# THE RELATIONSHIP OF SOME LINEAR AND AREA MEASUREMENTS TO MUSCLING IN PORK CARCASSES

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# ABSTRACT

## THE RELATIONSHIP OF SOME LINEAR AND AREA MEASUREMENTS TO MUSCLING IN PORK CARCASSES

By John MacLeod

The current emphasis placed upon the production of lean pork has created the need for the development of simple and reliable measurements of carcass muscling. This study was conducted to investigate certain linear and area measurements and their relationship to carcass muscling characteristics. Skeletal measurements of the length of chine bone and depth of loin, were correlated to the area of longissimus dorsi muscle and trimmed loin weight. The influence of the "bulge" of the ham upon separable lean of the ham was investigated from certain linear measurements on a longitudinal section while a cross section of the ham was studied to determine the influence of "thickness of cushion" on the muscling of the ham.

The product of the length of chine bone and depth of loin was significantly correlated with area of the longissimus dorsi muscle $R = .69$ and to weight of trimmed loin $R = .71$ for gilts. Corresponding values for barrows were slightly lower, $R = .63$ and $R = .52$ for area of longissimus dorsi muscle and loin weight, respectively. Area of longissimus dorsi muscle at the 10th rib was highly related to weight of separable lean of the ham $r = .78$ for gilts and $r = .64$ for barrows. The influence of "bulge" of ham, from the longitudinal section, upon the separable lean content of the ham was investigated. The multiple correlation coefficient indicated "bulge" of ham was only moderately related to separable lean content of the ham, $R = .44$ and $R = .63$ for gilts and

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barrows, respectively. The "thickness of cushion", as measured through the thickest portion of the ham on the cross section, was highly significantly related to separable lean content of the ham $R = .80$) for gilts and $R = .81$ for barrows. The single measurement with the highest relationship to separable lean in the ham was the thickness through the cushion of the ham, $r = .79$ for gilts and $r = .68$ for barrows. In general, the correlation for gilts were higher than barrows and greater variation in most measurements were observed in the case of barrows.

# THE RELATIONSHIP OF SOME LINEAR AND AREA MEASUREMENTS TO MUSCLING IN PORK CARCASSES

By

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# INTRODUCTION

In the past two decades increasing emphasis has been focused upon the production of lean pork. This trend has created the need for the development of accurate and simple measures of degree of muscling. The problem has been studied both on the live hog and the carcass with varying degrees of success. McMeekan (1939), Bratzler *et al.* (1947), Zobrisky *et al.* (1960) have used the composition of portions of the carcass such as a wholesale cut to estimate the gross composition of the whole carcass. Hazel and Kline (1952) used a probing technique to measure backfat and utilized this as an indicator of leanness and the percentage of lean cuts. Since the loin and ham provide most of the edible lean and represent approximately 55 percent of the carcass value, accuracy of estimating muscling in these cuts is of obvious importance to the swine industry. Estimation of the area or size of the longissimus dorsi muscle which is the major muscle of the loin, might well begin by studying the influence of skeletal characteristics. McMeekan (1939) and Kline and Hazel (1955) investigated the area of longissimus dorsi, while Kropf (1959) and Orme (1959) studied the relationship of muscle to the skeletal dimensions of the loin.

In the ham various attempts have been made to develop "indices of plumpness" and "ham indices" as estimates of muscling, Hankins and Hiner (1939), Zobrisky *et al.* (1959), but with varied success.

The present study was undertaken to investigate the relationship of the length of chine bone and depth of loin to the area of the longissimus dorsi muscle and weight of trimmed loin. The influence of "bulge" (plumpness) and "thickness of cushion", (thickness through the thickest portion of the ham) taken from linear and area measurements on longitudinal and cross sections of the ham upon the quantity of separable lean was investigated.

## REVIEW OF LITERATURE

The concept of estimating the overall muscling of an animal from the measurement of a single dimension or from a group of related factors has developed as the understanding of the interrelationship of various anatomical portions has been elucidated. Perhaps the first attempt to determine the composition of a carcass was carried out by Lawes and Gilbert (1859) who completed separation studies on 10 animals including a fat pig and a "store" pig. Hammond (1939) and McMeekan (1940, 1941) demonstrated the importance of the growth gradient in the meat animal and developed the concept of "anatomical joints" as a means of measuring degree of muscle. Hammond stressed that in order to gain accurate knowledge of the degree of muscling, the carcass must be cut and since the loin region is not only the most valuable portion of a carcass but also the latest developing part of the body, it was the most appropriate region for estimation of carcass muscling. He recommended a cut at the last rib, just anterior to the head of the rib at right angles to the back, revealing a cross section of the longissimus dorsi muscle. The relationship of the area of longissimus dorsi or an estimator of area based on linear measures to carcass lean and other carcass characteristics has been the subject of much research. Linear measures of the width and depth of longissimus dorsi or certain combinations of these measures as a shape index were used by Hirzel (1939) and by McMeekan (1939) before quantitative validification of their worth as indices of carcass leanness was obtained. The first investigation into the relationship between depth and width of longissimus dorsi and total weight of muscle was reported by McMeekan (1941)

in which he found that depth was more highly correlated to total muscle than width. The most satisfactory estimator of total muscle weight was 2 X depth + width and width X depth with correlation values of $r = .93$ and $r = .84$, respectively. Aunan and Winters (1949), however, failed to show a significant correlation between longissimus dorsi area as estimated by width X depth and the amount of separable lean in carcass. Cahill et al. (1953) used the area of longissimus dorsi muscle at the 10th rib as an estimate of lean as measured by percentage of the four primal cuts. Whiteman et al. (1953) evaluated the longissimus dorsi muscle both by planimeter readings and by area estimated by depth X width at the last rib. They found the method of approximating longissimus dorsi muscle by using length X depth was as good as the planimeter reading and easier to obtain. Kline and Hazel (1955) and Hegarty (1960) studied the relationship of the longissimus dorsi muscle at the 10th and last rib with percent lean cuts and percent loin for both left and right sides. The area of longissimus dorsi muscle at the last rib averaged .43 square inches larger than at the 10th rib. They found no difference among the correlations between percent lean cuts and loin area at the 10th and last rib. All these correlations determined by Hazel and Kline (1955) varied between .65 and .74. Because of the high correlation between areas of the longissimus dorsi muscle as measured at different points on the same carcass, there is little increase in accuracy of predicting lean cuts from measurements of the longissimus dorsi muscle in more than one place. Freeden et al. (1955) took planimeter readings at the last rib and found these highly correlated with percent lean in the ham. The area of longissimus dorsi muscle was correlated to lean weight in ham r = .85, to percent lean in ham r = .79 and to ham weight r = .66. Pearson et al. (1956) found correlation values of .53 and .52 between percent lean cuts and area of longissimus dorsi at 10th and last ribs, respectively. Zobrisky et al. (1959) estimated the area of longissimus dorsi muscle at the last rib by multiplying width X depth and found a correlation value of 0.60 with yield of four lean cuts plus lean trim. Cole et al. (1960) took measures of longissimus dorsi muscle at the 5th, 12th thoracic and last lumbar vertebra and the average of these measurements and found correlation coefficients with total separable lean of 0.59; 0.58; 0.39 and 0.68, respectively. In this study they also multiplied the carcass length by an average of the three longissimus dorsi areas and correlated these with total separable lean obtaining a value of 0.73. Marcum and Stouffer (1961) took cross sections of rough loin from twelve positions between the 10th and last ribs and recorded them photographically, measuring area of the longissimus dorsi muscle, width and depth, modified fat cover area and modified fat cover depth. The relationship of these values plus a lean to fat value (L.F.V.) to percent lean cuts was investigated. Area of the longissimus dorsi muscle at the 12th and 14th rib positions gave the highest correlations, r = .39 and r = .58, respectively, with percent lean cuts. The correlations between the L.F.V. and percent lean cuts were much higher, r = .71 and r = .76, respectively. Bowman et al. (1962) obtained a multiple correlation value of $R^2$ = .79 between percent lean cuts and longissimus dorsi muscle area. Doornenbal et al. (1962) took the ratio of lean to fat at the 10th rib and observed a correlation value of .80 with percent protein in the carcass.

In beef cattle, the use of the area of longissimus dorsi muscle has not been particularly successful as an estimator of total muscling and results have been even less consistent than in hogs. Butler (1957) when using longissimus dorsi muscle area per hundred pounds of carcass weight as a standard of comparison between beef carcasses found it was inadequate as the heavier carcasses were at a distinct disadvantage. Cole _et al._ (1959) obtained a correlation coefficient of .454 between the area of longissimus dorsi muscle and the weight of separable carcass lean. Cole _et al._ (1960) found that longissimus dorsi area was, however, associated with only 18 percent of the variation of separable carcass lean. Orme (1959) working with beef found an average measurement of the longissimus dorsi muscle taken at the 5th, 12th thoracic and last lumbar vertebra was correlated with the weight of carcass lean with an r value of .52. When this average measurement of the longissimus dorsi muscle was multiplied by carcass length the correlation coefficient increased to r=.61. Orme _et al._ (1960 working with the weight of certain whole muscles and the correlation of these to weight of total carcass lean found that, when slaughter weight was held constant, they obtained a standard partial regression coefficient between weight of total carcass lean and weight of longissimus dorsi muscle of 0.79. Goll _et al._ (1961), however, could show very few measurements or yields which were closely related to longissimus dorsi muscle area and in their study there was no evidence that longissimus dorsi muscle area is closely related to items representing overall carcass value. Cole _et al._ (1962) found when carcass weightwas held constant, fat thickness over the longissimus dorsi muscle at the 12th rib was associated with much more of the variation in pounds of separable carcass lean than was area of longissimus dorsi.

The relationship of muscle to bone and the skeletal dimensions of the loin and the longissimus dorsi muscle has been investigated by various workers. This field of study follows on from Hammond and Appleton (1932) who postulated that growth in length of a given muscle followed that of the bone to which it was connected; and that muscle thickness was linked with bone thickness. McMeekan (1941) showed a correlation of 0.80 between the length of the fore trotter and total carcass muscle. He also found a high correlation between certain individual bones and the total skeletal weight, .94, .90 and .94 between total skeletal weight and weight of bones in the ham, loin and in these two cuts combined. The correlations were also high for the bones of the limbs and the total skeletal weight. Lush (1926) reported that weight of shanks below hock was a good indicator of skeletal weight. Palsson (1939) reported that the weight of the four cannon bones had an extremely high correlation with total skeletal weight for lambs. These above workers found a strong positive correlation between the weight of bone in each animal and the total weight of muscle tissue. McMeekan (1956) states, "So strong is the relationship that the weight of muscle can be determined within one percent if the weight of the cannon bone is known." Not all investigators have found such high relationships between bone and muscling. Hankins _et al._ (1943) could demonstrate no relationship between live animal measurements and muscle-bone ratio and also no significant relationship between carcass measurement and the muscle to bone ratio. Orts (1959) showed that gross simple correlations indicated that cannon bone weight, area, weight to length ratio and specific gravity were highly related to wholesale cut weight and area of longissimus dorsi muscle. However, when a partial correlation was calculated, holding chilled carcass weight constant, the values were non-significant. Wythe et al. (1961) investigated the muscle to bone relationship in beef and found that a partial correlation coefficient with the chilled carcass weights held constant gave values of .64 and .49 for the weight of the metacarpus bone trimmed of all tissue to the total weight of the trimmed round, loin and rump and to the area of longissimus dorsi muscle, respectively. In the case of the tibia values of .73 and .51 for the same comparisons were found. When the weight to length ratio for the metacarpus was correlated to the total weight of trimmed round, rump and loin and the longissimus dorsi muscle area values of .60 and .46 were obtained while for the tibia the values were .58 and .59, respectively.

Kropf (1959a) studied the relationship of muscle and bone characteristics in swine and found that the percentage of bone (including ulna, radius, cannon bones, humerus, femur, tibia and pelvis) tended to be positively correlated with percent lean cuts $r = .35$ for barrows, $r = .45$ for gilts and negatively correlated with average backfat thickness in both sexes. In particular a highly significant relationship was calculated for lean cut yield and percentage femur $r = .52$ . Vertebral length (length of chine bone) was measured from the dorsal edge of the spinal canal to the lateral tip of the vertebra bone. The correlation with respect to longissimus dorsi area are summarized in the table below:

Correlation coefficient of longissimus dorsi muscle area

| Versus | Barrows | Gilts |
| --- | --- | --- |
| Vertebra length - 1st rib | -.212 | +.057 |
| Vertebra length - 7th rib | +.110 | -.147 |
| Vertebra length - last rib | +.504** | +.155 |
| Average vertebrae length | +.268 | +.147 |
| Percent lean cuts | +.349* | +.509** |

Thus longissimus dorsi area was not consistently correlated to vertebra length at 1st, 7th or last rib but showed a significant relationship to the percent lean cuts. Kropf (1959b) in a similar study with beef found non significant correlation coefficient of 0.14, 0.17, 0.21, respectively, between length of vertebrae at the 1st, 7th and last rib and the area of longissimus dorsi muscle in beef cattle. The percentage separable lean was, however, strongly related to area of longissimus dorsi per hundred pounds of carcass weight with a value of $r = 0.41$ . Mathews et al. (1959) working with lambs measured the depth of longissimus dorsi muscle by a needle probe over the right transverse process of the second lumbar vertebra while the width was estimated by halving the caliper measurement between lateral extremities of the transverse process of the second lumbar vertebra. Thus they were attempting to approximate the area of longissimus dorsi muscle by measuring the skeletal dimension of the vertebra in which confines the muscle lies. They estimated the cross section and area of longissimus dorsi muscle by multiplying width X depth and partial correlation coefficients were calculated while holding live weight constant. Highly significant correlations of .56 and .59 were observed between estimated depth and actual longissimus dorsi area in two trials while the estimated longissimus dorsi area and the actual longissimus dorsi area were correlated with $r = .55$ and $r = .69$ in the two trials. Orme et al. (1959) took radiographic measurements of the dorsal and lateral view of the lumbar vertebra which disclosed that width of the body of the lumbar vertebrae and width of the vertical process were the measurements most closely associated with longissimus dorsi muscle area, accounting for 22 percent and 20 percent, respectively, of the variation in longissimus dorsi muscle area. When the effects of live weight were held constant, width of the transverse process and height of the anterior articular process were equal to the two previous measurements in predicting longissimus dorsi muscle area, accounting for 18 to 21 percent of the variation in area. Orme (1958) points out that since these same partial regression equations showed an inverse relationship to rib eye with the exception of width of lumbar vertebra, larger vertebrae measurements tended to be associated with smaller longissimus dorsi muscle areas in beef cattle. The multiple correlation for longissimus dorsi area and live weight versus length of transverse process (distance from the lateral tip of left to the lateral tip of right transverse process) had a value of $R = .46$ and with length of vertical process (dorsal tip of body of vertebra to the tip of the spinous process) had a value $R = .40$.

Part of the difficulty in use of the skeletal dimensions of the loin could be assigned to the different rates of growth of the various portions. Hammond (1932), McMeekan (1941) and Palsson (1939) indicate this phenomenon. Rees-Evans (1954) found a gradual increase in length of vertebrae through the thoracic and lumbar sections followed by a rapid decrease through the sacral region making the lumbar vertebrae most important in final body length. Cuthbertson and Pomeroy (1962) found the rate of growth was fastest in the young pig in the sacral region while the cervical increased most in the second phase of growth and in both periods the growth in the lumbar region was slowest.

Another approach to estimates of muscling has been through the use of sample wholesale cuts to predict the lean yield of the whole carcass. Lush.. (1926) was the first to examine the relation between the composition of a single cut - the "wholesale rib cut" of beef - and the whole carcass composition. Subsequently, the value of the "9-10-11th rib" cut was confirmed by Hopper (1944) and the "12th rib cut" by Crown et al. (1960) who found correlation values between the 12th rib cut and total carcass of .82 for lean, .96 for fat and .75 for bone. Kidwell et al. (1959) found fairly high relation between slaughter score, carcass score, percent areas and longissimus dorsi muscle and fat in 9-10-11 rib. Hammond (1932), Palsson (1939) and McMeekan (1941) used the concept of an anatomical joint as a measure of total carcass value. The latter author found correlations between the weight of bone, muscular and fatty tissue in the combined leg and loin of swine and in the whole carcass were .94, .98 and .98, respectively. Aunan and Winters (1946) working with pigs observed correlation values of .80 and .82 between the percentage of lean and fat in the wholesale loin cut and the percent of separable lean and fat of the whole carcass. Bratzler et al. (1947) found a correlation coefficient of .82 between yield of primal cuts in the hog carcass and the relationship of trimmed loin to fatback. Pearson _et al_. (1958) suggested a loin index which was the relationship of rough loin to the percent trimmed loin and found a correlation of .81 to percent lean cuts. The percent ham on a carcass basis had a correlation of .76 to lean cuts. Zobrisky _et al_. (1960) expressed the wholesale cut value and yield of each carcass cut in terms of a single index, the ham equivalent, which reflected carcass merit. This ham equivalent was correlated to yield of four lean cuts $r = .82$ ; yield of loin $r = .56$ ; longissimus dorsi muscle area at 10th and last rib $r = .60$ and $r = .65$, respectively . Bowman _et al_. (1962) calculated correlation and regression relationships between various traits (indices) and suggested that the multiple correlation of weight of lean and fat in the ham had a high correlation to carcass leanness $R^2 = .92$ . Other workers have found a high relationship between percent trimmed ham and percent lean cuts: Whiteman _et al_. (1953) $r^2 = .89$ ; Smith _et al_. (1957) $r^2 = .89$ ; Pearson _et al_. (1958) $r^2 = .90$ ; and Hazel and Kline (1959) $r^2 = .96$ .

Estimates of muscling from linear and area measurements in the ham have been studied by several workers. Lean to fat and lean to bone ratios have been used. Zobrisky _et al_. (1958) reported that the pattern of ham muscle development is more closely related to the ham bone increase than to ham fat deposition. Hankins and Hiner (1937) developed an index of plumpness for hams to facilitate comparison of hams and to gain information regarding gross composition of the whole carcass, as regards fat, lean and bone. Aunan and Winters (1949) used a ham index as follows: circumference of ham at midpoint between aitch bone and hock X 100 divided by the length of the ham. This index showed a non significant correlation to lean content of the ham. The length of the ham had a correlation value of .61 to the area of longissimus dorsi muscle. When the ham was cut in cross section one inch from and parallel to the aitch bone, an estimate of area was made by multiplying the length X thickness but it had a non significant relationship to the separable lean of the carcass. Arthaud and Dickerson (1952) found that the higher the score for plumpness as estimated by visual appraisal, the greater the weight of skinned ham. Whiteman and Whatley (1953) removed the ham from the loin end at a point half way between the aitch bone and the posterior end of the 6th lumbar vertebra and at right angles to the long axis of the ham. The exposed surface was measured by planimeter and found to have a correlation of .68 to the percentage lean cuts. Freeden *et al.* (1955a) found the simplest and most reliable appraisal of ham composition was the percent area of lean in the ham exposed when that cut was removed during routine slaughter. By this measure the predictability of the percent lean in the ham was approximately 64 percent. In their study, they also found that tapering hams carrying weight well down the hock were leaner than those which appeared to be plump through being well filled in the upper portion. Freeden *et al.* (1955b) showed that when the percent area of lean in the proximal face of the ham was combined with the area of longissimus dorsi muscle exposed at the last rib this measure accounted for 72 percent of the variance in percent lean of the ham. Zobrisky *et al.* (1959) used the ham index developed by Hankins and Ellis (1934) but the correlation value to carcass lean was .13 which was non significant. They also estimated the ham lean area on the butt end by multiplying depth, as measured from

the exposed cut illium to the dorsal edge of the subcutaneous fat, by the width as measured at right angles to the previous dimension across the ventral edge of the illium. This cross sectional area had a correlation of .46 with carcass lean cuts and when combined with area of longissimus dorsi muscle the multiple correlation coefficient with carcass lean cuts was .65. Doornenbal _et al._ (1962) took a cross section of the ham at right angles to the femur, immediately posterior to the tuber ischii and found that the ratio of lean to fat in this section had a correlation of .66 to the percentage protein of the carcass.

From the point of view of practical production, it would be ideal if a reliable method of estimating muscle on the live animal could be developed. Phillips _et al._ (1936) studied a method of obtaining measurements for swine comparing direct measurements, a scaling instrument and a photographic method and found that the direct measurement technique was most accurate. Hetzer _et al._ (1950) measured the length from ear to tail, height at shoulder, width at shoulders, width at middle, width at hams, depth at chest, depth of middle and circumference of chest and it was found that the width at the hams was the most important measure when correlated to percent lean cuts and meat in the hams. Wiley _et al._ (1951) indicated that among lean groups of hogs within various weight ranges when body length was increased the average carcass cut out value tended to decrease. Hazel and Kline (1952) and many other workers used the fat cover of the live pig as an estimator of muscling. Bratzler and Margerum (1953) studied the accuracy of assessment of the live pig and found it needed considerable training and experience to accurately grade live hogs to U.S.D.A. standards.

Holland and Hazel (1958) measured the muscle thickness and fat thickness over the supraspinous fossa and over the illium and showed that fat cover was the most accurate measure of percent lean cuts. Orme (1963) summarized the current situation regarding the use of live animal measures as follows: "The validity and usefulness of live animal appraisal techniques (visual, linear measures and mechanical probes) depends largely upon the (1) objects for which they are intended; (2) care in which they are taken; (3) the ability to repeat a particular measurement. At the moment no particular live animal measurement will replace the so called 'eye ball' technique."

If accurate assessment of muscling is to be based on a particular carcass measurement then these measurements themselves must allow the minimum of error and have a high degree of repeatability. Butler (1956) showed that application of data from left to right sides was justified. In the 9-10-11 rib of beef the left to right correlation for bone was .99, for fat .97, for lean .99, for area of longissimus dorsi .98. Robison _et al_. (1960) gave further evidence for this assumption. Bowman _et al_. (1962) showed that left and right data were transferable, that the area of fat and lean was more accurately obtainable in the mid regions of the carcass than at the extremities and that division of the ham from the carcass and its subsequent separation into fat, lean and bone was more accurate than for middle and shoulder. Cuthbertson and Pomeroy (1962) in the course of a study in anatomy of pig removed the central portion of the vertebral column during slaughter and found that this did not give sufficient accuracy for comparison of left and right sides. Thus they suggested that a reduction in error would be achieved by cutting down through the center of the sacrum and through the vertebrae spines to the atlas. Lasley and Kline (1957) investigated the magnitude of cutting errors in the pig carcass and found that failure to split the carcass accurately was the main fault. They found that ham weights were more reliable than any other wholesale cut or combination of cuts. Harrington _et al_. (1960) investigated the accuracy of visual appraisal of longissimus dorsi muscle area and found it to be insufficiently accurate for experimental use. Bodwell _et al_. (1959a) investigated the repeatability of eight measures on a beef carcass and suggest that all measures should be taken on both sides of the carcass and averaged and also that certain of the standard reference points used in carcass evaluation should be redefined and clarified. As regards the measurement of the area of longissimus dorsi, Hirzel (1939) used maximum width X maximum depth while Naumann (1951) used three width measurements averaged times depth. Skjervold (1958) used a planimeter and an estimate based on width and depth gaining a correlation of .66 between the two. Backus _et al_. (1960) found a correlation ranging from .54 to .88 between width and planimeter measured area of longissimus dorsi muscle. Bodwell _et al_. (1959b) compared methods of measuring longissimus dorsi muscle area and found that taking a single area measurement from each duplicate tracing increased accuracy 30 percent. Superimposing a grid and counting squares gives 25 percent less accuracy than the planimeter. Area estimates based on linear measurements were highly repeatable but insufficiently accurate. Pearson (1957) points out that the plane of cut through the muscle causes variation in surface exposed. Also pressing down on the muscle when tracing

can cause considerable alteration in area and to minimize this the tracings should be done on the rough loin giving the maximum rigidity to the muscle.

# EXPERIMENTAL PROCEDURE

## History of Animals

Forty Yorkshire and crossbred swine of varying degree of muscling from heavy to very light muscling were included in this study. The forty hogs consisted of twenty barrows and twenty gilts. The data were recorded and analyzed separately for the two sexes.

## Slaughter Procedure

All animals were slaughtered at 200 to 210 pounds live weight in the Michigan State University Meat Laboratory in accordance with normal slaughter procedures. The animals were dressed with the heads off, leaf fat in, and with the hams unfaced in order to retain the natural shape of the ham and to facilitate later measurements. The carcasses were chilled at 34-38°F for 24 hours before measuring and cut after 48 hours chilling.

## Cutting Procedure and Loin Measurements

Carcass length and average backfat thickness were recorded. All linear measurements were recorded to the nearest millimeter. Length of the chine bone, which is the split exposed surface of the vertical spinous process of the vertebra, was recorded from the dorsal edge of the spinal canal to the dorsal tip of the spinous process, at right angles to the spinal canal. These measurements were recorded opposite the 3rd, 7th, 10th and last rib. For the measurement of depth of loin, a sliding T square shown in Figure 1 was used. The body of the square was placed against the split surface of the vertebra and the slide adjusted until it touched the corresponding rib. The first figure shows the T square at the

Figure I. Measurement of depth of loin

10th rib position and the depth of loin is the distance from the split body of the vertebra to the rib surface. This measurement was taken opposite the 3rd, 7th, 10th and last rib positions. The carcasses were cut according to the procedure described by the pork evaluation committee of the 1952 Reciprocal Meats Conference with the following exception: The ham was removed between the 2nd and 3rd sacral vertebrae and perpendicular to the line of the shank but was left untrimmed and with the foot remaining on the ham. The remainder of the carcass was separated into conventional wholesale cuts and both the rough and trimmed weights were recorded to the nearest .1 pound. The right rough loin was cut immediately posterior to the 10th and last rib and the area of longissimus dorsi muscle was traced on acetate paper and read by a polar planimeter. After tracing the right loin was trimmed and the trimmed weight recorded.

## Freezing and Storage of Hams

Immediately after separation from the carcass, the hams were suspended on a frame, by means of a string passed through the Achilles tendon, in such a fashion as to insure freedom from contact with other hams or the frame itself. Care was taken in suspending the hams to insure retention of their natural shape and to allow free passage of air between the hams to facilitate freezing. The hams were frozen in the blast freezer at -20° ± 4°F and after twenty four hours were removed and stored on the plate freezer at -20° ± 2°F degrees until subsequent splitting and separation.

## Splitting and Separation of Hams

Right ham - The right ham was cut in cross section at right angles to the longitudinal axis of the ham 3 1/2 inches posterior to the anterior tip of the pubic symphasis as indicated in Figure II. The frozen ham was split on a power band saw to obtain the section as shown in Figure III exposing the areas of lean, fat and bone at the thickest portion of the ham. A tracing was taken on acetate paper of the exposed areas of fat, lean and bone. Two axes were constructed on the acetate tracing as indicated on Figure III. The first axis was constructed from the most anterior point of the subcutaneous fat through the mid point of the exposed surface of the femur bone to the posterior edge of the subcutaneous fat. This axis will be referred to hereafter as the width axis of the cross section. Linear measurements were recorded along this axis for the total width of the ham including fat plus lean and that of the lean by itself. The second axis was constructed at right angles to the width axis at a point bisecting the linear measure of the width of lean. On this axis linear measurements were again taken with respect to the total dimensions and to the dimension of lean only. Planimeter readings were obtained on the acetate tracing of the area of bone, lean and fat left of the width axis as shown on the split ham section in Figure III. All area measurements were recorded to the nearest one tenth centimeter.

Left Ham - The frozen left ham was cut in longitudinal sections from the medial malleolus on the medial surface of the tibia to a point 1/4 inch laterally of the exposed surface of the illium on the anterior surface of the ham. These reference points were easily determined and produced a standard longitudinal section through the ham. The section obtained is shown in Figure IV indicating the exposed muscles of the ham,


Figure II. Location of the point of separation for the cross section of the ham

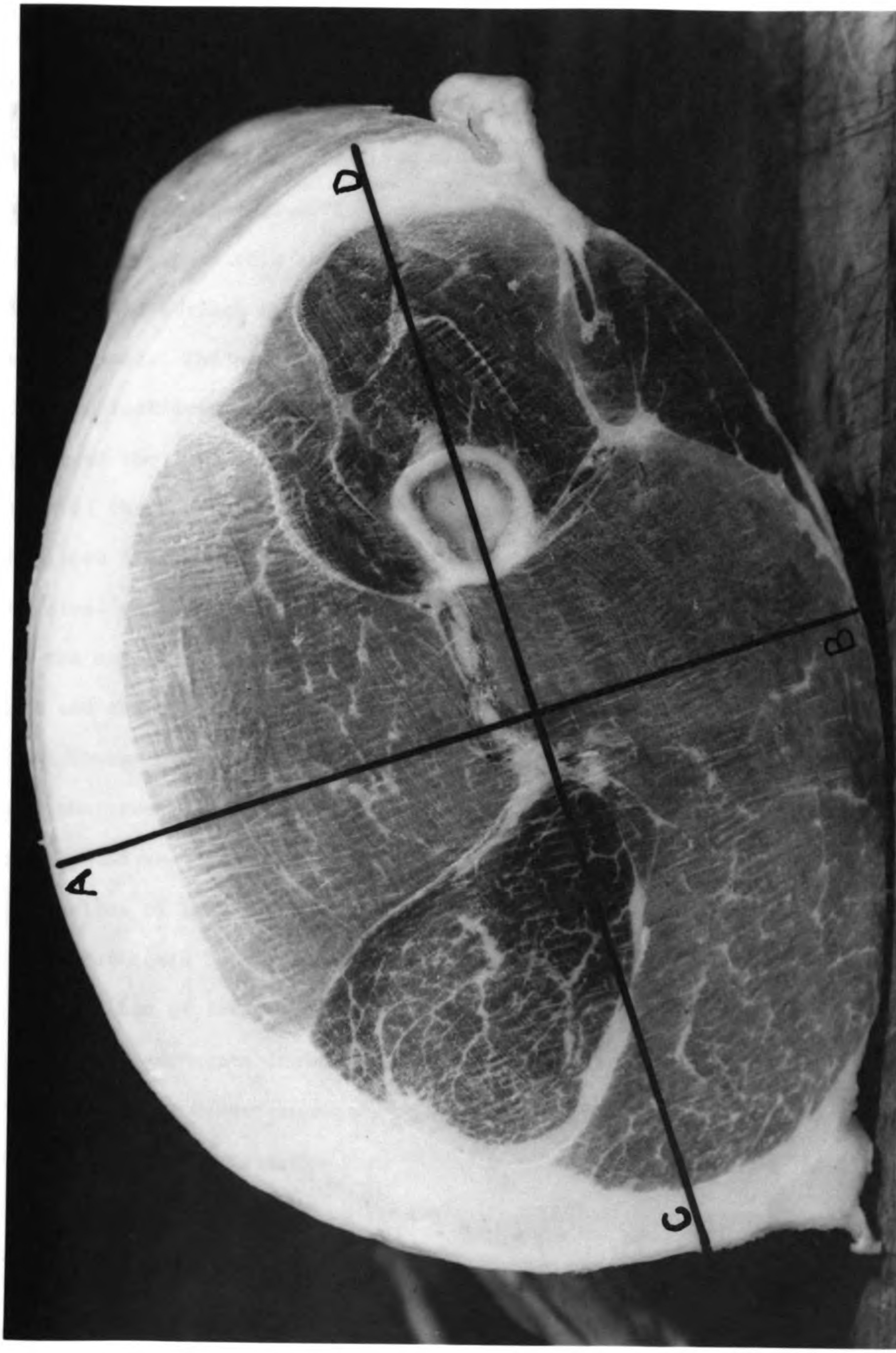


Figure III. Cross section of the ham showing constructed axis
A-B thickness of ham (cushion) C-D width of ham

subcutaneous fat cover and in particular the fat cover over the "bulge" portion of the ham, and the split surfaces of the tibia and femur. The tail bones and the pelvis including the cut illium remain in the portion removed to expose this surface. An acetate paper tracing was taken of the exposed surface and axes were constructed on the tracing to facilitate measurement. The positions of these axes are indicated in Figure IV. A longitudinal axis was drawn parallel to the shank and through the mid point of the hock joint extending to the cut surface of the anterior portion of the ham.. In an attempt to estimate the influence of the "bulge" of ham upon total ham muscle, a series of perpendicular measurements were obtained along the longitudinal axis at 10, 15, 20 and 25 cms anterior to the medial malleolus. Linear measurement of the lean plus subcutaneous fat and the lean alone were recorded at each of the 4 sites. It was hoped that these four measurements could be used as a measure of "bulge" of ham and that the influence of the "bulge" upon total ham muscle could be determined. It was felt that by considering both total dimensions and the dimensions of lean by itself, the effect of the lean and the subcutaneous fat cover could be separated and show whether a large "bulge" was reflected in more lean or fat. It can be seen from Figure IV that the four perpendicular measurements include the major portion comprising the "bulge" of the ham. Area measurements of lean, fat and bone were obtained by planimeter from the acetate tracings to the left of the longitudinal axis from the origin of the section at the medial malleolus to a perpendicular line drawn to the longitudinal axis at the separation point of the ham and loin. The spacial arrangement of the tibia, fibula, femur and pelvic bones is slightly variable from animal to animal. This slight variation in spacial

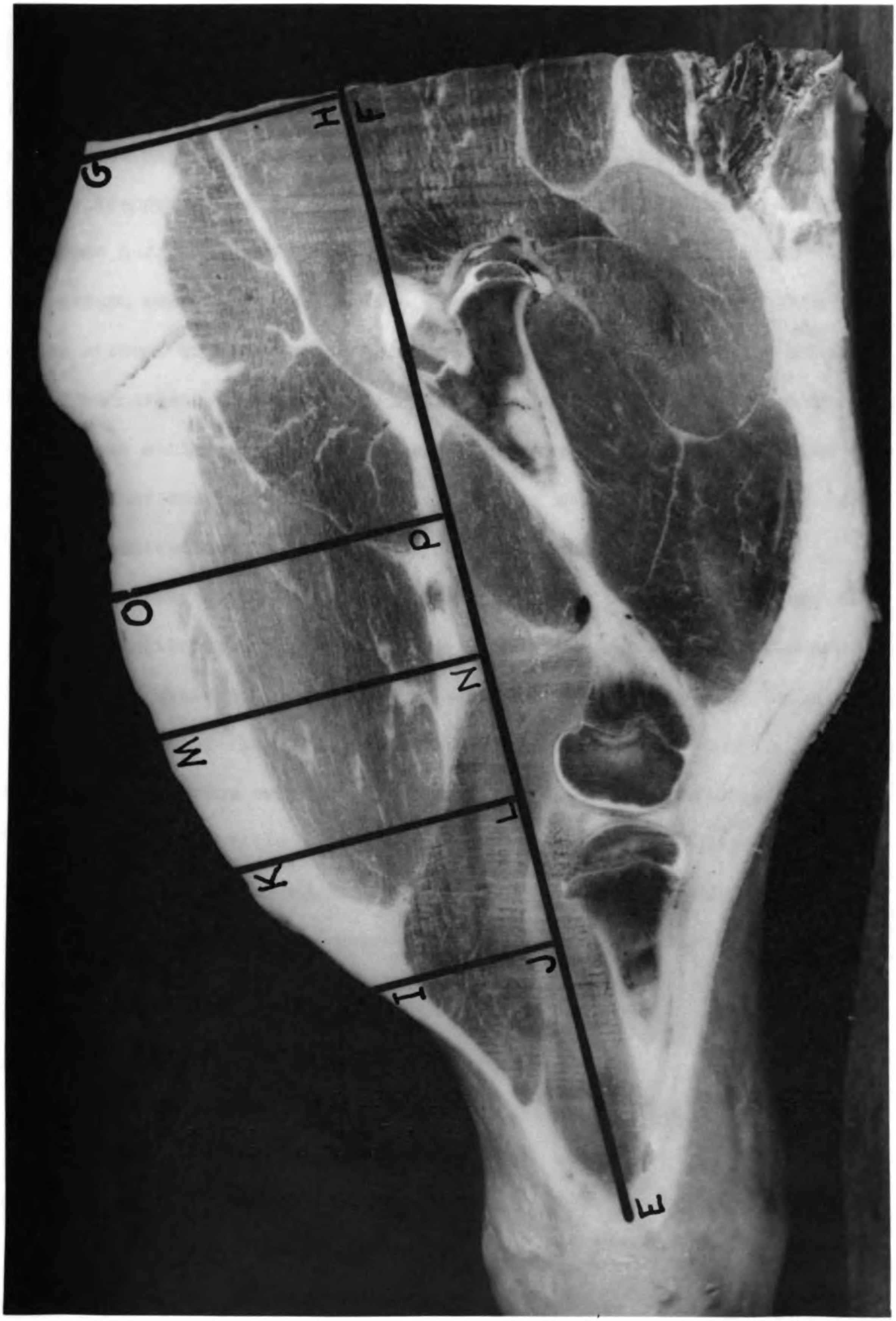


Figure IV. Longitudinal section of the ham showing constructed axis E-F longitudinal axis (length of ham) G-H anterior terminus I-J, K-L, M-N and O-P, perpendicular axis at 10, 15, 20 and arrangement of the bones produces variation in the surface areas of bone and muscle exposed on the longitudinal section. Since the bone was primarily responsible for this difference and since the greatest portion of the bone surface is to the right of the longitudinal axis, it was decided to measure only the areas of lean, fat and bone to the left of this axis in an attempt to minimize the effect of this inherent variation of the ham from carcass to carcass. It was felt that since the areas were to be used as an estimator of muscling and since the longitudinal axis was constant better results would be obtained using only the areas to the left of the longitudinal axis.

The weight of the frozen hams with the foot attached was recorded prior to splitting. After splitting the foot was removed as recommended by the pork evaluation committee of the 1952 Reciprocal Meats Conference and the weight of the foot and the untrimmed ham were recorded. The hams were thawed at room temperature under a damp shroud to minimize weight loss through evaporation. The weight of the thawed ham was recorded and then separated into lean, fat, bone and skin and the weight of each component was recorded to the nearest gram. The tail or caudal vertebrae were separated from each ham and the weight recorded.

## Analysis of Data

Statistical analysis procedures as outlined by Snedecor (1956) were applied to these data. Simple correlation coefficients were determined between all characteristics on a computer. Multiple correlations between the linear measurements in the loin and ham and some measures of muscling were computed. The r values were submitted to a test of significance.

In some instances a test for significant difference between particular correlations for gilts and barrows was applied.

## RESULTS AND DISCUSSION

### Loin Measurements

In an attempt to determine the influence of the length of chine bone and depth of loin upon trimmed loin weight and size of the longissimus dorsi muscle, these measurements were correlated with weight of the right trimmed loin and with area of longissimus dorsi muscle as exposed at the 10th and last rib.

Simple correlation coefficients between length of chine bone at the 3rd, 7th, 10th and last rib with area of the longissimus dorsi muscle at the 10th and last rib and with the weight of the right trimmed loin appear in table 1. Weight of the trimmed loin was significantly correlated with length of chine bone at the 7th rib for both barrows and gilts ($r = .57$) and ($r = .54$), respectively to length of chine bone for barrows at the 10th rib ($r = .46$) and for gilts at the last rib ($r = .44$). The correlation coefficients approached significance at the 5 percent level for gilts at 10th rib and for barrows at the last rib. Thus, with the exception of the 3rd rib, length of chine bone influences the weight of the trimmed loin in both gilts and barrows. The only significant correlations between the area of longissimus dorsi muscle at 10th and last rib with the length of chine bone were found at the 7th and last rib for barrows ($r = .53$, $r = .66$ and $r = .67$, $r = .45$, respectively) and between area at the last rib and the length of chine bone at the last rib for gilts ($r = .45$). Thus, it appears that individual measures of chine bone length are of little value with respect to influence upon area of the longissimus dorsi muscle. This is in agreement with the findings of Kropf

(1959). Similarly, the length of chine bone provides little effect upon the weight of the trimmed loin.

Table 1. Correlation coefficients between length of chine bone and weight of loin and area of longissimus dorsi muscle

| | Length of chine bone | | | |
|---|---|---|---|---|
| | 3rd rib | 7th rib | 10th rib | last rib |
| Weight of right trimmed loin | .26<br>(.22) | .54*<br>(.57)** | .43<br>(.46)* | .44*<br>(.41) |
| Area of longissimus dorsi at 10th rib | .22<br>(.30) | .39<br>(.53)* | .24<br>(.17) | .38<br>(.66)** |
| Area of longissimus dorsi at last rib | .20<br>(.43) | .32<br>(.67)** | .14<br>(.35) | .45*<br>(.45)* |

* $P < 0.05$
** $P < 0.01$
Values for barrows in parentheses

The simple correlation coefficients for depth of loin as measured by the T square at the 3rd, 7th, 10th and last rib with the weight of right trimmed loin and the area of longissimus dorsi muscle at the 10th and last rib are presented in table II. Of these correlations, only those for gilts between depth of loin at the last rib and the area of the longissimus dorsi muscle at the 10th and last rib are significant at a 5 percent level with values of .49 and .46, respectively. These data indicate that individual measurements of loin depth are of little value in estimating loin weight or area of the longissimus dorsi muscle. These observations are in agreement with the investigations of Mathews *et al.* (1959).

Table II. Correlation coefficients between depth of loin and weight of loin and area of longissimus dorsi muscle

| | Depth of loin | | | |
|---|---|---|---|---|
| | 3rd rib | 7th rib | 10th rib | Last rib |
| Weight of right trimmed loin | -.08 (-.26) | .36 (-.05) | .17 (-.37) | .19 (-.31) |
| Area of longissimus dorsi at 10th rib | .04 (.06) | .40 (.01) | .11 (-.13) | .49* (-.08) |
| Area of longissimus dorsi at last rib | .03 (-.18) | .32 (.15) | .13 (.05) | .46* (.08) |

* $P < 0.05$
** $P < 0.01$
Values for barrows in parentheses

Multiple correlation coefficients between the length of chine bone, depth of loin measures and the length& depth measure to weight of the right trimmed loin, the area of longissimus dorsi muscle at the 10th and last rib appear in table III. Multiple correlation coefficients for length of chine bone with the two areas of the longissimus dorsi muscle are higher for barrows $R = .74$, $R = .71$ than for gilts $R = .55$, $R = .56$, respectively. The correlations for barrows were significant at the $P < 0.05$ level, whereas those for gilts were not significant. However, the multiple correlations between the depth of loin and the two areas of the longissimus dorsi muscle for gilts were highly significant with values of $R = .74$ and $R = .66$ whereas the values for barrows $R = .24$ and $R = .28$ were not significant.

The multiple correlation coefficients for length of chine & depth of loin with area of the longissimus dorsi muscle at the 10th and last rib are quite similar, R = .69 and R = .66 , respectively for gilts and R = .63 and R = .59 for the barrows. Thus, these data indicate that the multiple correlation for length of chine bone & depth of loin has the highest relationship, in both gilts and barrows, with the area of longissimus dorsi as measured at the 10th and last rib.

Table III. Multiple correlations coefficients of length of chine bone at 4 locations or depth of loin at 4 locations or length X depth at 4 locations with loin measurements.

| | Weight of right trimmed loin | Area of longissimus dorsi at 10th rib | Area of longissimus dorsi at last rib |
|---|---|---|---|
| Length of chine bone at 3rd, 7th, 10th and last rib | .70* (.62) | .55 (.74)* | .56 (.71)* |
| Depth of loin at 3rd, 7th, 10th and last rib | .61 (.55) | .74* (.24) | .66 (.28) |
| Length & depth at 3rd, 7th, 10th and last rib | .71* (.52) | .69* (.63) | .66 (.59) |

* $P < 0.05$
Values for barrows in parentheses

The multiple correlations between weight of the trimmed loin and those three measurements of loin are consistently higher for gilts than for barrows. Weight of the trimmed loin was significantly ($P < 0.05$) correlated with length of chine bone (R = .70), but depth of loin was not significant for gilts (R = .61). Length of chine bone & depth of loin was significantly correlated with weight of trimmed loin for gilts (R = .71). Comparable multiple correlation coefficients between weight of trimmed loin and length of chine bone, depth of loin and length of chine bone & depth of loin for barrows were non significant (R = .62), (R = .58) and (R = .52), respectively. Thus, it appears from these data that a greater percentage of the variation in weight of right trimmed loin is attributable to skeletal dimensions of the loin (length of chine & depth of loin) for gilts (52 percent) than for barrows (27 percent). As might be expected, the correlations between skeletal dimensions and the three measuresments of the loin indicate that the influence of skeletal dimension is more consistently related to the weight of the right trimmed loin than with the areas of the longissimus dorsi muscle. However, a pig with greater loin skeletal dimensions, namely longer spinous processes and a greater spring of rib, would be more likely to have a larger longissimus dorsi muscle than a pig with smaller loin skeletal dimensions. This agrees with the work of Hammond (1932) and other later workers who have postulated that muscle size is correlated to the dimensions of the bones to which that muscle is attached.

Relationship of Loin and Ham Measurements of Muscling

Correlation coefficients between area of the longissimus dorsi muscle at the 10th and last rib and weight of right trimmed loin with weight of separable lean, area of lean of the left and right ham and the linear measurement of thickness through the ham appear in table IV. The correlations between weight of separable lean of the left and right ham with the area of longissimus dorsi muscle at the 10th and last rib were essentially the same as that for the weight of trimmed loin. All of these correlations were highly significant except that between the separable lean of the right ham and trimmed loin weight for barrows (.44), which was significant at the $P < 0.05$ level. The correlation coefficients were consistently higher for gilts than barrows, but markedly similar values were obtained between separable lean of the right and left hams and those loin measurements.

Table IV. Correlation coefficients for measurements of muscling between the ham and loin

| | Weight of right trimmed loin | Area of longissimus dorsi at 10th rib | Area of longissimus dorsi at last rib |
|---|---|---|---|
| Weight of separable lean left ham | .70** (.46)* | .73** (.63)** | .67** (.66)** |
| Weight of separable lean right ham | .72** (.44)* | .78** (.64)** | .72** (.64)** |
| Lean area left ham (longitudinal section) | .65** (.11) | .50* (.34) | .47* (.38) |
| Lean area right ham (cross section) | .75** (.64)** | .82** (.76)** | .82** (.76)** |
| Thickness of right ham (A-B axis) | .60** (.62)** | .51* (.64)** | .58** (.67)** |

* $P < 0.05$
** $P < 0.01$
Values for barrows in parentheses

When the correlations between the lean area of the left ham (longitudinal section) and the three measurements of the loin were examined, it was found that the values for gilts were all significant (r = .65), (r = .50), (r = .47) with weight of trimmed loin and the two area measurements, respectively. The corresponding values for barrows (r = .11), (r = .34), (r = .38) were non significant. These correlation coefficients between barrows and gilts were significantly different. Thus, the lean area of the longitudinal section was significantly associated with muscling in the loin of gilts but not barrows and it was shown that there was a significant difference between barrows and gilts in this respect.

The lean area of the right ham (cross section) was highly significantly correlated with the three measurements of the loin for both barrows and gilts. However, the correlations for gilts were consistently higher than those for barrows. Furthermore, the lean area of the right ham was more highly correlated to the area of the longissimus dorsi muscle at the 10th and last rib for both barrows and gilts than with weight of trimmed loin. Identical correlation coefficients were observed between the lean area of the right ham and the area of the longissimus dorsi muscle at both the 10th and last rib .82 for gilts and .76 for barrows. Thus, approximately 67 and 58 percent of the variation in lean area of the right ham was associated with the area of the longissimus dorsi muscle in gilts and barrows, respectively. The linear measure of thickness through the right ham (cross section) was more highly correlated to the loin measurements in barrows r = .62 , r = .64 , r = .67 than in gilts r = .60 , r = .51 , r = .58 for weight of trimmed loin and area of the longissimus dorsi muscle at the 10th and last rib, respectively. These values were highly significant with the exception of thickness of right ham with area of longissimus dorsi muscle at the 10th rib for gilts. Thus, ham thickness, which can readily be evaluated on the live hog, is highly related to the trimmed loin weight as well as area of longissimus dorsi muscle.

The correlations as shown in table IV, with the exception of the lean area of the left ham (longitudinal section) especially for barrows, show a high relationship between measurements of muscling in the loin and ham. In addition, these correlations show the differences between barrows and gilts and indicate the importance of analyzing such data separately.

Comparison of left and right ham separation values

The simple correlation coefficients between the physically separated components of the left and right hams, namely lean, fat, bone and skin are presented in table V. The correlation coefficient values from left and right hams for fat is higher for the gilts r = .87 than for barrows r = .73, but both values are highly significant. Highly significant and nearly identical correlations between left and right separable lean r = .89 for gilts and r = .80 for barrows were obtained.

The correlation coefficient between left and right bone separation values are surprisingly low, r = .62 for gilts and r = .46 for barrows. Other workers have shown that the bone to bone relationship between left and right sides is consistently high with correlation coefficients of r = .9 or more in many cases (Butler, 1956; Robison _et al._, 1960; and Bowman _et al._, 1962).

Table V. Correlation coefficients between left and right ham physical separation values

| | Left fat | Left lean | Left bone | Left skin |
|---|---|---|---|---|
| Right fat | .87**<br>(.73)** | -<br>- | -<br>- | -<br>- |
| Right lean | -<br>- | .89**<br>(.86)** | -<br>- | -<br>- |
| Right bone | -<br>- | -<br>- | .62**<br>(.46)* | -<br>- |
| Right skin | -<br>- | -<br>- | -<br>- | .87**<br>(.47)* |

* $P < 0.05$
** $P < 0.01$
Values for barrows in parentheses

There is considerable difference in the correlation coefficients for skin separation values between barrows and gilts. It is apparent that correlation values for gilts are consistently higher and it would appear from these data that there is more variation between left and right hams for barrows than gilts.

Measurements of Muscling in the Ham

Correlation coefficients between the separable lean and fat in the left and right ham and the respective total areas, lean areas and fat areas are shown in table VI. The total measured area of the left ham (longitudinal section) which includes lean, bone and subcutaneous fat showed a non significant correlation to separable lean or fat $r = .41$, $r = .30$ and $r = .22$, $r = .23$ for gilts and barrows, respectively. The lean area of the left ham, however, was significantly correlated to the separable lean $r = .56$ for gilts and $r = .45$ for barrows and as might be expected a non significant relationship was observed with separable fat. However, the fat area of the left ham was highly significantly correlated to the separable fat with r values .63 and .59 for gilts and barrows, respectively. Thus, the lean and fat areas are significantly correlated to the separation values of lean and fat, respectively, but the total area is of little use in predicting muscling.

The lean area of the right ham (cross section) was very highly correlated to separable lean with r values .92 for gilts and .82 for barrows. The area measurement on the cross section of the right ham through the thickest portion of the ham was of much greater value as an estimator of separable lean and muscling of the ham than was any of the area measurements of the longitudinal section of the left ham.

Table VI. Correlation coefficients between separable fat and lean of the ham and area measurements of the ham

| | Left ham separation values | | Right ham separation values | |
|---|---|---|---|---|
| | Lean | Fat | Lean | Fat |
| Total area left ham<br>(longitudinal section) | .41<br>(.22) | .30<br>(.23) | | |
| Lean area left ham<br>(longitudinal section) | .56**<br>(.45)* | .16<br>(-.08) | | |
| Fat area left ham<br>(longitudinal section) | -.04<br>(-.39) | .63**<br>(.59)** | | |
| Lean area right ham<br>(cross section) | | | .92**<br>(.82)** | .28<br>(-.20) |
| Fat area right ham<br>(cross section) | | | .15<br>(.28) | .77**<br>(.35) |

* $P < 0.05$
** $P < 0.01$
Values for barrows in parentheses

The correlation between lean area of the right ham and separable fat was non significant $r = .28$ and $r = -.20$ for gilts and barrows, respectively. A non significant relationship was found between the fat area of the right ham and the separable lean $r = .15$ and $r = .28$ for gilts and barrows, respectively. However, the correlation between the fat area and separable fat was highly significant for gilts $r = .77$ and non significant for barrows $r = .35$ Simple correlation coefficients between the linear measurements of the left ham (longitudinal section), and areas and separable lean.are presented in table VII. The "bulge" of the ham as measured by the four lines drawn perpendicular to the longitudinal axis of the ham (Figure IV) were constructed in an attempt to measure the influence of the "bulge" of the ham upon total ham muscle. The simple

Table VII. Correlation coefficients between left ham linear measurements and areas of separable lean

| | Total area | Lean area | Fat area | Separable lean left ham |
|---|---|---|---|---|
| Total at 10 cm | .54* (.29) | .21 (.22) | .19 (.20) | .01 (-.11) |
| Total at 15 cm | .66** (.29) | .42 (.18) | .06 (.28) | .15 (-.16) |
| Total at 20 cm | .83** (.37) | .62** (.34) | .04 (.12) | .25 (.06) |
| Total at 25 cm | .88** (.50)* | .61** (.38) | .14 (.20) | .21 (-.01) |
| Longitudinal axis of ham | -.12 (.40) | .19 (.32) | .04 (.09) | .41 (.46)* |

* $P < 0.05$
** $P < 0.01$
Values for barrows in parentheses

correlation coefficients between the total area of the left ham and the total linear measurements (linear measure of lean plus subcutaneous fat) increased in the gilts from $r = .54$ at 10 cms to $r = .88$ at 25 cms. There was a similar trend for barrows but the correlation coefficients were much lower $r = .29$, $r = .29$, $r = .37$, $r = .50$ and only the perpendicular at 25 cm was significant.. This trend of increasing correlation values for the perpendicular at 10 cm to that at 25 cms is repeated for the correlation for the area of lean but in this case all values are lower and only the correlations for gilts at 20 cm $r = .62$ and at 25 cm $r = .61$ are significant. In no instance were the values for barrows significant. The correlation coefficient between fat area and the total linear measurements of "bulge" of ham were not significantly correlated, but the linear measurement of the longitudinal axis was significant ($P < 0.05$) for barrows ($r = .46$) and approached significance at the 5 percent level for gilts ($r = .41$). Thus, the linear measurements of "bulge" of ham had little relationship to separable lean of the ham. The only linear measurement from the left ham which was significantly correlated with separable lean of the ham was the longitudinal axis.

The simple correlation coefficients for the linear measurements of the right ham (cross section) and areas and separable lean are presented in table VIII. The width axis of the ham (figure III) was highly related to the separable lean both gilts and barrows $r = .64$ and $r = .52$, respectively. Thickness of the ham, as measured through the thickest portion of the ham, (figure III) was highly significantly correlated with lean area of the ham $r = .83$ for gilts and $r = .85$ for barrows. The correlations between the thickness of ham and separable lean are highly significant $r = .79$ for gilts and $r = .68$ for barrows. These linear measures of the width and thickness through the "cushion" of the ham are of special interest since they can be estimated visually or measured by callipers on the live pig or carcass and therefore could provide a useful criterion for selection. The correlation coefficients were higher for gilts than for barrows but all values are significant, especially for thickness through the cushion which was the most significant single estimator of muscle in the ham.

The multiple correlation coefficients between linear measurements of the ham and areas and separable lean of the ham are presented in table IX. The combined linear measurements of "bulge" of ham on the left ham

Table VIII. Correlation coefficients between right ham linear measurements and areas and separable lean

| | Total width (C-D axis) | Total thickness (A-B axis) |
|---|---|---|
| Separable fat right ham | .56** (.29) | .55* (-.10) |
| Separable lean right ham | .64** (.52)* | .79** (.68)** |
| Lean area right ham (cross section) | .78** (.46)* | .83** (.85)** |
| Fat area right ham (cross section) | .68** (.18) | .55* (.14) |

* P < 0.05
** P < 0.01
Values for barrows in parentheses

Table IX. Multiple correlation coefficients between the linear measurements of the ham and areas and separable lean of the ham

| Combined linear measurements of "bulge" of ham (longitudinal section) | |
|---|---|
| Lean area left ham | .79* (.40) |
| Total area left ham | .92** (.56) |
| Separable lean left ham | .44 (.63) |
| **Linear measurements (depth & width) of right ham (cross section)** | |
| Lean area right ham | .88** (.92)** |
| Separable lean right ham | .80** (.81)** |

* P < 0.05
** P < 0.01
Values for barrows in parentheses

(longitudinal section) and the lean area was significant R = .79 and highly significant R = .92 for total area for gilts. However, corresponding values for barrows were not significant. The multiple correlation between the combined linear measurements of bulge of ham and separable lean of the ham were R = .44 and R = .63 for barrows and gilts, respectively. While the latter value is approaching significance these data indicate "bulge" of ham as measured in this study was of little predictive value for the separable lean content of the ham.

The multiple correlation coefficients between the combined width and depth linear measurements of the right ham (cross section) and the area of lean are highly significant R = .88 and R = .92 for gilts and barrows, respectively. The multiple correlation coefficients between the combined linear measurements of the right ham and separable lean R = .80 for gilts and R = .81 for barrows were also highly significant. Thus, the combined cross sectional linear measurement of the ham were more highly related to the separable lean of the ham than combined measurements of bulge of ham. The simple correlation coefficient also indicate separable lean of the ham is more highly associated with thickness of "cushion" than either "length" or "bulge" of ham.

# SUMMARY

This study was conducted to determine the relationship of some linear and area measurements to degree of muscling in the ham and loin of pork carcasses. The effect of length of chine bone and of depth of loin upon area of the longissimus dorsi muscle and weight of trimmed loin was investigated. The longissimus dorsi muscle was significantly correlated with the product of length of chine times depth of loin. There was a high correlation between the measures of muscling in the loin and ham. The simple correlation coefficients between area of the longissimus dorsi muscle and separable lean in the ham were $r = .78$ and $r = .64$ for gilts and barrows, respectively.

The influence of the "bulge" and "thickness of cushion" upon muscling in the ham was determined from linear and area measurements on longitudinal and cross sections of the ham. The measurements of "bulge" and length of ham were only moderately related to separable lean in the ham. The multiple correlation coefficients between "bulge" of ham and separable lean was $R = .44$ and $R = .63$ for gilts and barrows, respectively. The linear measurement of "thickness of cushion" was very highly correlated to muscling of the ham. The simple correlation coefficients between thickness of ham and separable lean in the ham were $r = .79$ and $r = .68$ for gilts and barrows, respectively. This single measurement of ham . dimensions had the highest relationship to separable lean of the ham. Thus, thickness of "cushion" of the ham was more highly related to separable lean of the ham than either "length" or "bulge" of ham.

In general, the correlations for gilts were higher than those for barrows. Also, more variation was observed among barrow data than that for gilts. These data indicate the need for separate statistical treatment of fat, lean and bone weights and measurements for barrows and gilt carcasses.

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# APPENDIX

Appendix I. Barrows - Carcass Data

| Tattoo | Number | Average backfat | Length of chine bone 3rd rib | 7th rib | 10th rib | last rib |
|---|---|---|---|---|---|---|
| | | – | cms | cms | cms | cms |
| X70-9, E18 | 1 | 3.40 | 9.3 | 6.8 | 4.8 | 3.5 |
| X70-10, E36 | 2 | 3.65 | 8.8 | 7.5 | 5.5 | 3.7 |
| X74-8, E16 | 3 | 3.35 | 7.1 | 5.5 | 3.9 | 3.6 |
| X76-6, E25 | 4 | 3.13 | 9.2 | 5.4 | 3.6 | 3.3 |
| X76-11, E26 | 5 | 4.00 | 7.5 | 5.9 | 4.3 | 3.2 |
| X76-7, E26 | 6 | 3.66 | 8.6 | 5.8 | 3.9 | 3.4 |
| X96-5, 26E | 7 | 2.95 | 9.2 | 7.1 | 4.5 | 3.9 |
| X98-4, 05E | 8 | 3.30 | 8.8 | 6.8 | 4.6 | 4.0 |
| Y19-8, E18 | 9 | 4.00 | 8.5 | 6.9 | 5.0 | 3.1 |
| Y21-8, E25 | 10 | 3.20 | 8.5 | 5.6 | 4.1 | 2.9 |
| Y22-6, E08 | 11 | 4.16 | 9.0 | 6.8 | 4.8 | 2.7 |
| Y23-9, E16 | 12 | 3.80 | 8.5 | 7.0 | 4.5 | 3.3 |
| Y24-11, E17 | 13 | 3.90 | 9.2 | 7.5 | 4.5 | 3.7 |
| Y26-11, E35 | 14 | 4.80 | 8.3 | 6.1 | 4.6 | 3.1 |
| A, 05E | 15 | 3.98 | 8.2 | 4.8 | 3.6 | 2.9 |
| C, 07E | 16 | 3.15 | 8.8 | 6.8 | 3.9 | 3.4 |
| D, 08E | 17 | 2.65 | 9.4 | 6.3 | 3.9 | 3.6 |
| G, 16E | 18 | 3.55 | 8.9 | 6.3 | 4.5 | 3.5 |
| H, 17E | 19 | 4.78 | 8.1 | 5.4 | 4.4 | 3.3 |
| I, 18E | 20 | 3.28 | 9.0 | 6.2 | 4.1 | 3.8 |
| Mean | | 3.64 | 8.6 | 6.3 | 4.4 | 3.4 |

Appendix I. Barrows - Carcass Data (continued)

| Number | Depth of loin 3rd rib | Depth of loin 7th rib | Depth of loin 10th rib | Depth of loin Last rib | Weight of right trimmed loin | Area of longissimus dorsi 10th rib | Area of longissimus dorsi Last rib |
|---|---|---|---|---|---|---|---|
| | cms | cms | cms | cms | kgs | sq. cms | sq. cms |
| 1 | 5.1 | 7.9 | 8.4 | 11.1 | 5.81 | 25.81 | 27.29 |
| 2 | 3.9 | 8.9 | 8.8 | 10.8 | 5.40 | 19.94 | 22.13 |
| 3 | 4.9 | 7.6 | 8.8 | 11.5 | 5.22 | 22.58 | 23.80 |
| 4 | 3.5 | 5.8 | 6.7 | 10.5 | 5.40 | 21.36 | 23.10 |
| 5 | 4.1 | 6.6 | 7.2 | 10.1 | 5.44 | 21.94 | 24.07 |
| 6 | 4.7 | 7.2 | 7.7 | 10.2 | 5.67 | 24.52 | 24.07 |
| 7 | 4.8 | 8.1 | 8.3 | 10.4 | 5.90 | 26.78 | 28.39 |
| 8 | 4.3 | 6.9 | 8.4 | 10.0 | 5.85 | 28.32 | 26.39 |
| 9 | 4.7 | 8.6 | 9.6 | 12.2 | 5.08 | 22.19 | 24.32 |
| 10 | 3.6 | 7.7 | 9.2 | 13.0 | 4.58 | 19.16 | 23.36 |
| 11 | 4.0 | 6.7 | 7.6 | 8 .8 | 5.62 | 20.13 | 25.16 |
| 12 | 4.7 | 7.4 | 8.1 | 11.4 | 5.62 | 23.29 | 23.23 |
| 13 | 4.0 | 7.4 | 8.7 | 11.5 | 5.58 | 24.58 | 28.64 |
| 14 | 5.3 | 7.5 | 8.4 | 12.3 | 5.03 | 22.65 | 23.87 |
| 15 | 5.3 | 7.1 | 9.0 | 10.3 | 4.04 | 16.39 | 16.19 |
| 16 | 4.2 | 6.8 | 8.0 | 10.4 | 4.57 | 22.84 | 23.87 |
| 17 | 5.3 | 8.6 | 9.3 | 11.6 | 4.72 | 22.64 | 24.39 |
| 18 | 4.9 | 8.0 | 9.9 | 11.8 | 5.03 | 19.87 | 25.74 |
| 19 | 4.8 | 7.4 | 7.6 | 10.5 | 4.85 | 18.78 | 19.94 |
| 20 | 5.3 | 7.0 | 8.4 | 10.5 | 4.85 | 22.26 | 22.52 |
| Mean | 4.6 | 7.5 | 8.4 | 10.9 | 5.22 | 22.3 | 24.02 |

Appendix I. Barrows - Carcass Data (continued)

| Number | Left ham separation values | | | | Areas of longitudinal section | | |
|---|---|---|---|---|---|---|---|
| | Fat | Lean | Bone | Skin | Total | Lean | Fat |
| | kgs | kgs | kgs | kgs | sq.cms | sq.cms | sq.cms |
| 1 | 2.40 | 4.13 | .69 | .28 | 369.44 | 254.53 | 82.71 |
| 2 | 2.54 | 3.67 | .66 | .27 | 288.15 | 181.04 | 81.23 |
| 3 | 2.81 | 3.86 | .58 | .23 | 262.82 | 158.53 | 87.88 |
| 4 | 2.22 | 3.67 | .68 | .33 | 286.47 | 196.14 | 63.94 |
| 5 | 2.72 | 3.45 | .67 | .33 | 315.51 | 178.14 | 106.65 |
| 6 | 2.68 | 3.95 | .64 | .30 | 258.98 | 157.69 | 88.52 |
| 7 | 2.04 | 4.54 | .69 | .27 | 324.02 | 236.21 | 64.20 |
| 8 | 2.72 | 4.49 | .73 | .32 | 367.25 | 238.14 | 92.46 |
| 9 | 2.45 | 4.17 | .59 | .35 | 351.83 | 245.11 | 72.33 |
| 10 | 1.95 | 3.86 | .58 | .21 | 239.24 | 167.49 | 63.94 |
| 11 | 2.54 | 4.13 | .62 | .31 | 324.28 | 199.24 | 95.04 |
| 12 | 2.63 | 4.22 | .68 | .23 | 288.08 | 173.95 | 86.91 |
| 13 | 2.09 | 4.26 | .64 | .31 | 299.89 | 213.11 | 69.42 |
| 14 | 2.72 | 3.90 | .60 | .20 | 264.60 | 156.78 | 90.78 |
| 15 | 2.30 | 3.45 | .54 | .31 | 367.83 | 214.92 | 107.62 |
| 16 | 2.13 | 3.58 | .64 | .25 | 307.76 | 205.95 | 71.68 |
| 17 | 3.08 | 4.17 | .74 | .40 | 383.96 | 244.85 | 85.81 |
| 18 | 3.49 | 4.26 | .68 | .36 | 349.05 | 221.37 | 90.13 |
| 19 | 3.13 | 3.49 | .62 | .37 | 313.44 | 176.85 | 113.88 |
| 20 | 2.95 | 4.54 | .61 | .32 | 295.50 | 192.85 | 76.97 |
| Mean | 2.58 | 3.99 | .64 | .30 | 312.9 | 200.64 | 84.61 |

Appendix I. Barrows - Carcass Data (continued)

| | Linear measurements of perpendiculars on longitudinal section | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 10 cms | | 15 cms | | 20 cms | | 25 cms | |
| Number | Total | Lean | Total | Lean | Total | Lean | Total | Lean |
| | cms | cms | cms | cms | cms | cms | cms | cms |
| 1 | 6.7 | 3.5 | 9.4 | 7.6 | 10.5 | 9.1 | 10.4 | 7.0 |
| 2 | 6.2 | 4.1 | 9.3 | 7.0 | 11.3 | 9.7 | 11.7 | 8.5 |
| 3 | 7.7 | 5.1 | 11.4 | 9.1 | 13.9 | 12.7 | 14.5 | 11.6 |
| 4 | 7.5 | 5.6 | 10.5 | 9.0 | 11.8 | 10.6 | 11.4 | 8.2 |
| 5 | 6.1 | 3.6 | 11.9 | 8.0 | 11.8 | 10.1 | 11.6 | 8.0 |
| 6 | 5.4 | 3.9 | 8.6 | 6.2 | 10.0 | 8.8 | 9.8 | 7.1 |
| 7 | 7.7 | 6.7 | 10.9 | 9.4 | 12.9 | 11.8 | 12.4 | 9.7 |
| 8 | 9.0 | 6.9 | 12.2 | 9.2 | 14.0 | 12.5 | 13.5 | 9.2 |
| 9 | 7.0 | 5.3 | 10.5 | 8.2 | 12.6 | 10.5 | 13.5 | 10.5 |
| 10 | 6.9 | 5.5 | 9.4 | 8.4 | 10.3 | 9.0 | 9.7 | 7.1 |
| 11 | 7.4 | 4.5 | 11.1 | 9.0 | 12.6 | 11.0 | 12.5 | 8.5 |
| 12 | 6.5 | 5.3 | 9.3 | 6.8 | 10.7 | 9.1 | 11.2 | 7.2 |
| 13 | 5.5 | 3.9 | 9.9 | 7.6 | 11.7 | 9.3 | 11.9 | 9.4 |
| 14 | 6.5 | 3.8 | 9.6 | 6.7 | 10.3 | 8.8 | 10.2 | 6.7 |
| 15 | 7.8 | 4.9 | 10.5 | 8.3 | 12.6 | 10.2 | 13.8 | 10.7 |
| 16 | 7.2 | 5.8 | 10.2 | 8.0 | 12.0 | 9.6 | 12.8 | 9.5 |
| 17 | 6.4 | 5.4 | 9.9 | 7.7 | 12.1 | 10.6 | 13.4 | 11.8 |
| 18 | 6.2 | 4.7 | 9.1 | 7.2 | 10.8 | 8.6 | 11.5 | 8.6 |
| 19 | 8.3 | 5.9 | 10.5 | 7.3 | 11.9 | 8.3 | 12.3 | 8.2 |
| 20 | 5.7 | 4.2 | 8.5 | 6.6 | 10.8 | 8.6 | 11.4 | 9.2 |
| Mean | 6.9 | 4.9 | 10.1 | 7.9 | 11.7 | 9.9 | 12.0 | 8.8 |

Appendix I. Barrows - Carcass Data (continued)

| Number | Length of long axis of longitudinal section | Right ham separation values Fat | Lean | Bone | Skin |
|---|---|---|---|---|---|
| | cms | kgs | kgs | kgs | kgs |
| 1 | 35.3 | 1.77 | 3.67 | .68 | .31 |
| 2 | 35.6 | 2.63 | 3.63 | .70 | .29 |
| 3 | 36.8 | 2.45 | 3.86 | .60 | .26 |
| 4 | 35.3 | 1.86 | 3.49 | .65 | .32 |
| 5 | 36.1 | 2.36 | 3.76 | .46 | .21 |
| 6 | 36.8 | 2.31 | 3.72 | .62 | .35 |
| 7 | 35.6 | 2.09 | 4.81 | .67 | .31 |
| 8 | 36.1 | 2.68 | 4.58 | .72 | .33 |
| 9 | 37.3 | 2.63 | 4.17 | .63 | .32 |
| 10 | 33.0 | 1.81 | 3.54 | .67 | .25 |
| 11 | 35.7 | 2.45 | 4.22 | .65 | .33 |
| 12 | 36.8 | 2.54 | 3.99 | .69 | .31 |
| 13 | 38.3 | 2.13 | 4.40 | .58 | .21 |
| 14 | 35.7 | 2.04 | 4.22 | .59 | .30 |
| 15 | 36.4 | 2.68 | 3.36 | .56 | .32 |
| 16 | 34.8 | 2.18 | 3.54 | .62 | .25 |
| 17 | 40.4 | 2.95 | 4.31 | .72 | .38 |
| 18 | 39.7 | 2.81 | 3.90 | .65 | .32 |
| 19 | 35.2 | 2.99 | 3.36 | .63 | .36 |
| 20 | 39.0 | 2.72 | 4.49 | .67 | .35 |
| Mean | 36.5 | 2.40 | 3.95 | .67 | .30 |

Appendix I. Barrows - Carcass Data (continued)

| Number | Linear measurements of axes on cross section: Width axis Total | Width axis Lean | Thickness axis Total | Thickness axis Lean | Areas of cross section: Total lean | Fat lateral to thick. axis |
|---|---|---|---|---|---|---|
| | cms | cms | cms | cms | sq.cms | sq.cms |
| 1 | 25.4 | 22.3 | 17.2 | 15.3 | 246.14 | 52.00 |
| 2 | 23.5 | 20.5 | 17.6 | 15.4 | 228.40 | 36.91 |
| 3 | 24.0 | 20.8 | 17.9 | 16.0 | 235.89 | 61.42 |
| 4 | 23.2 | 20.5 | 16.4 | 14.8 | 214.21 | 43.62 |
| 5 | 23.5 | 19.3 | 16.6 | 14.3 | 203.50 | 55.94 |
| 6 | 22.6 | 19.1 | 16.7 | 15.0 | 211.88 | 49.68 |
| 7 | 24.8 | 22.8 | 17.6 | 16.2 | 262.47 | 42.13 |
| 8 | 24.5 | 21.5 | 18.4 | 16.6 | 253.50 | 55.81 |
| 9 | 24.6 | 20.9 | 17.7 | 15.4 | 241.30 | 62.46 |
| 10 | 23.9 | 20.9 | 16.3 | 14.7 | 214.20 | 46.84 |
| 11 | 25.5 | 21.4 | 17.5 | 15.2 | 237.37 | 64.97 |
| 12 | 24.0 | 20.5 | 17.6 | 15.7 | 237.63 | 57.55 |
| 13 | 24.6 | 21.7 | 17.8 | 16.1 | 249.18 | 54.78 |
| 14 | 23.7 | 21.2 | 18.3 | 15.9 | 240.01 | 64.58 |
| 15 | 23.6 | 19.9 | 15.4 | 13.4 | 190.59 | 50.45 |
| 16 | 23.2 | 20.1 | 16.6 | 15.5 | 215.24 | 44.45 |
| 17 | 26.1 | 21.7 | 16.9 | 15.2 | 230.08 | 52.52 |
| 18 | 23.7 | 20.0 | 17.2 | 15.2 | 215.24 | 56.46 |
| 19 | 25.0 | 21.1 | 15.7 | 13.8 | 201.11 | 61.81 |
| 20 | 25.8 | 22.3 | 16.7 | 15.0 | 233.76 | 63.23 |
| Mean | 24.3 | 20.9 | 17.1 | 15.2 | 228.09 | 53.89 |

Appendix II. Gilts - Carcass Data

| Tattoo | Number | Average backfat | Length of chine bone 3rd rib | 7th rib | 10th rib | Last rib |
|---|---|---|---|---|---|---|
| | | cms | cms | cms | cms | cms |
| X36-2, 28E | 21 | 4.28 | 8.2 | 6.2 | 4.4 | 3.5 |
| X70-1, E28 | 22 | 3.25 | 8.5 | 5.4 | 4.2 | 3.5 |
| X70-3, E29 | 23 | 2.86 | 8.3 | 7.0 | 4.1 | 3.6 |
| X70-5, E17 | 24 | 3.25 | 8.7 | 6.0 | 4.8 | 3.5 |
| X98-1, 19E | 25 | 3.28 | 8.5 | 6.5 | 4.0 | 4.0 |
| Y18-4, E07 | 26 | 3.03 | 9.6 | 6.5 | 4.5 | 3.2 |
| Y16-6, E27 | 27 | 2.65 | 8.8 | 6.8 | 4.6 | 3.5 |
| Y21-2, E06 | 28 | 3.03 | 9.0 | 6.9 | 4.8 | 3.3 |
| Y21-4, E15 | 29 | 2.76 | 9.0 | 6.8 | 3.5 | 3.1 |
| Y23-2, E19 | 30 | 3.65 | 9.6 | 6.6 | 4.8 | 3.4 |
| Y23-4, E19 | 31 | 4.23 | 8.9 | 6.8 | 4.7 | 3.0 |
| Y26-1, E16 | 32 | 3.86 | 8.7 | 6.5 | 4.2 | 3.2 |
| Y26-3, E09 | 33 | 4.03 | 9.0 | 6.4 | 4.6 | 3.4 |
| Y26-5, E05 | 34 | 2.86 | 7.8 | 6.2 | 3.8 | 3.0 |
| Y31-4, 16E | 35 | 3.70 | 8.4 | 7.4 | 5.1 | 3.3 |
| Y38-2, 08E | 36 | 4.10 | 8.9 | 7.2 | 4.6 | 3.3 |
| Y40-1, 09E | 37 | 3.95 | 8.9 | 6.1 | 3.9 | 3.2 |
| B, 06E | 38 | 2.80 | 8.9 | 5.7 | 4.3 | 3.7 |
| E, 09E | 39 | 3.60 | 8.9 | 5.8 | 3.7 | 3.4 |
| F, 15E | 40 | 2.95 | 7.6 | 4.9 | 3.6 | 3.0 |
| Mean | | 3.41 | 8.7 | 6.4 | 4.3 | 3.4 |

Appendix II. Gilts - Carcass Data (continued)

| Number | Depth of loin 3rd rib | 7th rib | 10th rib | Last rib | Weight of right trimmed loin | Area of longissimus dorsi 10th rib | Last rib |
|---|---|---|---|---|---|---|---|
| | cms | cms | cms | cms | kgs | sq. cms | sq. cms |
| 21 | 4.7 | 7.9 | 8.4 | 10.5 | 6.12 | 27.74 | 27.74 |
| 22 | 4.4 | 8.2 | 9.8 | 11.0 | 6.17 | 28.39 | 29.94 |
| 23 | 4.1 | 7.9 | 8.6 | 11.4 | 6.35 | 26.90 | 29.42 |
| 24 | 4.3 | 7.2 | 7.0 | 10.2 | 5.94 | 26.65 | 27.10 |
| 25 | 4.5 | 8.6 | 8.6 | 10.8 | 6.21 | 31.61 | 31.94 |
| 26 | 4.5 | 7.9 | 8.6 | 11.0 | 6.12 | 29.16 | 27.10 |
| 27 | 4.8 | 7.9 | 8.9 | 11.8 | 6.03 | 27.55 | 31.68 |
| 28 | 4.5 | 7.2 | 7.7 | 10.0 | 6.31 | 26.13 | 27.10 |
| 29 | 4.5 | 7.4 | 7.6 | 10.7 | 5.62 | 28.26 | 28.52 |
| 30 | 4.5 | 7.4 | 7.6 | 11.8 | 5.58 | 29.23 | 28.77 |
| 31 | 4.0 | 6.3 | 8.0 | 10.1 | 5.44 | 21.94 | 23.61 |
| 32 | 3.8 | 6.2 | 6.7 | 9.1 | 6.08 | 28.20 | 32.26 |
| 33 | 3.4 | 6.4 | 7.1 | 9.4 | 5.67 | 23.55 | 22.71 |
| 34 | 4.0 | 6.1 | 7.1 | 10.0 | 5.26 | 24.90 | 23.29 |
| 35 | 5.1 | 8.6 | 9.2 | 10.4 | 6.08 | 26.90 | 24.45 |
| 36 | 4.7 | 7.2 | 8.0 | 10.0 | 5.81 | 25.42 | 25.36 |
| 37 | 4.3 | 7.3 | 7.8 | 10.2 | 6.03 | 25.23 | 26.84 |
| 38 | 6.3 | 8.5 | 9.8 | 11.4 | 5.35 | 23.16 | 25.23 |
| 39 | 4.1 | 7.2 | 7.9 | 8.5 | 5.13 | 18.26 | 19.36 |
| 40 | 4.7 | 7.2 | 8.1 | 10.7 | 4.58 | 20.58 | 20.32 |
| Mean | 4.5 | 7.4 | 8.1 | 10.5 | 5.79 | 25.99 | 26.64 |

Appendix II. Gilts - Carcass Data (continued)

| Number | Left ham separation values | | | | Areas of longitudinal section | | |
|---|---|---|---|---|---|---|---|
| | Fat | Lean | Bone | Skin | Total | Lean | Fat |
| | kgs | kgs | kgs | kgs | sq.cms | sq.cms | sq.cms |
| 21 | 2.59 | 4.13 | .72 | .26 | 347.70 | 227.17 | 93.04 |
| 22 | 2.45 | 5.26 | .66 | .32 | 331.37 | 221.63 | 85.68 |
| 23 | 2.27 | 5.13 | .71 | .34 | 372.80 | 237.89 | 72.65 |
| 24 | 2.49 | 4.58 | .60 | .35 | 299.50 | 216.01 | 64.00 |
| 25 | 2.49 | 4.58 | .64 | .33 | 299.37 | 208.14 | 78.78 |
| 26 | 2.72 | 5.31 | .68 | .30 | 368.15 | 264.40 | 77.94 |
| 27 | 2.13 | 4.72 | .73 | .25 | 340.34 | 243.05 | 46.45 |
| 28 | 2.27 | 4.49 | .66 | .27 | 336.47 | 222.14 | 70.00 |
| 29 | 2.04 | 4.49 | .65 | .29 | 303.18 | 213.88 | 66.58 |
| 30 | 2.72 | 4.94 | .75 | .31 | 393.31 | 221.24 | 94.20 |
| 31 | 3.08 | 4.13 | .59 | .29 | 323.70 | 204.40 | 99.88 |
| 32 | 2.18 | 4.76 | .67 | .30 | 332.92 | 233.89 | 71.75 |
| 33 | 2.54 | 4.80 | .64 | .29 | 285.82 | 192.91 | 75.17 |
| 34 | 1.68 | 3.99 | .62 | .30 | 303.70 | 203.43 | 61.55 |
| 35 | 2.72 | 4.49 | .69 | .29 | 343.83 | 241.56 | 68.00 |
| 36 | 2.45 | 4.45 | .64 | .31 | 362.22 | 244.34 | 83.36 |
| 37 | 2.40 | 4.63 | .71 | .20 | 369.05 | 236.21 | 95.61 |
| 38 | 2.29 | 3.99 | .63 | .25 | 341.63 | 207.93 | 82.00 |
| 39 | 2.45 | 3.45 | .58 | .33 | 322.92 | 207.24 | 79.17 |
| 40 | 2.18 | 3.86 | .66 | .36 | 286.15 | 193.95 | 75.17 |
| Mean | 2.41 | 4.51 | .66 | .30 | 333.21 | 222.07 | 77.05 |

Appendix II. Gilts - Carcass Data (continued)

| | Linear measurements of perpendiculars on longitudinal section | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 10 cms | | 15 cms | | 20 cms | | 25 cms | |
| Number | Total | Lean | Total | Lean | Total | Lean | Total | Lean |
| | cms | cms | cms | cms | cms | cms | cms | cms |
| 21 | 7.7 | 5.0 | 11.3 | 8.2 | 13.3 | 11.2 | 13.5 | 9.2 |
| 22 | 6.1 | 4.6 | 9.6 | 7.9 | 11.7 | 9.5 | 12.8 | 11.0 |
| 23 | 8.1 | 6.8 | 12.1 | 10.1 | 14.4 | 13.0 | 13.6 | 10.4 |
| 24 | 4.0 | 3.3 | 8.0 | 6.5 | 10.4 | 8.4 | 11.6 | 9.1 |
| 25 | 7.8 | 6.4 | 10.5 | 8.9 | 11.9 | 10.6 | 11.0 | 7.6 |
| 26 | 7.2 | 6.2 | 10.9 | 9.4 | 13.1 | 11.2 | 13.3 | 11.4 |
| 27 | 10.1 | 8.3 | 13.7 | 12.0 | 15.0 | 13.9 | 13.6 | 10.4 |
| 28 | 6.1 | 4.8 | 10.2 | 9.0 | 13.1 | 11.0 | 12.5 | 10.7 |
| 29 | 5.7 | 4.7 | 9.1 | 7.6 | 11.3 | 10.1 | 12.0 | 9.5 |
| 30 | 9.7 | 7.9 | 12.9 | 10.6 | 14.7 | 13.2 | 15.0 | 10.2 |
| 31 | 8.1 | 6.4 | 11.2 | 9.0 | 12.5 | 10.6 | 11.1 | 8.2 |
| 32 | 7.2 | 6.5 | 11.2 | 9.6 | 13.2 | 12.0 | 12.5 | 9.4 |
| 33 | 6.3 | 5.5 | 9.8 | 8.1 | 11.2 | 9.9 | 10.8 | 8.0 |
| 34 | 7.7 | 6.8 | 11.5 | 10.1 | 12.5 | 11.5 | 12.5 | 8.7 |
| 35 | 6.2 | 4.6 | 10.5 | 7.2 | 13.2 | 11.2 | 13.3 | 10.8 |
| 36 | 7.3 | 5.9 | 11.1 | 8.6 | 13.4 | 11.8 | 13.6 | 10.4 |
| 37 | 8.2 | 4.8 | 11.6 | 9.3 | 13.3 | 10.5 | 13.6 | 9.3 |
| 38 | 8.0 | 6.6 | 10.9 | 8.5 | 12.8 | 11.6 | 14.0 | 10.0 |
| 39 | 7.6 | 6.7 | 10.6 | 8.1 | 12.5 | 9.8 | 12.9 | 8.4 |
| 40 | 6.3 | 4.0 | 9.0 | 7.3 | 10.7 | 8.7 | 11.0 | 8.5 |
| Mean | 7.3 | 5.8 | 10.8 | 8.8 | 12.7 | 11.0 | 12.7 | 9.6 |

Appendix II. Gilts - Carcass Data (continued)

| Number | Length of long axis of longitudinal section | Right ham separation values Fat | Lean | Bone | Skin |
|---|---|---|---|---|---|
| | cms | kgs | kgs | kgs | kgs |
| 21 | 35.8 | 2.18 | 4.17 | .73 | .25 |
| 22 | 39.4 | 2.31 | 5.22 | .68 | .34 |
| 23 | 36.5 | 2.36 | 4.90 | .74 | .33 |
| 24 | 40.2 | 2.45 | 4.45 | .66 | .35 |
| 25 | 36.1 | 2.27 | 4.54 | .61 | .32 |
| 26 | 39.2 | 2.54 | 5.26 | .72 | .31 |
| 27 | 34.0 | 1.86 | 4.63 | .76 | .25 |
| 28 | 37.0 | 2.31 | 4.96 | .77 | .27 |
| 29 | 39.0 | 1.86 | 4.67 | .71 | .31 |
| 30 | 35.6 | 2.49 | 4.94 | .67 | .34 |
| 31 | 37.0 | 2.86 | 3.95 | .64 | .33 |
| 32 | 36.7 | 2.27 | 4.72 | .68 | .33 |
| 33 | 36.7 | 2.13 | 4.08 | .64 | .34 |
| 34 | 34.6 | 1.77 | 3.90 | .64 | .26 |
| 35 | 38.5 | 2.68 | 4.49 | .68 | .29 |
| 36 | 36.9 | 2.27 | 4.49 | .64 | .29 |
| 37 | 36.7 | 2.18 | 4.40 | .68 | .18 |
| 38 | 35.3 | 2.18 | 3.90 | .59 | .27 |
| 39 | 35.5 | 2.22 | 3.58 | .62 | .33 |
| 40 | 37.0 | 2.04 | 3.95 | .64 | .36 |
| Mean | 36.9 | 2.26 | 4.46 | .68 | .30 |

Appendix II. Gilts - Carcass Data (continued)

| | Linear measurements of axes on cross section | | | | Areas of cross section | |
|---|---|---|---|---|---|---|
| | Width axis | | Thickness axis | | Total | Fat lateral |
| Number | Total | Lean | Total | Lean | lean | to thick. axis |
| | cms | cms | cms | cms | sq.cms | sq.cms |
| 21 | 25.0 | 21.7 | 16.8 | 15.4 | 238.72 | 48.84 |
| 22 | 25.4 | 22.3 | 18.1 | 16.4 | 270.53 | 52.78 |
| 23 | 25.9 | 23.4 | 18.3 | 16.8 | 284.79 | 51.49 |
| 24 | 25.9 | 22.1 | 17.6 | 15.9 | 250.53 | 54.13 |
| 25 | 26.4 | 22.9 | 17.5 | 16.0 | 264.27 | 58.00 |
| 26 | 26.5 | 23.2 | 18.0 | 16.6 | 279.63 | 50.45 |
| 27 | 26.4 | 23.2 | 17.6 | 16.2 | 275.89 | 47.87 |
| 28 | 26.9 | 23.3 | 17.7 | 16.1 | 262.02 | 53.10 |
| 29 | 24.9 | 22.6 | 17.0 | 15.7 | 252.40 | 46.07 |
| 30 | 27.4 | 23.1 | 18.5 | 16.9 | 280.92 | 66.26 |
| 31 | 26.3 | 22.2 | 17.6 | 15.6 | 239.24 | 66.07 |
| 32 | 25.7 | 23.1 | 17.8 | 16.1 | 266.08 | 52.26 |
| 33 | 23.8 | 21.2 | 17.1 | 15.3 | 226.72 | 54.20 |
| 34 | 24.3 | 21.2 | 16.0 | 14.6 | 225.50 | 41.94 |
| 35 | 27.2 | 22.4 | 17.2 | 15.3 | 253.18 | 62.07 |
| 36 | 24.7 | 21.2 | 17.7 | 16.0 | 244.66 | 51.29 |
| 37 | 24.4 | 21.3 | 17.3 | 15.8 | 240.98 | 47.74 |
| 38 | 23.5 | 20.9 | 16.7 | 15.4 | 221.37 | 44.07 |
| 39 | 24.2 | 20.0 | 16.9 | 14.4 | 206.01 | 58.39 |
| 40 | 22.3 | 19.5 | 16.6 | 14.8 | 215.69 | 38.52 |
| Mean | 25.4 | 22.0 | 17.4 | 15.8 | 249.96 | 52.28 |