively, of the variation in trimmed wholesale cuts, while loin eye area ratio accounted for 18 percent.

Simple correlations of various probes, fat trim from respective cuts and total carcass fat with total carcass lean.

Correlation coefficients between total carcass lean and measurements of fatness appear in Table 2. Total carcass lean was highly significantly negatively correlated with all the probes except the chuck and rib probes. The sirloin (-.64) and round (-.60) probes were most highly correlated with total carcass lean. A highly significant negative correlation of (-.57) was found between 12th rib fat depth and total carcass lean which indicated that measurement of fat at the 12th rib is nearly as accurate a measurement of total carcass lean as the most accurate probes. Highly significant negative correlations were noted between total carcass lean and fat trim from the chuck (-.70), loin (-.69), plate (-.68), flank (-.68), brisket (-.60), round (-.58), and rib (-.52). Total carcass lean was highly significantly correlated negatively (-.91) with total fat which points up the fact that as fat increases, total lean decreases. These data are in agreement with the results of Dunn (19) in which study the trimmed wholesale cuts were highly significantly negatively correlated (-.85) with total fat trim.

Table 2. Simple correlation coefficients of various probes, fat trim from respective cuts, % kidney knob and total fat with total carcass lean and % kidney knob.

	Total Carcass Lean	% Kidney Knob
% Kidney Knob	.15	
Fat Depth 12th Rib (Av. 3 measurements)	-.57**	-.002
Chuck Probe	-.28	.08
Rib Probe	-.16	-.28
Shortloin Probe	-.48**	-.16
Round Probe	-.60**	-.18
Sirloin Probe	-.64**	.07
Rib Fat	-.52**	.32*
Chuck Fat	-.70**	.13
Loin Fat	-.69**	-.002
Round Fat	-.58**	.03
Plate Fat	-.68**	.19
Flank Fat	-.68**	.13
Brisket Fat	-.60**	-.04
Total Fat	-.91**	.28

*Significant at .05 level

**Significant at .01 level

Table 3. Multiple correlation coefficients of carcass lean with loin eye area ratio, lean of major wholesale cuts and interrelationship of the major untrimmed wholesale cuts and hindquarter with the combined lean of the cut.[a]

	Correlated With	Correlation Coefficient
Total Carcass Lean	Loin eye area ratio, total lean of round, loin, rib and chuck.	.93**
Untrimmed Round	Lean of the round, loin, rib, chuck and total lean of these four wholesale cuts.	.79**
Untrimmed Loin	Lean of the round, loin, rib, chuck and total lean of these four wholesale cuts.	.81**
Untrimmed Rib	Lean of the round, loin, rib, chuck and total lean of these four wholesale cuts.	.92**
Untrimmed Chuck	Lean of the round, loin, rib, chuck and total lean of these four wholesale cuts.	.77**
Hindquarter	Lean of the round, loin, rib, chuck and total lean of these four wholesale cuts.	.66**

*Significant at .05 level

**Significant at .01 level

[a]Lean of individual cuts expressed as percent of chilled carcass wt.

Results of the simple correlations shown in Table 1 indicated total lean from the round, loin, rib and chuck accounted for 83 percent of the variation in total carcass lean.

A multiple correlation of (.93) was found between total carcass lean vs loin eye area ratio and total lean from the round, loin, rib and chuck. According to these data, loin eye area ratio and total lean from the round, loin, rib and chuck account for 87 percent of the variation in total carcass lean.

Eighty-four percent of the variation in total lean from each of the major lean cuts and total lean from the combined major wholesale cuts can be accounted for by the untrimmed rib. From these data the rib accounts for a greater percentage of the variation in total lean from the major wholesale cuts than any of the other major untrimmed wholesale cuts. These results are somewhat in agreement with those of Hankins and Howe (26) who reported a high correlation between percent separable lean of the 9-10-11 rib cut and that of the carcass for steers. Hopper (29) also found the physical and chemical composition of the whole and edible portion of wholesale and 9-10-11 rib cuts to be highly correlated with physical and chemical composition of empty body, carcass and edible portion of the carcass.

Simple correlation coefficients for total fat trim with kidney knob and fat probes. Percent kidney knob has been used as a measure in estimating amount of carcass fat and appraising carcass cutability. The only significant correlation between kidney knob and all other factors studied was fat trim from the rib (.32), Table 2. A non-significant correlation was noted between kidney knob and total fat (.28). Correlations between the fat probes and total fat trim of the carcass are presented in Table 4. The round probe was highly significantly correlated (.65) and the chuck probe significantly correlated (.39) with total fat trim which is not in agreement with the correlations (.27) and (.11) found by Dunn (19). This is probably explained by difference in fat trim. There was agreement, however, in a highly significant correlation (.61) between shortloin probe and fat trim from the loin. The sirloin probe (.65), shortloin probe (.47) and fat depth at the twelfth

Table 4. Simple correlation coefficients of fat trim from respective cuts, total carcass fat trim and 12th rib fat depth (one measurement) with various probes and 12th rib fat depth (av. 3 measurements).

	12th Rib Fat Depth (one measurement)	Total Carcass Fat Trim	Fat Trim on Respective Cut
Round Probe	.33*	.65**	.40*
Sirloin Probe	.51**	.65**	.53** (Loin)
Shortloin Probe	.58**	.47**	.61** (Loin)
Rib Probe	.25	.12	-.04
Chuck Probe	.31	.39*	.19
12th Rib Fat Depth (Av. 3 measurements)	.62**	.57**	
Total Carcass Fat Trim	.58**		

*Significant at .05 level

**Significant at .01 level

rib (av. 3 measurements) (.57) were highly significantly correlated with total fat trim. The rib probe (.12) was not significantly correlated with total fat trim.

The sirloin and round probes appear to be the best indicators of total carcass fat trim of the probes studied. Both of these probes were highly significantly correlated with total carcass fat (.65) which indicated that 42 percent of the variation in total carcass fat can be accounted for by each of these probes.

Dunn (19) found the shortloin probe to be the best indicator of total fat trim with a highly significant correlation of (.63). Variation in this probe accounted for 40 percent of the variation in total fat trim from the round, loin, rib and chuck.

A highly significant correlation (.62) was noted between fat depth at the 12th rib (av. of 3 measurements) and fat depth at the 12th rib taken from one measurement two-thirds the length of the longissimus dorsi muscle measured from the chine bone, Table 4.

Fat depth at the 12th rib has been used as an indicator of degree of fatness and is one of the factors employed by the U.S.D.A. (3) in their equation for estimating total lean of the round, loin, rib and chuck. Fat depth at the 12th rib (av. of 3 measurements) was highly significantly negatively correlated (-.70) with estimated total lean from the round, loin, rib and chuck while fat depth at the 12th rib (one measurement), which is the method used by U.S.D.A., was only significantly negatively correlated (-.40) with estimated total lean from the round, loin, rib and chuck. Highly significant correlations were noted between 12th rib fat depth (av. 3 measurements) and estimated total fat (.70) and estimated total carcass lean (-.70). These estimates represent a visual appraisal of total percent carcass fat, allowing 14 percent of the carcass weight for bone.

Identical multiple correlation coefficients (.72) were observed between fat depth at the 12th rib (av. 3 measurements) and a single measurement of fat depth at the 12th rib with percent kidney knob, chuck probe, rib probe, shortloin probe, round probe, sirloin probe and total carcass fat trim, (Table 6).

A multiple correlation of (.80) was found between total carcass fat trim with the fat probes and measurement of fat depth at the 12th rib (av. of 3 measurements) and a single measurement of fat depth at the 12th rib. Thus 64 percent of the variation in total carcass fat could be accounted for by variation in these probes and measurements.

Table 5. Simple correlation coefficients of measurements of fat depth at the 12th rib (one and 3 measurements) with U.S.D.A. estimated combined lean from R.L.R.C.[a], estimated total carcass lean and estimated total carcass fat.

	U.S.D.A. Est. Combined Lean From R.L.R.C.[a]	Estimated Total Carcass Lean	Estimated Total Carcass Fat
Fat Depth at 12th Rib (Av. 3 measurements)	-.70**	-.70**	.70**
Fat Depth at 12th Rib (one measurement)	-.40*	-.63**	.63**
Estimated Carcass Fat Trim	-.56**		

*Significant at .05 level

**Significant at .01 level

[a]Round, loin, rib and chuck

Table 6. Multiple correlations of fat probes and measurements with fat depth at the 12th rib (one measurement) (av. 3 measurements) and total fat.

	Correlated With	Correlation Coefficient
Fat Depth at 12th rib (av. 3 measurements)	Kidney Knob, chuck probe, rib probe, shortloin probe, round probe, sirloin probe, total fat.	.72**
Total Fat	Fat depth 12th rib (av. 3 meas.), fat depth 12th rib (one meas.), chuck probe, rib probe, shortloin probe, round probe, sirloin probe.	.80**
Fat Depth at 12th rib (one measurement)	Kidney knob, chuck probe, rib probe, shortloin probe, round probe, sirloin probe, total fat.	.72**
Total Fat	Kidney knob, fat trim of round, loin, rib, and chuck.	.93**

**Significant at .01 level

A multiple correlation coefficient of (.93) was found between total carcass fat trim with percent kidney knob and fat trim from the round, loin, rib and chuck. These measurements accounted for 87 percent of the variation in total carcass fat trim.

Simple correlations of fat trim from wholesale cuts with total carcass fat trim. Total fat trim was highly significantly correlated with fat trim from the round (.63), loin (.72), rib (.62), chuck (.75), plate (.79), flank (.64) and brisket (.62). This is somewhat in agreement with results noted by Chatfield (14) who found a close relationship between content of fat for any wholesale cut determined by ether extract and carcass fat. Lush (34) found the percent fat of the wholesale rib cut to be the most accurate indicator of degree of fatness of the entire animal than any other indicators studied.

The correlation coefficients between fat trim from the round and rib with total fat trim in Table 7 were similar to the results noted by Dunn (19) (.64) and (.58), respectively, however, he found a higher correlation for fat trim from the loin (.89) and a lower correlation for fat trim from the chuck (.55). The higher correlation of fat trim from the chuck may be attributed to the fact that seam fat was removed in this study, whereas, only the exterior fat was trimmed in Dunn's study.

A highly significant correlation (.75) was noted between estimated total carcass fat and actual total trimmed carcass fat. This indicates that an individual with some experience can quite accurately estimate the amount of fat a carcass has by visual appraisal of the ribbed carcass.

Percent carcass bone has been used as an indicator of carcass lean. The most highly significant correlations between total carcass bone and the

Table 7. Simple correlation coefficients of total fat trim, 12th rib fat depth with fat trim of wholesale cuts.

	Total Fat Trim	12th Rib Fat Depth (av. 3 measurements)
Fat depth 12th rib (av. 3 measurements)	.57**	
Round trim	.63**	.24
Loin trim	.72**	.62**
Rib trim	.62**	.24
Chuck trim	.75**	.38*
Plate trim	.79**	.41**
Shank trim	.36*	.24
Flank trim	.64**	.52**
Brisket trim	.62**	.38*
Estimated Total Fat trim	.75**	

*Significant at .05 level

**Significant at .01 level

factors in this study were estimated total carcass lean (.62) and estimated total carcass fat (-.62). This may be attributed to the fact that all the carcasses were estimated to have 14 percent bone of which the actual average was 14.6 percent. The identical correlation coefficient observed between estimated fat and estimated lean was probably due to automaticity. The highly significant negative correlations between total bone with the measurements of fat indicated that as the fat content of the wholesale cuts or the carcass increases, percent bone decreases. This is in agreement with the results of Kropf _et al._ (33).

Table 8. Simple correlation coefficients of total carcass bone with total carcass fat trim and lean.

	Total Carcass Bone
Total Carcass Lean	.26
Total Carcass Fat Trim	-.56**
Estimated Total Lean	.62**
Estimated Total Fat	-.62**

*Significant at .05 level

**Significant at .01 level

A non-significant correlation (.26) was found between total carcass bone and total carcass lean. This is not in agreement with results reported by Cole et al. (17) who found a highly significant correlation (.75) between carcass bone weight and separable carcass lean.

Simple correlations were made between the percent untrimmed wholesale cuts and percent hindquarter to determine relationships. These correlation coefficients appear in Table 9 of which only the correlation coefficients between the chuck and brisket (-.53) and chuck and hindquarter (-.43) were highly significant. Significant correlation coefficients were noted between rib and shank (-.32), round and flank (-.40), and flank and hindquarter (.32).

Green et al. (22) reported weights of a number of individual wholesale cuts to be statistically significantly correlated, even though structurally independent cuts such as the round and fore shank (.69).

Further study must be made to draw any definite conclusions as to what are reliable indicators of beef carcass cutability. Perhaps correlating the same type data on a weight basis rather than percent and correcting for

Table 9. Simple correlation coefficients between the percent untrimmed wholesale cuts and percent hindquarter.

	Round	Loin	Rib	Chuck	Flank	Plate	Brisket	Shank	Hindquarter
Round	-	-.22	-.09	.07	-.40*	.10	-.12	.11	.31
Loin	-.22	-	-.18	.003	-.30	.02	-.22	.07	.24
Rib	-.09	-.18	-	-.17	.03	.29	.02	-.32*	-.30
Chuck	.07	.003	-.17	-	-.30	-.03	-.53**	-.01	-.43**
Flank	-.40*	-.30	.03	-.30	-	-.02	.20	-.20	-.32*
Plate	.10	.02	.29	-.03	-.02	-	-.26	.04	-.01
Brisket	-.12	-.22	.02	-.53**	.20	-.26	-	.03	-.12
Shank	.11	.07	-.32*	-.01	-.20	.04	.03	-	-.03

*Significant at .05 level

**Significant at .01 level

difference in slaughter weights would give different results.

SUMMARY AND CONCLUSIONS

Thirty-eight Hereford steers of a Kansas State University feeding trial were included in this study. The average slaughter weight of the steers was 1046 pounds with a range from 912 to 1236 pounds.

Slaughter weight, hot dressed weight and chilled weight were recorded to the nearest pound.

Loin eye area was measured and recorded as loin eye area and loin eye area ratio (loin eye area per 100 pounds carcass weight). Fat depth at the 12th rib was measured at four sites, one recorded as a single measurement, another recorded an average of three measurements.

Conformation grade, marbling score and carcass grade to the nearest one-third grade as well as a visual estimate of percent fat, bone and edible portion were reported for each carcass. Five fat probe measurements consisting of the round, sirloin, shortloin, rib and chuck probes were made. Weights of the untrimmed wholesale cuts consisting of round (cut New York Style plus rump), loin, 8 inch rib, flank, plate, chuck, brisket and shank from the right side were recorded to the nearest one-fourth pound. The wholesale cuts were cut into retail cuts, completely boned and trimmed of external fat covering plus seam fat in excess of one-fourth inch. Weights were recorded of all boned and trimmed retail cuts, fat trim, lean trim and bone were weighed to the nearest one-tenth pound.

The percent total fat trim (including kidney knob), lean trim, total lean (retail cuts plus lean trim) and total bone of the chilled carcass weight were calculated and recorded.

Simple and multiple correlation coefficients were calculated between 38 different fat measurements, wholesale cut percentages, fat and lean percentages, loin eye area and loin eye area ratio.

Loin eye area and loin eye area ratio were highly significantly correlated (.42) and (.59), respectively, with total carcass lean. The lean of the round was found to be the best indicator of total carcass lean with a highly significant correlation of (.78) followed by the lean of the chuck (.77). The lean from the round and chuck accounted for 61 and 59 percent, respectively, of the variation in total carcass lean while loin eye area and loin eye area ratio accounted for only 18 and 35 percent, respectively. Eighty-four percent of the variation in total lean from the major wholesale cuts can be accounted for by the weight of untrimmed rib.

Fat trim from the chuck was most highly significantly negatively correlated (-.70) with total lean followed by fat trim from the loin (-.69), plate (-.68), flank (-.68), brisket (-.60) round (-.58) and rib (-.52). Total carcass lean was highly significantly negatively correlated with total fat (-.91) which indicates that as percent fat increases, percent lean decreases.

Percent kidney knob was significantly correlated only with fat trim from the rib (.32). Percent kidney knob was non-significantly correlated (.28) with total carcass fat indicating that percent kidney knob was not a reliable indicator of total carcass fat.

The round and sirloin probes were the best indicators of total carcass fat, both being highly significantly correlated (.65).

Identical multiple correlation coefficients of (.72) were found between fat depth at the 12th rib (av. 3 measurements) and a single measurement of fat at the 12th rib with percent kidney knob, the five fat probes, and total carcass fat trim.

Fat trim from the plate was most highly significantly correlated (.79) with total carcass fat followed by the chuck (.75), loin (.72), flank (.64), round (.63), rib (.62) and brisket (.62).

A highly significant correlation (.75) was noted between estimated total fat and actual total fat trim.

Results of this study did not indicate percent bone to be an accurate indicator of carcass cutability.

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APPENDIX

Table 10. Simple correlation coefficients of each characteristic studied with all other characteristics.

	H.Q.	Ch.	Ri.	Lo.	Ro.	E.F.	E.L.	E.L.RIRC	L.RIRC	L.Ch.	L.Ri.	L.Lo.	L.Ro.
1. H.Q.													
2. Ch.	-.43**												
3. Ri.	-.30	-.17											
4. Lo.	.24	.0032	-.18										
5. Ro.	.31	.07	-.09	-.22									
6. E.F.	.08	-.30	-.04	.16	-.43**								
7. E.L.	-.08	-.30	.04	-.16	.43**	-1.0***							
8. E.L.RIRC	.25	.38*	.22	.09	.24	-.56**	.56**						
9. L.RIRC	-.19	.65**	-.05	-.01	.36*	-.61**	.61**	.53**					
10. L.Ch.	-.36*	.76**	-.23	-.13	.16	-.41**	.41**	.45**	.88**				
11. L.Ri.	-.29	.02	.86**	-.18	.04	-.12	.12	.28	.22	.03			
12. L.Lo.	.07	.27	-.14	.68**	.05	-.37*	.37*	.33*	.51**	.31	-.13		
13. L.Ro.	.17	.32*	-.18	-.17	.70**	-.60**	.60**	.34*	.79**	.55**	.89**	.29	
14. T.C.L.	-.20	.48**	-.05	-.14	.37*	-.63**	.63**	.47**	.91**	.77**	.30	.43**	.78**
15. L.D.A./100	-.19	.34*	.27	-.04	.28	-.43**	.43**	.64**	.56**	.41**	.34*	.39*	.45**
16. L.D.A.	-.35*	.27	.44**	-.17	.02	-.28	.28	.51**	.39*	.35*	.45**	.19	.17
17. Pl.	-.01	-.03	.29	.02	.10	-.02	.02	.09	.14	.01	.48**	-.04	.09
18. Fl.	.32*	-.30	.03	-.30	-.40*	.38*	-.38*	-.27	-.54**	-.41**	-.09	-.54**	-.40*
19. Br.	-.12	-.53**	.02	-.22	-.12	.27	-.27	-.19	-.55**	-.47**	-.17	-.43**	-.31
20. Sh.	-.03	-.01	-.32*	.07	.11	-.16	.16	-.35*	.10	.05	-.13	.06	.25
21. Br.Tr.	.02	.54**	.05	-.07	-.07	.44**	-.45**	-.24	-.62**	-.55**	-.10	-.42**	-.39*
22. Fl.Tr.	.16	-.19	-.19	-.09	-.46**	.52**	-.52**	-.33*	-.59**	-.39*	-.34*	-.43**	-.51**
23. Sh.Tr.	.24	-.10	-.01	.003	.11	.31	-.31	-.28	-.25	-.17	-.03	-.18	-.17
24. Pl.Tr.	-.03	-.26	-.06	.01	-.30	.50**	-.50**	-.19	-.55**	-.35*	-.18	-.30	-.59**
25. Ch.Tr.	.02	-.26	.35*	.13	-.33*	.59**	-.59**	-.40*	-.69**	-.73**	.15	-.27	-.60**
26. Ri.Tr.	-.17	-.41**	.43**	.0006	-.50**	.36*	-.36*	-.17	-.56**	-.53**	.02	-.07	-.65**
27. Lo.Tr.	.14	-.42**	-.01	.58**	.47**	.73**	-.73**	-.50**	-.58**	-.51**	-.14	-.05	-.62**
28. Ro.Tr.	.30	-.45**	-.08	.01	.23	.40*	-.40*	-.28	-.58**	-.48**	-.21	-.27	-.41**
29. T.F.	.14	-.48**	.05	.09	-.38*	.75**	-.75**	-.46**	-.84**	-.69**	-.18	-.40*	-.76**
30. Si.Pr.	.36*	-.30	.08	.09	-.26	.60**	-.60**	-.29	-.57**	-.45**	-.18	-.36*	-.51**
31. Ro.Pr.	.07	-.40*	.28	.31	-.24	.48**	-.48**	-.21	-.55**	-.52**	.09	-.08	-.59**
32. S.Lo.Pr.	.08	-.19	-.06	.31	-.36*	.63**	-.63**	-.31	-.48**	-.30	-.08	-.19	-.54**
33. Ri.Pr.	-.02	-.07	-.29	.11	.05	.22	-.22	-.17	-.19	-.05	-.32*	-.08	-.08
34. Ch.Pr.	.11	.01	-.18	.46**	-.27	.64**	-.64**	-.18	-.14	-.01	-.15	.09	-.27
35. F.D.(1)	.06	-.42**	-.08	.13	-.56**	.63**	-.63**	-.40*	-.61**	-.38*	-.16	-.55**	-.54**
36. F.D.(3)	.12	-.31	-.22	.14	-.39*	.70**	-.70**	-.70**	-.57**	-.36*	-.32*	-.34*	-.51**
37. Ki.K.	-.02	-.09	.11	-.26	-.30	.28	-.28	-.24	-.15	-.08	.05	-.26	-.24
38. T.B.	-.08	.34*	-.17	-.06	.34*	-.62**	.62**	.22	.28	.24	-.13	.04	.34*

	T.C.L.	L.D.A./100	L.D.A.	Pl.	Fl.	Br.	Sh.	Br.Tr.	Fl.Tr.	Sh.Tr.	Pl.Tr.	Ch.Tr.	Ri.Tr.
15. L.D.A./100	.59**												
16. L.D.A.	.42**	.82**											
17. Pl.	.14	.13	.15										
18. Fl.	-.44**	-.28	-.08	-.02									
19. Br.	-.45**	-.32*	-.20	-.26	.20								
20. Sh.	.20	-.09	-.20	.04	-.20	.03							
21. Br.Tr.	-.60**	-.40*	-.25	-.08	.17	.88**	-.12						
22. Fl.Tr.	-.68**	-.42**	-.21	-.11	.72**	.26	-.14	.25					
23. Sh.Tr.	-.30	-.07	.04	.11	.06	-.13	-.03	.04	.05				
24. Pl.Tr.	-.68**	-.17	.004	-.13	.28	.17	-.19	.35*	.46**	.31			
25. Ch.Tr.	-.70**	-.31	-.14	.02	.35*	.25	-.17	.41**	.45**	.27	.43**		
26. Ri.Tr.	-.52**	-.09	.13	-.23	.23	.38*	-.31	.36*	.29	.08	.42**	.60**	
27. Lo.Tr.	-.69**	-.42**	-.30	-.07	.13	.30	-.14	.50**	.37*	.21	.43**	.54**	.39*
28. Ro.Tr.	-.58**	-.37*	-.31	-.15	.06	.35*	-.18	.53**	.07	.44**	.50**	.31	.22
29. T.F.	-.91**	-.45**	-.23	-.11	.43**	.43**	-.28	.62**	.64**	.36*	.79**	.75**	.62**
30. Si.Pr.	-.64**	-.43**	-.27	-.04	.59**	.25	-.30	.43**	.63**	.24	.42**	.46**	.17
31. Ro.Pr.	-.60**	-.25	.04	.07	.22	.26	-.18	.43**	.33*	.18	.53**	.57**	.45**
32. S.Lo.Pr.	-.48**	-.35*	-.14	-.04	.27	.12	-.17	.24	.36*	.18	.33*	.37*	.16
33. Ri.Pr.	-.16	-.14	-.10	-.39*	.01	.20	.21	.17	.03	.05	.14	.002	-.04
34. Ch.Pr.	-.28	-.01	-.07	.04	-.02	-.04	-.19	.13	.24	.30	.37	.19	.05
35. F.D.(1)	-.58**	-.56**	-.30	-.14	.67**	.45**	-.21	.45**	.70**	.01	.39*	.35*	.29
36. F.D.(3)	-.57**	-.38*	-.19	-.07	.44**	.33*	.11	.38*	.52**	.24	.41**	.38*	.24
37. Ki.K.	-.15	-.08	-.04	.13	.15	-.08	-.20	-.04	.13	.12	.19	.13	.32*
38. T.B.	.26	-.05	-.18	-.10	-.25	.002	.28	-.18	-.23	-.28	-.51**	-.38*	-.45**

	Lo.Tr.	Ro.Tr.	T.F.	Si.Pr.	Ro.Pr.	S.Lo.Pr.	Ri.Pr.	Ch.Pr.	F.D.(1)	F.D.(3)	Ki.K.	T.B.
28. Ro.Tr.	.37*											
29. T.F.	.72**	.63**										
30. Si.Pr.	.53**	.36*	.65**									
31. Ro.Pr.	.61**	.40*	.65**	.59**								
32. S.Lo.Pr.	.61**	.27	.47**	.49**	.49**							
33. Ri.Pr.	.21	.28	.12	-.06	.07	.28						
34. Ch.Pr.	.60**	.14	.39*	.32*	.21	.54**	.03					
35. F.D.(1)	.50**	.15	.58**	.51**	.33*	.58**	.25	.31				
36. F.D.(3)	.62**	.24	.57**	.51**	.46**	.61**	.29	.46**	.62**			
37. Ki.K.	-.002	.03	.28	.07	-.18	-.16	-.28	.08	.10	-.002		
38. T.B.	-.45**	-.25	.56**	-.28	-.32*	-.24	-.06	-.48**	-.37*	-.30	-.41**	

*Significant at .05 level

**Significant at .01 level

***Perfect Correlation

Codes for Observations

1. H.Q.——Hindquarter[a]
2. Ch.——Chuck[a]
3. Ri.——Rib[a]
4. Lo.——Loin[a]
5. Ro.——Round[a]
6. E.F.——Estimated Carcass Fat[a]
7. E.L.——Estimated Carcass Lean[a]
8. E.L.RIRC——Estimated Lean Round, Loin, Rib & Chuck[a]
9. L.RIRC——Lean Round, Loin, Rib & Chuck[a]
10. L.Ch.——Lean from Chuck[a]
11. L.Ri.——Lean from Rib[a]
12. L.Lo.——Lean from Loin[a]
13. L.Ro.——Lean from Round[a]
14. T.C.L.——Total Carcass Lean[a]
15. L.D.A./100——Longissimus dorsi area per 100# carcass weight
16. L.D.A.——Longissimus dorsi area
17. Pl.——Plate[a]
18. Fl.——Flank[a]
19. Br.——Brisket[a]
20. Sh.——Shank[a]
21. Br.Tr.——Brisket fat trim[a]
22. Fl.Tr.——Flank fat trim[a]
23. Sh.Tr.——Shank fat trim[a]
24. Pl.Tr.——Plate fat trim[a]
25. Ch.Tr.——Chuck fat trim[a]
26. Ri.Tr.——Rib fat trim[a]
27. Lo.Tr.——Loin fat trim[a]
28. Ro.Tr.——Round fat trim[a]
29. T.F.——Total Carcass Fat[a]
30. Si.Pr.——Sirloin Probe
31. Ro.Pr.——Round Probe
32. S.Lo.Pr.——Shortloin Probe
33. Ri.Pr.——Rib Probe
34. Ch.Pr.——Chuck Probe
35. F.D.(1)——Fat Depth 12th Rib (one Meas.)
36. F.D.(3)——Fat Depth 12th Rib (av. 3 Meas.)
37. Ki.K.——Kidney knob[a]
38. T.B.——Total Bone[a]

[a]Calculated on a percent chilled carcass weight basis.

RELATIONSHIPS OF MUSCLE, FAT, BONE AND SOME PHYSICAL MEASUREMENTS TO BEEF CARCASS CUTABILITY

by

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The proportion of muscle, fat and bone in a beef carcass determines the yield of edible meat and these proportions are of importance to the producer, processor, retailer and consumer. This study was conducted in an effort to evaluate cutability of beef by studying the relationship of muscle, fat and bone as well as various carcass measurements and components upon the yield of trimmed retail cuts.

Thirty-eight steers averaging 1046 pounds at slaughter weight were included in this study. Slaughter and carcass weights were recorded to the nearest pound. Loin eye area, loin eye area ratio (loin eye area per 100 pounds carcass weight) and fat depth at the 12th rib were calculated and recorded.

The carcasses were graded and visual appraisal of percent fat, bone and edible portion of each carcass was recorded. Fat probes were taken over the round, sirloin, shortloin, rib and chuck of each carcass.

The wholesale cuts were removed from the right side of each carcass, reported to nearest one-fourth pound, cut into boneless retail cuts and trimmed of external and seam fat in excess of one-fourth inch. Weights of the trimmed retail cuts, fat and bone were recorded to the nearest one-tenth pound and subsequently each weight was calculated as percent of chilled carcass weight. Correlation coefficients were calculated between most characteristics studied.

The lean of the round was found to be the best indicator of total carcass len with a highly significant correlation of (.78) followed by the lean of the chuck (.77). The lean from the round and chuck accounted for 61 and 59 percent, respectively, of the variation in total carcass lean while loin eye area and loin eye area ratio accounted for only 18 and 35 percent, respectively.

Percent kidney knob was significantly correlated only with fat trim from the rib (.32). Percent kidney knob was non-significantly correlated (.28) with total carcass fat indicating that percent kidney knob was not a reliable indicator of total carcass fat.

The round and sirloin probes were highly significantly correlated with total carcass fat (.65).

Identical multiple correlation coefficients of (.72) were found between fat depth at the 12th rib (av. 3 measurements) and a single measurement of fat depth at the 12th rib with percent kidney knob, the five fat probes and total carcass fat trim. A highly significant correlation (.75) was noted between estimated total fat and actual total fat.