LIVE AND CARCASS MEASUREMENTS AS INDICATORS

OF LEAN CUT YIELD IN SWINE

By

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INTRODUCTION

Improved methods for selecting breeding stock are continuously being sought. In the past, swine selection has been based on visual appraisal, performance data and sometimes littermate carcass data. As of yet, a precise objective measure of lean content of swine has not been proven.

Most carcass studies indicate that percentage of lean cuts is a practical endpoint to choose when trying to predict meatiness. However, measurements of traits used in carcass studies require the sacrifice of the animal. Thus, there is a need for predictive measures taken from the live animal to prevent this possible sacrifice of good breeding stock.

In order to use predictive measures from live animals they must be tested against proven carcass measurements. Also they must be accurate enough to detect differences among large numbers of reasonably uniform individuals.

This study was designed to evaluate the relative differences in predictive power of live measures as compared to carcass measures of meatiness.

REVIEW OF LITERATURE

Most studies involving live measurements for predicting yield of lean cuts in swine have not been satisfactory. Hetzer _et al_. (1950) took eight different measurements on live hogs only to find that the correlations with carcass traits were very low and essentially useless in predicting meatiness. Thus it is obvious that more desirable measurements of the live animal are needed before muscling can accurately be predicted in swine.

Pearson (1957) stated that a complete physical separation or a chemical analysis is the only fully reliable prediction of lean yield. However, these methods were too time consuming and expensive to be practical. Therefore, only those studies concerned with practical live animal and carcass measurements were reviewed in this study.

Live Animal Evaluation

Backfat Probe

Four methods of measuring backfat thickness have been used successfully and appear to be equally accurate. The methods generally used are the ruler probe developed by Hazel and Kline (1952), the lean meter developed by Andrews and Whaley (1954), ultrasonic devices and x-ray techniques. These live measurement techniques are only moderately correlated with carcass backfat (Table I), but have often been considered more precise than carcass backfat when used as indicators of carcass leanness (Hazel and Kline, 1952, 1959; Hetzer _et al_., 1956; Holland and Hazel, 1958; Pearson _et al_., 1957; Pearson, Bratzler and Magee, 1958; Price _et al_., 1960b; Omtvedt _et al_., 1967; and Arganosa, 1968). In a few investigations carcass backfat has shown an advantage over the probe (DePape and Whatley, 1956; Anderson and Wahlstrom, 1969; Hazel and Kline, 1953; and Hetzer _et al_., 1950). Single probe measures have varied greatly and thus the necessity of taking at least three or four readings has been established by Hazel and Kline, 1953; Holland and Hazel, 1959; and Price _et al_., 1960b.

TABLE I

SUMMARY OF CORRELATIONS BETWEEN LIVE PROBE AND CARCASS BACKFAT

r	Number	Source
.70	99	Pearson _et al_., 1957
.59	228	Omtvedt _et al_., 1967
.72	140	Hetzer, Zeller & Hankins, 1956
.81	96	Hazel & Kline, 1952
.58	650	Arganosa, 1968
.83	56	Hazel & Kline, 1959
.66	78	Anderson & Wahlstrom, 1969
.75	11	Moser, 1970
.84	39	Tuma, Merkel & Mackintosh, 1958

Correlations between live probe and percent lean cuts based on live and carcass weight are shown in Table II. These data indicate that live probe could possibly account for 24 to 79 percent of the total variance in percent lean cuts in the carcass. However, the range is only 14 to 53 percent of the total variance accounted for when using percent lean cuts based on live weight.

TABLE II

SUMMARY OF LIVE PROBE CORRELATIONS WITH PERCENT LEAN CUTS OF CARCASS WEIGHT AND LIVE WEIGHT

Percent Lean Cuts of:			
Car. Wt.	Live Wt.	Number	Source
-.53	-.44	650	Arganosa, 1968
-.49	-.38	228	Omtvedt *et al.*, 1967
-.61	-.55	145	Pearson, Bratzler & Magee, 1958
-.79	-.73	84	Price *et al.*, 1960b
-.80	-.72	74	Price *et al.*, 1960b
	-.70	64	Tribble *et al.*, 1956
-.61		78	Anderson & Wahlstrom, 1969
-.57		111	DePape & Whatley, 1956
-.78		105	Holland & Hazel, 1958
-.65		288	Hazel & Kline, 1953
-.89		56	Hazel & Kline, 1959
-.69		42	Bowman, Whatley & Walters, 1962
-.78		11	Moser, 1970
-.66		39	Tuma, Merkel & Mackintosh, 1958
-.36		116	Zobrisky *et al.*, 1954
-.57		222	Lasley, Hazel & Kline, 1956

Loin Eye Area

Loin eye area measured by ultrasonics and by tracing are moderately associated as indicated by a range of correlations from 0.52 to 0.81 reported by the following seven studies: Moser (1970), Zobrisky *et al.* (1960), Stouffer *et al.* (1961), Price, Pearson and Emerson (1960a), Johnson et al. (1968) two trials, and Anderson and Wahlstrom (1969). Since loin eye area may be estimated on the live animal and is commonly used as an indicator of muscling along with backfat probe, it would be of interest to note that the two traits are not as highly associated as one might expect. This information is illustrated in Table III.

TABLE III

SUMMARY OF CORRELATIONS BETWEEN LIVE PROBE AND LOIN EYE AREA

r	Number	Source
-.08	228	Omtvedt et al., 1967
-.44	96	Hazel & Kline, 1952
-.21	650	Arganosa, 1968
-.59	11	Moser, 1970

Carcass Evaluation

Carcass Backfat

Many studies have involved the role of carcass backfat and its association with percent lean cuts and other carcass traits; therefore, it is the objective of this review to include only some of the more recent studies. Table IV shows a range of correlations from -.42 found by Omtvedt et al. (1967) to -.80 reported by Pearson, Deans and Bratzler (1959) when they studied the association between carcass backfat and percent lean cuts based on carcass weight. The range of -.26 (Omtvedt et al., 1967) to -.67 (Price et al., 1960b) is shown when comparing carcass backfat with percent lean cuts based on live weight. As would be expected Tables II and IV indicate that both live probe and carcass backfat are more highly associated with percent lean cuts of carcass weight than percent lean cuts of live weight.

TABLE IV

SUMMARY OF CARCASS BACKFAT CORRELATIONS WITH PERCENT LEAN CUTS OF CARCASS WEIGHT AND LIVE WEIGHT

Percent Lean Cuts of:			
Car. Wt.	Live Wt.	Number	Source
-.47	-.38	145	Pearson, Bratzler & Magee, 1958
-.42	-.26	228	Omtvedt et al., 1967
-.49	-.36	650	Arganosa, 1968
-.74	-.67	74	Price et al., 1960b
	-.48	114	Skelly, Handlin & Byrd, 1969
	-.66	64	Tribble et al., 1956
-.60		42	Bowman, Whatley & Walters, 1962
-.75		288	Hazel & Kline, 1953
-.66		111	DePape & Whatley, 1956
-.66		78	Anderson & Wahlstrom, 1969
-.80		142	Pearson, Deans & Bratzler, 1959
-.62		79	Henry, Bratzler & Luecke, 1963
-.65		53	King, Hetzer & Zeller, 1962
-.58		54	King, Hetzer & Zeller, 1962
-.44		11	Moser, 1970
-.65		77	Bowers et al., 1969
-.54		585	Jensen, Craig & Robison, 1967
-.51		39	Tuma, Merkel & Mackintosh, 1958
-.70		999	Lu et al., 1958
-.59		203	Whiteman & Whatley, 1953
-.51		222	Lasley, Hazel & Kline, 1956

Recent results showing the relationship of carcass backfat with loin eye area and length are tabulated in Table V. The extreme variation in the correlations between these traits casts doubt as to their actual association.

TABLE V

SUMMARY OF CARCASS BACKFAT CORRELATIONS WITH LOIN EYE AREA AND CARCASS LENGTH

Loin Area	Carcass Length	Number	Source
-.05	-.33	650	Arganosa, 1968
-.27	-.36	531	Enfield & Whatley, 1961
.10	-.66	89	Topel, Merkel & Mackintosh, 1965
	-.47	79	Henry, Bratzler & Luecke, 1963
	.12	999	Lu _et al_., 1958
-.29		203	Whiteman & Whatley, 1953
.11		228	Omtvedt _et al_., 1967
-.41		96	Hazel & Kline, 1952
-.13		114	Skelly, Handlin & Byrd, 1969
-.50		142	Pearson, Deans & Bratzler, 1959
-.49		54	King, Hetzer & Zeller, 1962
-.43		53	King, Hetzer & Zeller, 1962
-.10		585	Jensen, Craig & Robison, 1967

Whiteman and Whatley (1953), using 203 animals, reported a correlation of -.46 between carcass backfat and percent ham and loin based on carcass weight. A more recent study by Skelly, Handlin and Byrd (1969) shows a correlation of -.52 when 114 animals were used. This same study indicated that slaughter weight was only slightly associated with carcass backfat (r = 0.31).

When Moser (1970) and Topel, Merkel and Mackintosh (1965) correlated total pounds of lean cuts with carcass backfat, they found that the association was similar to what others had found when correlating carcass backfat with percent lean cuts.

Loin Eye Area

Loin eye area has been readily used as an indicator of muscling primarily because the measurement is easy to obtain. However, Skelly, Handlin and Byrd (1969) and Omtvedt et al. (1967) agree that loin eye area can account for only about 25% of the variation in percent lean cuts of live weight. A summary of studies in Table VI reveals that loin eye area can explain only 12 to 48 percent of the variation in percent lean cuts calculated from carcass weight. Loin eye area appears to be superior to carcass length as an indicator of leanness. As might be expected, the correlations between loin eye area and carcass length are very low and are not even consistent in direction (Enfield and Whatley, 1961; Pearson, Deans and Bratzler, 1959; Henry, Bratzler and Luecke, 1963; Fredeen et al., 1965; and Topel, Merkel and Mackintosh, 1965).

The association between total pounds of lean cuts and loin eye area were similar to percent lean cuts and loin eye area in that loin eye area could account for only about 25% of the variation (Pearson et al., 1970; Moser, 1970; and Topel, Merkel and Mackintosh, 1965).

A recent extensive study by Pearson et al. (1970) involving 1,002 market hogs used a carcass monetary value as an indicator of leanness. When individual carcass backfat measures were compared with the average of three measurements, it was found that backfat at the last lumbar vertebra was essentially equal to average carcass backfat in predicting carcass value. Each trait (last lumbar vertebra and average carcass backfat) could explain approximately 50% of the variation in carcass value when used alone. A correlation of 0.92 indicates that carcass value is highly associated with percent lean cuts of carcass weight.

TABLE VI

SUMMARY OF PERCENT LEAN CUTS OF CARCASS WEIGHT CORRELATIONS WITH LOIN EYE AREA AND CARCASS LENGTH

Loin Area	Carcass Length	Number	Source
.35	.26	236	Fredeen *et al.*, 1964
.51	.29	77	Bowers *et al.*, 1969
.57	.10	216	Carpenter *et al.*, 1962
.69	.38	222	Lasley, Hazel & Kline, 1956
.39		228	Omtvedt *et al.*, 1967
.56		78	Anderson & Wahlstrom, 1969
.57		204	Zobrisky *et al.*, 1954
.57		11	Moser, 1970
.37		585	Jensen, Craig & Robison, 1967
.46		203	Whiteman & Whatley, 1953
.65		23	Kline & Hazel, 1955
	.33	145	Pearson, Bratzler & Magee, 1958
	.57	142	Pearson, Deans & Bratzler, 1959
	-.28	79	Henry, Bratzler & Luecke, 1963
	.28	39	Tuma, Merkel & Mackintosh, 1958
	.01	999	Lu *et al.*, 1958

Multiple Correlations

Lu *et al.* (1958) using percent lean cuts of carcass weight as the dependent variable found that average carcass backfat was the best single indicator of lean yield by accounting for about 49% of the variation (r = -.70). When cold carcass weight, length and 5th rib backfat thickness were added to average carcass backfat as independent variables, about 57% of the total variation was explained (r = 0.75).

Lasley, Hazel and Kline (1956) used live animal and easily measured carcass traits in an attempt to find the best combination of traits to predict percent lean cuts of carcass weight. Using shrunk live weight (24 hour shrink) and live probe, 44% of the variation in percent lean cuts could be explained. Only 6% more of the variation was explained when carcass weight, backfat thickness and length were used. Using only carcass weight and weight of the ham, 80% of the variation in percent lean cuts was explained. However, 91% of the variation was accounted for when backfat thickness, length and loin eye area were added to the above two variables.

Pearson _et al_. (1970) using live value per 100 kg. of live weight as an indicator of leanness found that a combination of live slaughter weight, dressing percentage and backfat at last lumbar vertebra could account for 72% of the variation. Sixty-nine percent of the variation was accounted for in the best combination of traits when carcass value per 100 kg. of live weight was used as a muscling indicator. The independent variables included were: cold carcass weight, backfat thickness at last lumbar vertebra, length and loin eye area.

Carpenter _et al_. (1962) used 216 animals to study the predictive power of the three individual backfat measures, length, loin eye area and specific gravity of the untrimmed ham. The four variables ranked in order of importance by a stepwise regression analysis were: specific gravity of untrimmed ham, backfat at first rib, backfat at last lumbar vertebra and loin eye area. These four variables accounted for approximately 71% of the variation in lean cut yield.

Effect of Sex and Season on Meatiness

Two extensive studies by Bruner and Swiger (1968) and Quijandria, Woodward and Robison (1970) involving 2,508 and 1,632 pigs respectively indicated a highly significant ($P < .01$) sex and season effect on percent lean cuts. Both studies agreed with a third study by Zobrisky et al. (1961) that spring farrowed pigs were fatter than those farrowed in the fall and thus yielded a lower percent of lean cuts. This difference is most likely due to the fact that some of the excess fat is converted to energy needed in maintaining body temperature in those hogs being fed during the winter.

The traits reviewed indicate that some have been overused and others need more testing to insure their value as indicators of leanness. Most studies reviewed indicate that carcass length does not play an important role in predicting meatiness, while live probe and weights of ham and loin are relatively good indicators of muscling.

MATERIALS AND METHODS

The animals used in this study were obtained from the Experimental Swine Breeding Herd maintained at Stillwater, Oklahoma. The data were collected from fall, 1964 through fall, 1969 involving 476 Hampshire pigs. All pigs were self-fed from approximately eight weeks of age until they weighed 200 pounds liveweight. Pigs were removed from test and slaughtered at weekly weighing intervals.

During the fall of 1964 the pigs were slaughtered at the Oklahoma State University Meat Laboratory. Beginning in the spring of 1965 through the spring of 1968 slaughtering was done at the Harris Meat Company, Oklahoma City. For two seasons, fall 1968 and spring 1969, the slaughtering was at Ralph's Packing Plant, Perkins, Oklahoma. Slaughtering was resumed at the University Meat Laboratory in the fall of 1969 in an attempt to get a closer trim of the lean cuts. Table VII shows the number of pigs slaughtered per season.

The traits studied were:

Slaughter weight was the off-test full weight in all seasons except for fall 1969 when it was the live weight recorded after a 24 hour shrink.

Average probe backfat was an average of six readings taken on both sides of the animal about 1 1/2 inches from the midline approximately over the first rib (shoulder probe), last rib (rib probe) and last lumbar vertebra (rump probe) using a lean meter. Each location probed was an average of two readings. Probing was done as each pig reached slaughter weight.

Carcass weight was the chilled carcass weight minus the kidney fat.

Dressing percent was calculated by dividing the cold carcass weight by the slaughter weight and multiplying by 100.

Carcass length was the average length of the two sides measured from the forward edge of the first rib to the anterior edge of the aitch bone.

Carcass backfat thickness was measured approximately over the first rib (shoulder backfat), last rib (rib backfat) and last lumbar vertebra (last lumbar backfat) on both sides of the carcass at the midline. Each individual site was an average of two readings with the average carcass backfat being derived from a total of six readings.

Loin eye area was the measurement of the cross section of the _longissimus dorsi_ muscle between the tenth and eleventh ribs. The area was determined with a compensating polar planimeter from the tracings made from the right side loin before the fat was trimmed.

Total lean was composed of combined weights of the trimmed hams, loins and shoulders which were also used as individual traits in the analysis. Lean cuts received a standard packing house trim except for fall 1969 in which cuts were closely trimmed to an average of approximately one-tenth of an inch of fat. The lean cut weight was also analyzed as a percentage of slaughter and cold carcass weight.

Ham-loin index = (% Ham - 10%) X 10 + loin eye area (sq. in.) X 10.

Percent ham and loin was calculated by dividing the total weights of the trimmed hams and loins by the cold carcass weight and multiplying by 100.

TABLE VII

DISTRIBUTION OF PIGS BY YEAR AND SEASON

Year	Season	Number
1964	Fall	31
1965	Spring	33
	Fall	24
1966	Spring	51
	Fall	61
1967	Spring	60
	Fall	50
1968	Spring	48
	Fall	60
1969	Fall	58
TOTAL		476

Statistical Analysis

Phenotypic correlations between any two traits were calculated according to the following formula given by Snedecor and Cochran (1967):

$$r_p = \frac{\Sigma\ x_1 x_2}{\sqrt{(\Sigma\ x_1^2)(\Sigma\ x_2^2)}}$$

This phenotypic correlation study involved 21 variables, three of which were dependent (percent lean cuts of carcass weight, percent lean cuts of live weight, total pounds of lean). Percent ham and loin of carcass weight, rump probe, dressing percentage and last lumbar backfat were independent variables that were eliminated due to their extremely low association with all other variables or because they represented a portion of another variable being used. The three dependent variables and

14 independent variables were then used in a regression analysis. Different combinations of variables were used in each equation to avoid the part-whole relationship between some of the variables.

The data were divided into 15 groups according to year, season and sex. The means, standard deviations, corrected sums of squares and correlation coefficients were calculated for each group. Tables of correlations arranged by group are in the appendix. These within group correlations were used to test the hypothesis that several r's are from the same ρ (Snedecor and Cochran, 1967). Within group correlation coefficients were transformed to z values and weighted by the reciprocal of their variance so that small samples would receive less weight than large samples (Lush, 1931). The weighted z values were corrected for bias and a chi-square test of adjusted z values was used to determine the probability that within group correlations were from the same population. Since none of the chi-square values were significant, the within year, season and sex corrected r values were pooled.

The raw data were then converted to deviations from group means by the following procedure. If Y_{ij} denoted the jth raw response in group i, then Y_{ij} was replaced by $Y_{ij} - \overline{Y}_{i\cdot}$, where $\overline{Y}_{i\cdot}$ is the mean of the responses in the ith group.

The mean differences were then used in the BMDO2R stepwise linear regression program outlined by Dixon (1968). The program computed the covariance matrix and the correlation matrix for all 17 variables used in the regression study. The stepwise procedure then entered one variable at a time into the regression equation, starting with the independent variable that had the highest simple correlation coefficient with the dependent variable being estimated. The remaining independent variables were then re-evaluated by computing their partial correlation coefficients after the effect of the variable that had been entered was removed. This is equivalent to entering the variable which accounts for the greatest reduction in the error sum of squares after the first variable has been entered. This procedure was continued until all independent variables had been considered for the equation.

For each independent variable X_k in the regression equation; the regression coefficient b_k, its standard error, S_{b_k}, and the F value for the test of the hypothesis $H_0 : b_k = 0$ were computed at each step of the procedure. The F value is the square of the t test. That is

$$F_k = \left(\frac{b_k - 0}{S_{b_k}} \right)^2$$

where k indexes the particular coefficient for the variable which is being considered (Dixon, 1968).

Since the data had been corrected for the mean prior to performing the regression analysis, the model fitted had a zero intercept. That is, at each step the regression equation was

$$\hat{Y}_{ij} - \overline{Y}_{i\cdot} = \beta_1(X_{i1} - \overline{X}_{i\cdot}) + \beta_2(X_{i2} - \overline{X}_{i\cdot}) \cdot \cdot \cdot + \beta_k(X_{ik} - \overline{X}_{i\cdot})$$

rather than

$$\hat{Y}_{ij} = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} \cdot \cdot \cdot + \beta_k X_{ik}$$

After the final variable is entered or removed from the equation, a summary is computed listing the variables entered or removed at each step with the multiple correlation coefficients, R^2 values and the increase or decrease in R^2.

Draper and Smith (1966) recommended the stepwise regression procedure as the best variable selection procedure that could be used since it is an improved version of the forward - selection procedure. These improvements involve re-examining the variables that are incorporated into the model at each stage of regression. The variable which at an early stage may have been found to be the best single variable to enter into the equation, may be found to be unnecessary due to relationships between it and other variables now in the regression. This is checked by using the partial F criterion for each variable in the regression and comparing it with a preselected percentage point of the appropriate F distribution. This evaluation provides a judgment on the contribution of each variable as if it was the most recently entered variable regardless of its point of entry into the model. All variables that do not make a significant contribution are removed from the model. This process continues until all variables are admitted to the equation or rejected.

RESULTS AND DISCUSSION

Phenotypic Correlations

Backfat Probe

When comparing the three individual live probes with their average, the shoulder probe had less association with the other traits than either the last rib or the rump probe (Table VIII). Last rib, rump and average probes showed similar trends in their relationships with the other traits but rump probe was essentially equal to average probe. The correlation coefficients between last rib and rump probes with percent lean cuts of carcass weight were -.51 and -.52, respectively. These values are lower than those reported earlier by Hazel and Kline (1953) and Holland and Hazel (1958); however, the current study involves a much greater number of more uniform animals than either of the previous studies.

Carcass Backfat

A review of Table IX shows that average carcass backfat was generally more closely associated with the other traits than was any of the individual measurements. Most average backfat thickness correlations with other carcass traits were low, but the trait did account for approximately 27% of the variation in percent lean cuts of carcass weight and 21% of the variation in ham and loin as a percentage of carcass weight.

TABLE VIII

PHENOTYPIC CORRELATIONS FOR LIVE PROBE MEASUREMENTS WITH SOME CARCASS TRAITS*

	Live Probe			
	Shldr.	Last Rib	Rump	Avg.
Slaughter weight	.19	.19	.21	.22
Carcass weight	.14	.22	.20	.21
Dressing percent	-.01	.09	.04	.04
Carcass length	-.21	-.20	-.25	-.24
Carcass backfat-1st rib	.31	.27	.34	.34
last rib	.42	.51	.50	.53
last lumbar	.43	.49	.60	.56
avg.	.48	.51	.58	.58
Loin eye area	-.12	-.20	-.18	-.18
Total lean	-.21	-.24	-.26	-.26
Percent lean cuts (L.Wt.)	-.34	-.39	-.42	-.43
Percent lean cuts (C.Wt.)	-.41	-.51	-.52	-.54
Weight of ham	-.20	-.15	-.19	-.21
Weight of loin	-.11	-.18	-.19	-.17
Weight of shoulder	-.15	-.20	-.21	-.21
Ham-loin index	-.30	-.32	-.34	-.37
Percent ham & loin (C.Wt.)	-.37	-.46	-.47	-.48

*$r > .12$, $P < .01$ (d.f. = 458)
$r > .09$, $P < .05$

When comparing Tables VIII and IX one finds that live probe tended to be more closely associated with all other traits than was carcass backfat. Exceptions were carcass weight, dressing percentage and carcass length. Fatter animals tended to have shorter carcasses, smaller loin eye areas and lower lean cut yields which fully agrees with data reported by Arganosa (1968). Both live probe and carcass backfat were more closely correlated with the percentage lean cuts of carcass weight than with either total lean cuts or lean cuts of live weight.

These results are in agreement with other stations (Pearson *et al.*, 1958; Price *et al.*, 1960b).

TABLE IX

PHENOTYPIC CORRELATIONS FOR CARCASS BACKFAT MEASUREMENTS WITH SOME CARCASS TRAITS*

	Carcass Backfat			
	1st Rib	Last Rib	Last Lumbar Vertebra	Avg.
Slaughter weight	.11	.17	.15	.17
Carcass weight	.14	.23	.19	.22
Dressing percent	.09	.13	.11	.13
Carcass length	-.18	-.30	-.25	-.30
Loin eye area	-.06	-.01	-.09	-.07
Total lean	-.15	-.17	-.24	-.23
Percent lean cuts (L.Wt.)	-.23	-.30	-.36	-.36
Percent lean cuts (C.Wt.)	-.35	-.42	-.48	-.52
Weight of ham	-.14	-.10	-.18	-.17
Weight of loin	-.11	-.10	-.16	-.15
Weight of shoulder	-.07	-.17	-.18	-.17
Ham-loin index	-.19	-.16	-.25	-.25
Percent ham & loin (C.Wt.)	-.32	-.36	-.43	-.46

*$r > .12$, $P < .01$ (d.f. = 458)
$r > .09$, $P < .05$

Although average probe and carcass backfat are believed to be measuring the same thing, the correlation coefficient between these two measures was only -.58 (Table VIII). However, this correlation is in exact agreement with Arganosa (1968) and essentially the same as that reported by Omtvedt *et al.* (1967). Other workers (Pearson *et al.*, 1957; Hetzer et al., 1956; Hazel and Kline, 1952, 1959; Anderson and Wahlstrom, 1969; Moser, 1970; Tuma et al., 1958) have reported higher values. The association between the two measurements would probably be closer if it were not for the well known fact that the carcass measurement is taken directly over the spinal processes or midline of the carcass while the live probe is recorded from approximately 1 1/2 inches off the midline or approximately over the center of the *longissimus dorsi* muscle. However even with the differences in measuring live probe and carcass backfat; live rump probe tends to be more closely associated with the last lumbar vertebra backfat than average probe is with average carcass backfat.

Carcass Length

Although the correlation between carcass length and loin eye area was zero, longer carcasses tended to have a higher yield of lean cuts than shorter carcasses (Table X). Total lean was more closely associated with carcass length than was lean cuts when expressed as a percentage of carcass or live weight. Carcass length accounted for more of the variation in weight of the loin (10%) than any other trait except total lean. However the magnitude of the carcass length correlations were too small to be very important. Four estimates included in the literature review indicated that approximately two percent of the variation in loin eye area could be accounted for by carcass length. In this study carcass length accounted for less than 1% of the variation in loin eye area.

TABLE X

PHENOTYPIC CORRELATIONS FOR CARCASS LENGTH AND LOIN EYE AREA WITH SOME CARCASS TRAITS*

	Carcass Length	Loin Eye Area
Loin eye area	-.00	
Slaughter weight	.21	.16
Carcass weight	.19	.32
Dressing percent	.01	.28
Total lean	.34	.57
Percent lean cuts (L.Wt.)	.21	.52
Percent lean cuts (C.Wt.)	.25	.43
Weight of ham	.25	.43
Weight of loin	.32	.49
Weight of shoulder	.19	.39
Ham-loin index	.11	.77
Percent ham & loin (C.Wt.)	.26	.42

*$r > .12$, $P < .01$ (d.f. = 458)
$r > .09$, $P < .05$

Loin Eye Area

A review of Table X reveals that loin eye area was a better indicator of carcass leanness than was carcass length. The correlation between loin eye area and percent lean cuts of carcass weight was 0.43 which was similar to 0.47 reported by Arganosa (1968) and within the range of 0.35 (Fredeen *et al.*, 1964) to 0.69 (Lasley *et al.*, 1956) reported in the literature review.

The correlation between loin eye area and lean yield as a percentage of live weight and total pounds of lean were 0.52 and 0.57, respectively. Both values were much higher than when yield was expressed on a carcass weight basis. The first value was in agreement with Omtvedt *et al.* (1967) and Skelly *et al.* (1969) while the second figure was almost equal to a 0.56 correlation between loin eye area and total pounds of lean cuts reported by Pearson et al. (1970) in a study involving 1,002 animals.

The highest association was between loin eye area and ham-loin index (r = 0.77). This high value was probably due to the part-whole relationship between these two traits. However, these results indicate that loin eye area accounted for 27 and 18 percent of the variation in percentage of lean cuts based on live and carcass weight, respectively. On the other hand, carcass backfat accounted for 13% of the variation when expressed as a percentage of live weight and 27% when expressed as a percentage of carcass weight. Thus neither trait should be overused simply because it is easy to measure.

Lean Cut Yield

The correlations between any two of the three measures of meatiness were relatively high (Table XI). However, since weight of lean cuts is part of either slaughter or carcass weight the relationships are easily understood. Total weight of lean cuts accounted for about 59% of the variation in lean cut yield when expressed as a percentage of live weight and for only 46% of the variation when expressed as a percentage of lean of carcass weight. The correlation between percent lean of live weight and percent lean of carcass weight was 0.81, which was very similar to the 0.83 correlation reported between the two traits by both Omtvedt et al. (1967) and Arganosa (1968). As slaughter weight increased total pounds of lean cuts increased, but when lean cut yield was expressed as a percent of live or carcass weight the opposite relationship was indicated. This means as slaughter weight increased percentage of lean cuts decreased due to the rate of fat deposition being greater than that of lean at heavier weights. The correlations of any of the three measures of meatiness with individual weights of ham, loin or shoulder; ham-loin index or ham and loin as a percentage of carcass weight were relatively high and of the same magnitude due to the part-whole relationship.

TABLE XI

PHENOTYPIC CORRELATIONS FOR YIELD OF LEAN CUTS WITH SOME CARCASS TRAITS*

	Total Lean	Percent Lean Cuts	
		Live Wt.	Carcass Wt.
Percent lean cuts (L.Wt.)	.77		
Percent lean cuts (C.Wt.)	.68	.81	
Slaughter weight	.49	-.12	-.09
Carcass weight	.65	.21	-.11
Dressing percent	.36	.50	-.05
Weight of ham	.80	.63	.50
Weight of loin	.79	.58	.56
Weight of shoulder	.73	.57	.49
Ham-loin index	.71	.80	.65
Percent ham & loin (C.Wt.)	.61	.72	.89

*$r > .12$, $P < .01$ (d.f. = 458)
$r > .09$, $P < .05$

However in all three measures of lean cut yield, the ham weight was generally superior to either the loin or shoulder weights as an indicator of muscling. The one exception being that loin weight could account for 6% more of the variation when lean cuts were expressed as a percentage of carcass weight. Weight of ham alone accounted for 25%

of the variation in lean cuts as a percentage of carcass weight and 64% of the variation in total weight of lean cuts. Shoulder weight was correlated with total weight of lean cuts (r = 0.73), percent lean of live weight (r = 0.57) and percent lean of carcass weight (r = 0.49), but still showed the lowest association of the three individual lean cut weights.

Regression Analysis

The stepwise regression study involved the use of the first 14 independent variables in various combinations to predict three dependent variables (percent lean cuts of live weight, percent lean cuts of carcass weight and total pounds of lean). The variables, their means and standard deviations are in the appendix. The regression study was divided into three sections corresponding with the three dependent variables.

Percent Lean Cuts of Live Weight

Only small amounts of variation could be accounted for when using live animal measurements to predict percent lean cuts of live weight. Table XII shows that average live probe accounted for only 19% of the variation in percent lean cuts of live weight with a standard error of estimate of 1.425%. The addition of slaughter weight to the equation showed no improvement in either the standard error of estimate or the magnitude of R^2. When loin eye area was the first variable entered into the regression equation (Table XIII), it accounted for approximately 27% of the variation in percent lean cuts of live weight. Average live probe removed an additional 12% of the variation. The combination

TABLE XII

MULTIPLE REGRESSION EQUATIONS USING WEIGHT AND PROBE FOR ESTIMATING WITHIN GROUP DEVIATIONS OF PERCENT LEAN CUTS OF LIVE WEIGHT

	Avg. Probe (d_4) $(X_4-\bar{X}_4)$	Sla. Wt. (d_1) $(X_1-\bar{X}_1)$	R^2	Std. Err. of Est.
$\hat{Y}_1 - \bar{Y}_1 =$	$- 4.864d_4$		.188	1.425
$\hat{Y}_1 - \bar{Y}_1 =$	$- 4.792d_4$	$- 0.008d_1$	.188	1.426

Y_1 = Percent Lean Cuts of Live Weight (S.D. = 1.604)

TABLE XIII

MULTIPLE REGRESSION EQUATIONS USING WEIGHT, PROBE AND LOIN EYE AREA FOR ESTIMATING WITHIN GROUP DEVIATIONS OF PERCENT LEAN CUTS OF LIVE WEIGHT

	LEA (d_{10}) ($X_{10}-X_{10}$)	Avg. Probe (d_4) (X_4-X_4)	Sla. Wt. (d_1) (X_1-X_1)	Sh. Probe (d_2) (X_2-X_2)	Rib Probe (d_3) (X_3-X_3)	R^2	Std. Err. of Est.
$\hat{Y}_1 - \bar{Y}_1 =$	$1.562d_{10}$					.266	1.355
$\hat{Y}_1 - \bar{Y}_1 =$	$1.368d_{10}$	$- 3.940d_4$				.386	1.241
$\hat{Y}_1 - \bar{Y}_1 =$	$1.453d_{10}$	$- 3.549d_4$	$- 0.036d_1$			.401	1.226
$\hat{Y}_1 - \bar{Y}_1 =$	$1.450d_{10}$	$- 3.807d_4$	$- 0.036d_1$	$+ 0.212d_2$		.402	1.227
$\hat{Y}_1 - \bar{Y}_1 =$	$1.453d_{10}$	$- 4.411d_4$	$- 0.036d_1$	$+ 0.398d_2$	$+ 0.414d_3$	.402	1.228

Y_1 = Percent Lean Cuts of Live Weight (S.D. = 1.604)

of loin eye area, average live probe and slaughter weight removed a total of 40% of the variation in percent lean cuts of live weight with a standard error of estimate of 1.226%. The addition of individual live shoulder and rib probes did not increase the accountable variation.

When comparing Tables XIII and XIV, it can be seen that substituting average carcass backfat for average live probe decreased the accountable variation 1.5% when each variable was used with loin eye area to predict percent lean cuts of live weight. When slaughter weight was added to both equations, the equation with average live probe accounted for 0.6% more variation the standard errors of estimate being essentially the same for both equations. The addition of carcass length to the equation of loin eye area, average carcass backfat and slaughter weight (Table XIV) removed an additional 2.9% of the variation making the total accountable variation for percent lean cuts of live weight 42.4% with a standard error of estimate of 1.205%. As was the case with individual live probes, the addition of individual carcass shoulder and rib backfat measurements did not increase the R^2 value nor decrease the standard error of estimate significantly.

As would be expected, more variation was accounted for when individual weights of the trimmed hams, loins and shoulders were considered by the stepwise regression procedure. Tables XV and XVI indicate that weight of the trimmed hams accounted for 39% of the variation in percent lean cuts of live weight. Slaughter weight, the second variable considered, accounted for an additional 17.4% of the variation. The third variable entered into the equation was weight of the trimmed loins which increased the accountable variation by 19.6%. Thus a total of 76.2% of the variation of percent lean cuts of live weight was

TABLE XIV

MULTIPLE REGRESSION EQUATIONS USING WEIGHT, CARCASS BACKFAT, LOIN EYE AREA AND LENGTH FOR ESTIMATING WITHIN GROUP DEVIATIONS OF PERCENT LEAN CUTS OF LIVE WEIGHT

	LEA (d_{10}) ($X_{10}-\bar{X}_{10}$)	Avg. B.F. (d_9) ($X_9-\bar{X}_9$)	Sla. Wt. (d_1) ($X_1-\bar{X}_1$)	Length (d_6) ($X_6-\bar{X}_6$)	Sh. B.F. (d_7) ($X_7-\bar{X}_7$)	Rib B.F. (d_8) ($X_8-\bar{X}_8$)	R^2	Std. Err. of Est.
$\hat{Y}_1 - \bar{Y}_1 =$	$1.562d_{10}$						.266	1.355
$\hat{Y}_1 - \bar{Y}_1 =$	$1.491d_{10}$	$- 4.129d_9$					.371	1.256
$\hat{Y}_1 - \bar{Y}_1 =$	$1.577d_{10}$	$- 3.756d_9$	$- 0.044d_1$				.395	1.233
$\hat{Y}_1 - \bar{Y}_1 =$	$1.617d_{10}$	$- 2.933d_9$	$- 0.058d_1$	$+ 0.468d_6$			.424	1.205
$\hat{Y}_1 - \bar{Y}_1 =$	$1.615d_{10}$	$- 3.906d_9$	$- 0.057d_1$	$+ 0.452d_6$	$+ 0.879d_7$		.427	1.202
$\hat{Y}_1 - \bar{Y}_1 =$	$1.611d_{10}$	$- 4.357d_9$	$- 0.057d_1$	$+ 0.455d_6$	$+ 1.025d_7$	$+ 0.311d_8$	.427	1.204

Y_1 = Percent Lean Cuts of Live Weight (S.D. = 1.604)

TABLE XV

MULTIPLE REGRESSION EQUATIONS USING WEIGHT, CARCASS BACKFAT, LOIN EYE AREA, LENGTH AND WHOLESALE CUTS FOR ESTIMATING WITHIN GROUP DEVIATIONS OF PERCENT LEAN CUTS OF LIVE WEIGHT

	Wt. of Ham (d_{11}) ($X_{11}-\bar{X}_{11}$)	Sla. Wt. (d_1) ($X_1-\bar{X}_1$)	Wt. of Loin (d_{12}) ($X_{12}-\bar{X}_{12}$)	LEA (d_{10}) ($X_{10}-\bar{X}_{10}$)	Rib B.F. (d_8) ($X_8-\bar{X}_8$)	Avg. B.F. (d_9) ($X_9-\bar{X}_9$)	Sh. B.F. (d_7) ($X_7-\bar{X}_7$)	Length (d_6) ($X_6-\bar{X}_6$)	R^2	Std. Err. of Est.
$\hat{Y}_1 - \bar{Y}_1 =$	$0.597d_{11}$								.392	1.234
$\hat{Y}_1 - \bar{Y}_1 =$	$0.777d_{11}$	$- 0.126d_1$							.566	1.043
$\hat{Y}_1 - \bar{Y}_1 =$	$0.589d_{11}$	$- 0.161d_1$	$+ 0.539d_{12}$						.762	0.773
$\hat{Y}_1 - \bar{Y}_1 =$	$0.553d_{11}$	$- 0.157d_1$	$+ 0.486d_{12}$	$+ 0.394d_{10}$					.774	0.754
$\hat{Y}_1 - \bar{Y}_1 =$	$0.535d_{11}$	$- 0.148d_1$	$+ 0.467d_{12}$	$+ 0.426d_{10}$	$- 1.081d_8$				.784	0.739
$\hat{Y}_1 - \bar{Y}_1 =$	$0.532d_{11}$	$- 0.147d_1$	$+ 0.465d_{12}$	$- 0.426d_{10}$	$- 0.837d_8$	$- 0.381d_9$			.784	0.739
$\hat{Y}_1 - \bar{Y}_1 =$	$0.531d_{11}$	$- 0.147d_1$	$+ 0.463d_{12}$	$+ 0.423d_{10}$	$- 0.405d_8$	$- 1.484d_9$	$+ 0.633d_7$		.785	0.738
$\hat{Y}_1 - \bar{Y}_1 =$	$0.530d_{11}$	$- 0.147d_1$	$+ 0.461d_{12}$	$+ 0.428d_{10}$	$- 0.392d_8$	$- 1.471d_9$	$+ 0.631d_7$	$+ 0.017d_6$	.785	0.739

Y_1 = Percent Lean Cuts of Live Weight (S.D. = 1.604)

TABLE XVI

MULTIPLE REGRESSION EQUATIONS USING WEIGHT, PROBE, LOIN EYE AREA AND WHOLESALE CUTS FOR ESTIMATING WITHIN GROUP DEVIATIONS OF PERCENT LEAN CUTS OF LIVE WEIGHT

	Wt. of Ham (d_{11}) ($X_{11}-\bar{X}_{11}$)	Sla. Wt. (d_1) ($X_1-\bar{X}_1$)	Wt. of Loin (d_{12}) ($X_{12}-\bar{X}_{12}$)	Wt. of Sh. (d_{13}) ($X_{13}-\bar{X}_{13}$)	LEA (d_{10}) ($X_{10}-\bar{X}_{10}$)	Avg. Probe (d_4) ($X_4-\bar{X}_4$)	R^2	Std. Err. of Est.
$\hat{Y}_1 - \bar{Y}_1 =$	$0.597d_{11}$						.392	1.234
$\hat{Y}_1 - \bar{Y}_1 =$	$0.777d_{11}$	$- 0.126d_1$					.566	1.043
$\hat{Y}_1 - \bar{Y}_1 =$	$0.589d_{11}$	$- 0.161d_1$	$+ 0.539d_{12}$				.762	0.773
$\hat{Y}_1 - \bar{Y}_1 =$	$0.468d_{11}$	$- 0.180d_1$	$+ 0.475d_{12}$	$+ 0.508d_{13}$			.901	0.501
$\hat{Y}_1 - \bar{Y}_1 =$	$0.461d_{11}$	$- 0.179d_1$	$+ 0.463d_{12}$	$+ 0.499d_{13}$	$+ 0.102d_{10}$		.901	0.499
$\hat{Y}_1 - \bar{Y}_1 =$	$0.456d_{11}$	$- 0.176d_1$	$+ 0.459d_{12}$	$+ 0.494d_{13}$	$+ 0.102d_{10}$	$- 0.217d_4$	.902	0.499

Y_1 = Percent Lean Cuts of Live Weight (S.D. = 1.604)

contributed to weight of trimmed hams, slaughter weight and weight of trimmed loins with a standard error of estimate of 0.773%. Table XV further shows that loin eye area and carcass rib backfat accounted for 1.2 and 1.0 percent of the variation, respectively. Thus weight of trimmed hams, slaughter weight, weight of trimmed loins, loin eye area and carcass rib backfat removed 78.4% of the variation of percent lean cuts of live weight with a standard error of estimate of 0.739%. The further addition of average carcass backfat, carcass shoulder backfat and carcass length made no contribution to the accountable variation. However, Table XVI illustrates that the entry of weight of trimmed shoulders to the basic equation of weight of trimmed hams, slaughter weight and weight of trimmed loins ($R^2 = 0.762$) increased the variation accounted for by 13.9% for a total of 90.1% of the variation with a standard error of estimate of 0.501%. The addition of both loin eye area and average live probe gave no further increase in the accountable variation for percent lean cuts of live weight.

When 13 of the 14 independent variables used in the regression study were considered by the stepwise regression procedure, ham-loin index was the first variable selected and accounted for 63.8% of the variation in percent lean cuts of live weight (Table XVII) with a standard error of estimate or "average miss" of only 0.951%. The next three variables entered into the equation were weight of trimmed loins, slaughter weight and loin eye area which increased the accountable variation 6.1, 6.8 and 3.0 percent, respectively. The further addition of carcass rib backfat and carcass weight accounted for 1.3% of the variation which completed an equation of six variables accounting for 81% of the variation in percent lean cuts of live weight with a standard error

TABLE XVII

MULTIPLE REGRESSION EQUATIONS USING LIVE AND CARCASS MEASUREMENTS FOR ESTIMATING WITHIN GROUP DEVIATIONS OF PERCENT LEAN CUTS OF LIVE WEIGHT

	Ham-Loin Index (d_{14}) ($X_{14}-\bar{X}_{14}$)	Wt. of Loin (d_{12}) ($X_{12}-\bar{X}_{12}$)	Sla. Wt. (d_1) ($X_1-\bar{X}_1$)	LEA (d_{10}) ($X_{10}-\bar{X}_{10}$)	Rib B.F. (d_8) ($X_8-\bar{X}_8$)	Car. Wt. (d_5) ($X_5-\bar{X}_5$)	Rib Probe (d_3) ($X_3-\bar{X}_3$)	Wt. of Ham (d_{11}) ($X_{11}-\bar{X}_{11}$)	Avg. B.F. (d_9) ($X_9-\bar{X}_9$)	Sh. B.F. (d_7) ($X_7-\bar{X}_7$)	Sh. Probe (d_2) ($X_2-\bar{X}_2$)	Length (d_6) ($X_6-\bar{X}_6$)	Avg. Probe (d_4) ($X_4-\bar{X}_4$)	R^2	Std. Err. of Est.
$\hat{Y}_1 - \bar{Y}_1 =$	$0.117d_{14}$													.638	0.951
$\hat{Y}_1 - \bar{Y}_1 =$	$0.099d_{14}$	$+ 0.286d_{12}$												.699	0.869
$\hat{Y}_1 - \bar{Y}_1 =$	$0.089d_{14}$	$+ 0.439d_{12}$	$- 0.080d_1$											.767	0.765
$\hat{Y}_1 - \bar{Y}_1 =$	$0.118d_{14}$	$+ 0.473d_{12}$	$- 0.071d_1$	$- 0.854d_{10}$										.797	0.715
$\hat{Y}_1 - \bar{Y}_1 =$	$0.115d_{14}$	$+ 0.457d_{12}$	$- 0.066d_1$	$- 0.788d_{10}$	$- 0.954d_8$									.804	0.703
$\hat{Y}_1 - \bar{Y}_1 =$	$0.108d_{14}$	$+ 0.435d_{12}$	$- 0.090d_1$	$- 0.735d_{10}$	$- 1.205d_8$	$+ 0.043d_5$								.810	0.693
$\hat{Y}_1 - \bar{Y}_1 =$	$0.106d_{14}$	$+ 0.425d_{12}$	$- 0.091d_1$	$- 0.735d_{10}$	$- 0.955d_8$	$+ 0.050d_5$	$- 0.644d_3$							.812	0.690
$\hat{Y}_1 - \bar{Y}_1 =$	$0.081d_{14}$	$+ 0.424d_{12}$	$- 0.109d_1$	$- 0.495d_{10}$	$- 0.920d_8$	$+ 0.047d_5$	$- 0.687d_3$	$+ 0.133d_{11}$						.815	0.686
$\hat{Y}_1 - \bar{Y}_1 =$	$0.081d_{14}$	$+ 0.422d_{12}$	$- 0.109d_1$	$- 0.487d_{10}$	$- 0.765d_8$	$+ 0.048d_5$	$- 0.670d_3$	$+ 0.133d_{11}$	$- 0.269d_9$					.815	0.687
$\hat{Y}_1 - \bar{Y}_1 =$	$0.081d_{14}$	$+ 0.421d_{12}$	$- 0.109d_1$	$- 0.490d_{10}$	$- 0.402d_8$	$+ 0.049d_5$	$- 0.605d_3$	$+ 0.131d_{11}$	$- 1.263d_9$	$+ 0.559d_7$				.816	0.686
$\hat{Y}_1 - \bar{Y}_1 =$	$0.081d_{14}$	$+ 0.421d_{12}$	$- 0.110d_1$	$- 0.494d_{10}$	$- 0.395d_8$	$+ 0.049d_5$	$- 0.669d_3$	$+ 0.132d_{11}$	$- 1.320d_9$	$+ 0.565d_7$	$+ 0.119d_2$			.816	0.686
$\hat{Y}_1 - \bar{Y}_1 =$	$0.081d_{14}$	$+ 0.422d_{12}$	$- 0.109d_1$	$- 0.498d_{10}$	$- 0.405d_8$	$+ 0.049d_5$	$- 0.672d_3$	$+ 0.132d_{11}$	$- 1.328d_9$	$+ 0.566d_7$	$+ 0.116d_2$	$- 0.014d_6$		.816	0.687
$\hat{Y}_1 - \bar{Y}_1 =$	$0.081d_{14}$	$+ 0.422d_{12}$	$- 0.109d_1$	$- 0.497d_{10}$	$- 0.414d_8$	$+ 0.049d_5$	$- 0.587d_3$	$+ 0.132d_{11}$	$- 1.300d_9$	$+ 0.558d_7$	$+ 0.178d_2$	$- 0.014d_6$	$- 0.174d_4$	.816	0.688

Y_1 = Percent Lean Cuts of Live Weight (S.D. = 1.604)

of estimate of 0.693%. The remaining seven variables shown in Table XVII increased the R^2 value of the equation less than 1%.

Live animal measurements accounted for less than half of the variation in percent lean cuts of live weight; however, the addition of carcass measurements such as trimmed weights of hams, loins and shoulders greatly increased the magnitude of R^2. Thus the use of all live animal measurements to predict percent yield of lean cuts on a live weight basis lacked precision.

It should be understood that the equations discussed in this study are useful only for predicting the change in percent lean cuts of live weight (or other dependent variables) from the average of the population described in the Materials and Methods section. Thus the equation should not be used to compare animals of different breeds or those reared under different conditions. However, the equations may be used for comparisons of individuals within a group or as a guide for selecting variables to be entered in a multiple regression equation.

Percent Lean Cuts of Carcass Weight

Tables XVIII and XIX indicate that average live probe can account for only 28.7% of the variation in percent lean cuts of carcass weight. However when loin eye area is added to the equation in Table XIX the amount of variation accounted for increases to 40.4% with a standard error of estimate of 1.451%. Slaughter weight shows no significant effect in either Table XVIII or XIX. When weights of the trimmed hams, loins and shoulders were used in the stepwise regression with average live probe and slaughter weight (Table XX); weight of the trimmed loins was the first variable chosen and was responsible for 31.7% of the

TABLE XVIII

MULTIPLE REGRESSION EQUATIONS USING WEIGHT AND PROBE FOR ESTIMATING WITHIN GROUP DEVIATIONS OF PERCENT LEAN CUTS OF CARCASS WEIGHT

	Avg. Probe (d_4) ($X_4-\bar{X}_4$)	Sla. Wt. (d_1) ($X_1-\bar{X}_1$)	R^2	Std. Err. of Est.
$\hat{Y}_2 - \bar{Y}_2 =$	$- 7.129d_4$		.287	1.583
$\hat{Y}_2 - \bar{Y}_2 =$	$- 7.230d_4$	$+ 0.011d_1$	.288	1.586

Y_2 = Percent Lean Cuts of Carcass Weight (S.D. = 1.903)

TABLE XIX

MULTIPLE REGRESSION EQUATIONS USING WEIGHT, PROBE AND LOIN EYE AREA FOR ESTIMATING WITHIN GROUP DEVIATIONS OF PERCENT LEAN CUTS OF CARCASS WEIGHT

	Avg. Probe (d_4) ($X_4-\overline{X}_4$)	LEA (d_{10}) ($X_{10}-\overline{X}_{10}$)	Sla. Wt. (d_1) ($X_1-\overline{X}_1$)	R^2	Std. Err. of Est.
$\hat{Y}_2 - \overline{Y}_2 =$	$- 7.129d_4$			.287	1.585
$\hat{Y}_2 - \overline{Y}_2 =$	$- 6.283d_4$	$+ 1.252d_{10}$		.404	1.451
$\hat{Y}_2 - \overline{Y}_2 =$	$- 6.132d_4$	$+ 1.285d_{10}$	$- 0.014d_1$	.406	1.450

Y_2 = Percent Lean Cuts of Cracass Weight (S.D. = 1.903)

TABLE XX

MULTIPLE REGRESSION EQUATIONS USING WEIGHT, PROBE AND WHOLESALE CUTS FOR ESTIMATING WITHIN GROUP DEVIATIONS OF PERCENT LEAN CUTS OF CARCASS WEIGHT

	Wt. of Loin (d_{12}) $(X_{12}-\overline{X}_{12})$	Avg. Probe (d_4) $(X_4-\overline{X}_4)$	Wt. of Sh. (d_{13}) $(X_{13}-\overline{X}_{13})$	Sla. Wt. (d_1) $(X_1-\overline{X}_1)$	Wt. of Ham (d_{11}) $(X_{11}-\overline{X}_{11})$	R^2	Std. Err. of Est.
$\hat{Y}_2 - \overline{Y}_2 =$	$0.692d_{12}$					.317	1.551
$\hat{Y}_2 - \overline{Y}_2 =$	$0.597d_{12}$	$- 6.021d_4$				.516	1.308
$\hat{Y}_2 - \overline{Y}_2 =$	$0.491d_{12}$	$- 5.490d_4$	$+ 0.372d_{13}$			.575	1.227
$\hat{Y}_2 - \overline{Y}_2 =$	$0.648d_{12}$	$- 3.816d_4$	$+ 0.523d_{13}$	$- 0.118d_1$		.664	1.092
$\hat{Y}_2 - \overline{Y}_2 =$	$0.558d_{12}$	$- 3.128d_4$	$+ 0.441d_{13}$	$- 0.143d_1$	$+ 0.316d_{11}$	.713	1.010

Y_2 = Percent Lean Cuts of Carcass Weight (S.D. = 1.903)

variation in percent lean cuts of carcass weight. Average live probe, the second variable entered into the equation, increased the R^2 value 19.9% while decreasing the standard error of estimate 0.243%. Weight of the trimmed shoulders, slaughter weight and weight of the trimmed hams accounted for 5.9, 8.9 and 4.9 percent of the variation in percent lean cuts of carcass weight. Thus, the combination of the above five variables removed 71.3% of the variation in percent lean cuts of carcass weight with a standard error of estimate of 1.010%.

Using only two variables in the regression equation indicated that weight of the trimmed loins and carcass weight (Table XXVI) accounted for 52.1% of the variation of percent lean cuts of carcass weight with a standard error of estimate of 1.301%. The next best combination of two variables was weight of the trimmed hams and carcass weight (Table XXI) which accounted for 47.4% of the variation with an "average miss" of 1.363%. Lasley et al. (1956) in a study of less uniform animals reported 80% of the variation of percent lean cuts of carcass weight was removed by these two variables. The further addition of weight of the trimmed shoulders and hams to the equation in Table XXVI removed a total of 95.2% of the variation of percent lean cuts of carcass weight with a standard error of estimate of only 0.413%.

When average carcass backfat was the first variable entered into the equation it removed 26.8% of the variation of percent lean cuts of carcass weight (Tables XXII through XXV). Table XXII shows that the addition of carcass length and weight had no significant effect on the accountable variation. However, Lasley et al. (1956) and Lu et al. (1958) reported 50 and 51 percent of the variation accounted for by these three variables in their particular studies. When loin eye area

TABLE XXI

MULTIPLE REGRESSION EQUATIONS USING WEIGHT OF HAM AND CARCASS FOR ESTIMATING WITHIN GROUP DEVIATIONS OF PERCENT LEAN CUTS OF CARCASS WEIGHT

	Wt. of Ham (d_{11}) ($X_{11}-\bar{X}_{10}$)	Car. Wt. (d_5) ($X_5-\bar{X}_5$)	R^2	Std. Err. of Est.
$\hat{Y}_2 - \bar{Y}_2 =$	$0.569d_{11}$		.252	1.624
$\hat{Y}_2 - \bar{Y}_2 =$	$0.933d_{11}$	$- 0.222d_5$	.474	1.363

Y_2 = Percent Lean Cuts of Carcass Weight (S.D. = 1.903)

TABLE XXII

MULTIPLE REGRESSION EQUATIONS USING WEIGHT, CARCASS BACKFAT AND LENGTH FOR ESTIMATING WITHIN GROUP DEVIATIONS OF PERCENT LEAN CUTS OF CARCASS WEIGHT

	Avg. B.F. (d_9) (X_9-X_9)	Length (d_6) (X_6-X_6)	Car. Wt. (d_5) (X_5-X_5)	R^2	Std. Err. of Est.
$\hat{Y}_2 - \bar{Y}_2 =$	$- 7.823d_9$			.268	1.606
$\hat{Y}_2 - \bar{Y}_2 =$	$- 7.343d_9$	$+ 0.322d_6$		.278	1.597
$\hat{Y}_2 - \bar{Y}_2 =$	$- 7.246d_9$	$+ 0.339d_6$	$- 0.008d_5$	.278	1.598

Y_2 = Percent Lean Cuts of Carcass Weight (S.D. = 1.903)

TABLE XXIII

MULTIPLE REGRESSION EQUATIONS USING WEIGHT, CARCASS BACKFAT, LENGTH, LOIN EYE AREA AND WEIGHT OF HAM FOR ESTIMATING WITHIN GROUP DEVIATIONS OF PERCENT LEAN CUTS OF CARCASS WEIGHT

	Avg. B.F. (d_9) ($X_9-\bar{X}_9$)	Wt. of Ham (d_{11}) ($X_{11}-\bar{X}_{11}$)	Car. Wt. (d_5) ($X_5-\bar{X}_5$)	LEA (d_{10}) ($X_{10}-\bar{X}_{10}$)	Length (d_6) ($X_6-\bar{X}_6$)	R^2	Std. Err. of Est.
$\hat{Y}_2 - \bar{Y}_2 =$	$- 7.823d_9$					.268	1.606
$\hat{Y}_2 - \bar{Y}_2 =$	$- 6.711d_9$	$+ 0.482d_{11}$				.443	1.403
$\hat{Y}_2 - \bar{Y}_2 =$	$- 4.567d_9$	$+ 0.783d_{11}$	$- 0.167d_5$			.548	1.264
$\hat{Y}_2 - \bar{Y}_2 =$	$- 4.379d_9$	$+ 0.658d_{11}$	$- 0.182d_5$	$+ 1.119d_{10}$		.627	1.151
$\hat{Y}_2 - \bar{Y}_2 =$	$- 3.683d_9$	$+ 0.641d_{11}$	$- 0.195d_5$	$+ 1.195d_{10}$	$+ 0.402d_6$	.641	1.129

Y_2 = Percent Lean Cuts of Carcass Weight (S.D. = 1.903)

TABLE XXIV

MULTIPLE REGRESSION EQUATIONS USING WEIGHT, CARCASS BACKFAT AND LOIN EYE AREA FOR ESTIMATING WITHIN GROUP DEVIATIONS OF PERCENT LEAN CUTS OF CARCASS WEIGHT

	Avg. B.F. (d_9) ($X_9-\bar{X}_9$)	LEA (d_{10}) ($X_{10}-\bar{X}_{10}$)	Car. Wt. (d_5) ($X_5-\bar{X}_5$)	Sh. B.F. (d_7) ($X_7-\bar{X}_7$)	Rib B.F. (d_8) ($X_8-\bar{X}_8$)	R^2	Std. Err. of Est.
$\hat{Y}_2 - \bar{Y}_2 =$	$- 7.823d_9$					.268	1.606
$\hat{Y}_2 - \bar{Y}_2 =$	$- 7.388d_9$	$+ 1.434d_{10}$				.426	1.423
$\hat{Y}_2 - \bar{Y}_2 =$	$- 6.832d_9$	$+ 1.613d_{10}$	$- 0.058d_5$			.445	1.402
$\hat{Y}_2 - \bar{Y}_2 =$	$- 8.409d_9$	$+ 1.606d_{10}$	$- 0.056d_5$	$+ 1.457d_7$		.451	1.395
$\hat{Y}_2 - \bar{Y}_2 =$	$- 9.095d_9$	$+ 1.601d_{10}$	$- 0.056d_5$	$+ 1.678d_7$	$+ 0.466d_8$	.452	1.396

Y_2 = Percent Lean Cuts of Carcass Weight (S.D. = 1.903)

TABLE XXV

MULTIPLE REGRESSION EQUATIONS USING WEIGHT, CARCASS BACKFAT, LENGTH AND LOIN EYE AREA FOR ESTIMATING WITHIN GROUP DEVIATIONS OF PERCENT LEAN CUTS OF CARCASS WEIGHT

	Avg. B.F. (d_9) ($X_9-\bar{X}_9$)	LEA (d_{10}) ($X_{10}-\bar{X}_{10}$)	Car. Wt. (d_5) ($X_5-\bar{X}_5$)	Length (d_6) ($X_6-\bar{X}_6$)	Sh. B.F. (d_7) ($X_7-\bar{X}_7$)	Rib B.F. (d_8) ($X_8-\bar{X}_8$)	R^2	Std. Err. of Est.
$\hat{Y}_2 - \bar{Y}_2 =$	$-\ 7.823d_9$						.268	1.606
$\hat{Y}_2 - \bar{Y}_2 =$	$-\ 7.388d_9$	$+\ 1.434d_{10}$					.426	1.423
$\hat{Y}_2 - \bar{Y}_2 =$	$-\ 6.832d_9$	$+\ 1.613d_{10}$	$-\ 0.058d_5$				.445	1.402
$\hat{Y}_2 - \bar{Y}_2 =$	$-\ 5.828d_9$	$+\ 1.695d_{10}$	$-\ 0.079d_5$	$+\ 0.530d_6$			.470	1.370
$\hat{Y}_2 - \bar{Y}_2 =$	$-\ 7.133d_9$	$+\ 1.686d_{10}$	$-\ 0.077d_5$	$+\ 0.507d_6$	$+\ 1.165d_7$		.475	1.366
$\hat{Y}_2 - \bar{Y}_2 =$	$-\ 8.343d_9$	$+\ 1.678d_{10}$	$-\ 0.078d_5$	$+\ 0.517d_6$	$+\ 1.559d_7$	$+\ 0.839d_8$	.476	1.366

Y_2 = Percent Lean Cuts of Carcass Weight (S.D. = 1.903)

TABLE XXVI

MULTIPLE REGRESSION EQUATIONS USING WEIGHT, CARCASS BACKFAT, LOIN EYE AREA AND WHOLESALE CUTS FOR ESTIMATING WITHIN GROUP DEVIATIONS OF PERCENT LEAN CUTS OF CARCASS WEIGHT

	Wt. of Loin (d_{12}) ($X_{12}-\bar{X}_{12}$)	Car. Wt. (d_5) ($X_5-\bar{X}_5$)	Wt. of Sh. (d_{13}) ($X_{13}-\bar{X}_{13}$)	Wt. of Ham (d_{11}) ($X_{11}-\bar{X}_{11}$)	Avg. B.F. (d_9) ($X_9-\bar{X}_9$)	LEA (d_{10}) ($X_{10}-\bar{X}_{10}$)	R^2	Std. Err. of Est.
$\hat{Y}_2 - \bar{Y}_2 =$	$0.692d_{12}$						.317	1.551
$\hat{Y}_2 - \bar{Y}_2 =$	$1.015d_{12}$	$- 0.203d_5$					.521	1.301
$\hat{Y}_2 - \bar{Y}_2 =$	$0.904d_{12}$	$- 0.294d_5$	$+ 0.832d_{14}$				.783	0.876
$\hat{Y}_2 - \bar{Y}_2 =$	$0.753d_{12}$	$- 0.368d_5$	$+ 0.696d_{13}$	$+ 0.597d_{11}$			.952	0.413
$\hat{Y}_2 - \bar{Y}_2 =$	$0.738d_{12}$	$- 0.355d_5$	$+ 0.678d_{13}$	$+ 0.579d_{11}$	$- 0.806d_9$		.954	0.404
$\hat{Y}_2 - \bar{Y}_2 =$	$0.724d_{12}$	$- 0.353d_5$	$+ 0.668d_{13}$	$+ 0.570d_{11}$	$- 0.852d_9$	$+ 0.110d_{10}$	.955	0.402

Y_2 = Percent Lean Cuts of Carcass Weight (S.D. = 1.903)

was considered along with average carcass backfat, the increase in R^2 was 15.8% (Tables XXIV, XXV). The magnitude of R^2 was increased 17.5% in Table XXIII when weight of the trimmed hams was entered as the second variable for estimating within group deviations of percent lean cuts of carcass weight. The third variable to be entered into regression in Tables XXIII, XXIV and XXV was carcass weight. When carcass weight was entered into the regression equation after average carcass backfat and loin eye area it accounted for only 1.9% of the variation in percent lean cuts of carcass weight (Tables XXIV and XXV); however, it accounted for 10.5% of the variation when entered after average carcass backfat and weight of the trimmed hams (Table XXIII). When loin eye area and carcass length were added to the equation in Table XXIII, the five-variable equation accounted for a total of 64.1% of the variation in percent lean cuts of carcass weight with a standard error of estimate of 1.129%. Carcass length (Table XXV) accounted for an additional 2.5% of the variation making a total of 47% of the variation of percent lean cuts of carcass weight removed by the following four variables: average carcass backfat, loin eye area, carcass weight and carcass length. The standard error of estimate for this equation was 1.370%. These same four variables removed 70% of the variation of percent lean cuts of carcass weight in the study by Lasley _et al_., 1956. Tables XXIV and XXV indicate that the addition of individual shoulder and rib backfat measurements did not increase the R^2 value of the equations.

Table XXVII shows the results of considering eight variables for estimating within group deviations of percent lean cuts of carcass weight. The first variable chosen by the stepwise regression procedure was weight of the trimmed loins which accounted for 31.7% of the

TABLE XXVII

MULTIPLE REGRESSION EQUATIONS USING WEIGHT, CARCASS BACKFAT, LENGTH, LOIN EYE AREA AND WHOLESALE CUTS FOR ESTIMATING WITHIN GROUP DEVIATIONS OF PERCENT LEAN CUTS OF CARCASS WEIGHT

	Wt. of Loin (d_{12}) ($X_{12}-\bar{X}_{12}$)	Car. Wt. (d_5) ($X_5-\bar{X}_5$)	Wt. of Ham (d_{11}) ($X_{11}-\bar{X}_{11}$)	Avg. B.F. (d_9) ($X_9-\bar{X}_9$)	LEA (d_{10}) ($X_{10}-\bar{X}_{10}$)	Sh. B.F. (d_7) ($X_7-\bar{X}_7$)	Length (d_6) ($X_6-\bar{X}_6$)	Rib B.F. (d_8) ($X_8-\bar{X}_8$)	R^2	Std. Err. of Est.
$\hat{Y}_2 - \bar{Y}_2 =$	$0.692d_{12}$								.317	1.551
$\hat{Y}_2 - \bar{Y}_2 =$	$1.015d_{12}$	$- 0.203d_5$							.521	1.301
$\hat{Y}_2 - \bar{Y}_2 =$	$0.812d_{12}$	$- 0.310d_5$	$+ 0.719d_{11}$						.775	0.892
$\hat{Y}_2 - \bar{Y}_2 =$	$0.759d_{12}$	$- 0.274d_5$	$+ 0.650d_{11}$	$- 2.521d_9$					.797	0.849
$\hat{Y}_2 - \bar{Y}_2 =$	$0.694d_{12}$	$- 0.272d_5$	$+ 0.607d_{11}$	$- 2.612d_9$	$+ 0.488d_{10}$				.810	0.822
$\hat{Y}_2 - \bar{Y}_2 =$	$0.691d_{12}$	$- 0.269d_5$	$+ 0.605d_{11}$	$- 3.515d_9$	$+ 0.490d_{10}$	$+ 0.817d_7$			.812	0.818
$\hat{Y}_2 - \bar{Y}_2 =$	$0.684d_{12}$	$- 0.271d_5$	$+ 0.603d_{11}$	$- 3.389d_9$	$+ 0.508d_{10}$	$+ 0.785d_7$	$+ 0.063d_6$		.812	0.818
$\hat{Y}_2 - \bar{Y}_2 =$	$0.684d_{12}$	$- 0.271d_5$	$+ 0.602d_{11}$	$- 3.553d_9$	$+ 0.508d_{10}$	$+ 0.839d_7$	$+ 0.065d_6$	$+ 0.113d_8$	.812	0.819

Y_2 = Percent Lean Cuts of Carcass Weight (S.D. = 1.903)

variation with a standard error of estimate of 1.551%. The second variable, carcass weight, removed 20.4% of the variation while weight of the trimmed hams accounted for an additional 25.4% of the variation and decreased the standard error of the estimate 0.409%. Average carcass backfat and loin eye area accounted for 2.2 and 1.3 percent of the variation, respectively. Thus, the first five variables (Table XXVII) accounted for 81% of the variation of percent lean cuts of carcass weight with a standard error of estimate of 0.822%. The remaining three variables (carcass shoulder backfat, carcass length and carcass rib backfat) failed to increase the R^2 value.

When the 12 variables listed in Table XXVIII were considered for estimating within group deviations of percent lean cuts of carcass weight, five variables accounted for 81.9% of the variation while the remaining seven removed only 0.1%. The first variable, ham-loin index, accounted for 42% of the variation; while average carcass backfat accounted for 13.4% as the second variable. Weight of the trimmed loins, carcass weight and weight of the trimmed hams accounted for 8.2, 14.5 and 3.8 percent of the variation which gave a total of 81.9% with a standard error of estimate of 0.803%.

When predicting percent lean cuts of carcass weight, average live probe as a single indicator accounted for 1.9% more variation than average carcass backfat with a slightly smaller standard error of estimate. The best single indicator of percent lean cuts of carcass weight was ham-loin index (R^2 = .420). This was expected since it is a combination of loin eye area and percentage of ham. A combination of the weights of trimmed hams, loins and shoulders with slaughter or carcass

TABLE XXVIII

MULTIPLE REGRESSION EQUATIONS USING LIVE AND CARCASS MEASUREMENTS FOR ESTIMATING WITHIN GROUP DEVIATIONS OF PERCENT LEAN CUTS OF CARCASS WEIGHT

	Ham-Loin Index (d_{14}) ($X_{14}-\bar{X}_{14}$)	Avg. B.F. (d_9) ($X_9-\bar{X}_9$)	Wt. of Loin (d_{12}) ($X_{12}-\bar{X}_{12}$)	Car. Wt. (d_5) ($X_5-\bar{X}_5$)	Wt. of Ham (d_{11}) ($X_{11}-\bar{X}_{11}$)	Rib Probe (d_3) ($X_3-\bar{X}_3$)	Sla. Wt. (d_1) ($X_1-\bar{X}_1$)	LEA (d_{10}) ($X_{10}-\bar{X}_{10}$)	Sh. B.F. (d_7) ($X_7-\bar{X}_7$)	Avg. Probe (d_4) ($X_4-\bar{X}_4$)	Length (d_6) ($X_6-\bar{X}_6$)	Rib B.F. (d_8) ($X_8-\bar{X}_8$)	R^2	Std. Err. of Est.
$\hat{Y}_2 - \bar{Y}_2 =$	$0.113d_{14}$												.420	1.429
$\hat{Y}_2 - \bar{Y}_2 =$	$0.096d_{14}$	$-5.717d_9$											.554	1.255
$\hat{Y}_2 - \bar{Y}_2 =$	$0.071d_{14}$	$-5.522d_9$	$+0.394d_{12}$										.636	1.135
$\hat{Y}_2 - \bar{Y}_2 =$	$0.084d_{14}$	$-3.100d_9$	$+0.680d_{12}$	$-0.186d_5$									.781	0.882
$\hat{Y}_2 - \bar{Y}_2 =$	$0.043d_{14}$	$-2.446d_9$	$+0.699d_{12}$	$-0.248d_5$	$+0.420d_{11}$								.819	0.803
$\hat{Y}_2 - \bar{Y}_2 =$	$0.039d_{14}$	$-2.012d_9$	$+0.684d_{12}$	$-0.240d_5$	$+0.425d_{11}$	$-0.953d_3$							.822	0.795
$\hat{Y}_2 - \bar{Y}_2 =$	$0.050d_{14}$	$-2.030d_9$	$+0.665d_{12}$	$-0.263d_5$	$+0.370d_{11}$	$-0.905d_3$	$+0.033d_1$						.826	0.789
$\hat{Y}_2 - \bar{Y}_2 =$	$0.077d_{14}$	$-1.932d_9$	$+0.677d_{12}$	$-0.265d_5$	$+0.263d_{11}$	$-0.878d_3$	$+0.051d_1$	$-0.386d_{10}$					.828	0.785
$\hat{Y}_2 - \bar{Y}_2 =$	$0.078d_{14}$	$-2.677d_9$	$+0.676d_{12}$	$-0.264d_5$	$+0.258d_{11}$	$-0.746d_3$	$+0.052d_1$	$-0.389d_{10}$	$+0.621d_7$				.829	0.783
$\hat{Y}_2 - \bar{Y}_2 =$	$0.077d_{14}$	$-2.567d_9$	$+0.676d_{12}$	$-0.264d_5$	$+0.256d_{11}$	$-0.425d_3$	$+0.052d_1$	$-0.380d_{10}$	$+0.605d_7$	$-0.475d_4$			.829	0.783
$\hat{Y}_2 - \bar{Y}_2 =$	$0.077d_{14}$	$-2.506d_9$	$+0.672d_{12}$	$-0.265d_5$	$+0.255d_{11}$	$-0.426d_3$	$+0.052d_1$	$-0.368d_{10}$	$+0.590d_7$	$-0.451d_4$	$+0.039d_6$		.829	0.784
$\hat{Y}_2 - \bar{Y}_2 =$	$0.077d_{14}$	$-2.627d_9$	$+0.672d_{12}$	$-0.265d_5$	$+0.255d_{11}$	$-0.435d_3$	$+0.052d_1$	$-0.368d_{10}$	$+0.628d_7$	$-0.443d_4$	$+0.040d_6$	$+0.084d_8$	.829	0.785

Y_2 = Percent Lean Cuts of Carcass Weight (S.D. = 1.903)

weight proved to be the best combination of traits for predicting either percent lean cuts of live or carcass weight.

Total Pounds of Lean

The third dependent variable used was total pounds of lean which was earlier defined as the total weight of the trimmed hams, loins and shoulders. Table XXIX indicates that loin eye area can account for 32.1% of the variation in total lean, while slaughter weight and average live probe remove an additional 15.8 and 7.7 percent, respectively. Thus the three live animal measurements account for 55.6% of the variation in total lean with a standard error of estimate of 2.392 pounds.

Table XXX shows a combination of both live and carcass measurements that were considered for estimating within group deviations of total pounds of lean. The variable with the highest simple correlation with total lean was carcass weight which removed 42.6% of the variation. The second variable, average live probe, accounted for 16.5% of the variation in total lean while loin eye area removed an additional 7.9%. Average carcass backfat and carcass length combined to account for 4.6% of the variation. Thus the total variation of total lean accounted for by the first five variables was 71.6% with a standard error of estimate of 1.919 pounds. The remaining five variables showed essentially no increase in R^2 or decrease in standard error of the estimate. This equation is the best combination of easily measured traits that accounted for a major portion of the variation in this study. These five variables can be measured on the live animal or on the split carcass as it hangs in the cooler of any packing house. This assumes that loin eye area can be measured by sonaray techniques.

TABLE XXIX

MULTIPLE REGRESSION EQUATIONS USING WEIGHT, PROBE AND LOIN EYE AREA FOR ESTIMATING WITHIN GROUP DEVIATIONS OF TOTAL POUNDS OF LEAN

	LEA (d_{10}) ($X_{10}-\overline{X}_{10}$)	Sla. Wt. (d_1) ($X_1-\overline{X}_1$)	Avg. Probe (d_4) ($X_4-\overline{X}_4$)	R^2	Std. Err. of Est.
$\hat{Y}_3 - \overline{Y}_3 =$	$3.884d_{10}$			.321	2.952
$\hat{Y}_3 - \overline{Y}_3 =$	$3.431d_{10}$	$+ 0.251d_1$		.479	2.588
$\hat{Y}_3 - \overline{Y}_3 =$	$2.980d_{10}$	$+ 0.298d_1$	$- 7.422d_4$	.556	2.392

Y_3 = Total Pounds of Lean (S.D. = 3.633)

TABLE XXX

MULTIPLE REGRESSION EQUATIONS USING LIVE AND CARCASS MEASUREMENTS FOR ESTIMATING WITHIN GROUP DEVIATIONS OF TOTAL POUNDS OF LEAN

	Car. Wt. (d_5) ($X_5-\bar{X}_5$)	Avg. Probe (d_4) ($X_4-\bar{X}_4$)	LEA (d_{10}) ($X_{10}-\bar{X}_{10}$)	Avg. B.F. (d_9) ($X_9-\bar{X}_9$)	Length (d_6) ($X_6-\bar{X}_6$)	Sla. Wt. (d_1) ($X_1-\bar{X}_1$)	Sh. Probe (d_2) ($X_2-\bar{X}_2$)	Sh. B.F. (d_7) ($X_7-\bar{X}_7$)	Rib Probe (d_3) ($X_3-\bar{X}_3$)	Rib B.F. (d_8) ($X_8-\bar{X}_8$)	R^2	Std. Err. of Est.
$\hat{Y}_3 - \bar{Y}_3 =$	$0.485d_5$										.426	2.715
$\hat{Y}_3 - \bar{Y}_3 =$	$0.548d_5$	$- 10.558d_4$									.591	2.293
$\hat{Y}_3 - \bar{Y}_3 =$	$0.464d_5$	$- 8.540d_4$	$+ 2.104d_{10}$								.670	2.063
$\hat{Y}_3 - \bar{Y}_3 =$	$0.482d_5$	$- 5.220d_4$	$+ 2.097d_{10}$	$- 6.708d_9$							.705	1.953
$\hat{Y}_3 - \bar{Y}_3 =$	$0.453d_5$	$- 4.704d_4$	$+ 2.226d_{10}$	$- 5.772d_9$	$+ 0.660d_6$						.716	1.919
$\hat{Y}_3 - \bar{Y}_3 =$	$0.415d_5$	$- 4.890d_4$	$+ 2.250d_{10}$	$- 5.706d_9$	$+ 0.626d_6$	$+ 0.043d_1$					.718	1.914
$\hat{Y}_3 - \bar{Y}_3 =$	$0.422d_5$	$- 6.692d_4$	$+ 2.215d_{10}$	$- 5.674d_9$	$+ 0.624d_6$	$+ 0.040d_1$	$+ 1.445d_2$				.719	1.910
$\hat{Y}_3 - \bar{Y}_3 =$	$0.423d_5$	$- 6.422d_4$	$+ 2.220d_{10}$	$- 6.636d_9$	$+ 0.614d_6$	$+ 0.040d_1$	$+ 1.358d_2$	$+ 0.778d_7$			.720	1.910
$\hat{Y}_3 - \bar{Y}_3 =$	$0.424d_5$	$- 5.432d_4$	$+ 2.211d_{10}$	$- 6.613d_9$	$+ 0.613d_6$	$+ 0.039d_1$	$+ 1.056d_2$	$+ 0.755d_7$	$- 0.691d_3$		.720	1.912
$\hat{Y}_3 - \bar{Y}_3 =$	$0.424d_5$	$- 5.388d_4$	$+ 2.209d_{10}$	$- 6.900d_9$	$+ 0.615d_6$	$+ 0.039d_1$	$+ 1.044d_2$	$+ 0.847d_7$	$- 0.722d_3$	$+ 0.199d_8$	.720	1.914

Y_3 = Total Pounds of Lean (S.D. = 3.633)

When all three dependent variables (percent lean cuts of live weight, percent lean cuts of carcass weight, total pounds of lean) were predicted by loin eye area, slaughter weight and average live probe; it was shown that 55.6% of the variation of total pounds of lean was accounted for compared to only 40% accounted for in both percent lean cuts of live and carcass weight. The standard errors of estimate were 2.392 lbs., 1.226% and 1.451% for total pounds of lean, percent lean cuts of live weight and percent lean cuts of carcass weight, respectively.

In general, carcass measurements accounted for more variation in percent lean cuts of live or carcass weight than live animal measurements. Most of the variation was removed after four or five variables were entered into the equations. More than five variables in any one equation seemed not to remove enough variation to justify the added time and expense of their consideration. The most precise prediction of percent lean cuts was obtained when trimmed weights of hams, loins and shoulders were entered into the equations. The best equations excluding wholesale cuts accounted for approximately 56 and 72 percent of the variation in total pounds of lean. Average live probe and carcass backfat measurements were more precise indicators of lean cut yields than were individual probe and carcass backfat measurements.

SUMMARY

The objective of this study was to evaluate the relative accuracy of estimating lean cut yield by live measurements as compared to carcass measurements. Data were collected from fall 1964 through fall 1969 involving a rather uniform group of 476 Hampshire slaughter pigs. The animals were from the Experimental Swine Breeding Herd at Stillwater.

Twenty-one traits were investigated. Live animal traits were slaughter weight and individual probes at the shoulder, rib and rump and their average. Carcass traits included: carcass weight, dressing percentage, length, backfat thickness, ham-loin index, percent ham and loin of carcass weight, total lean (total weight for trimmed hams, loins and shoulders), percent lean cuts of both live and carcass weight and loin eye area. Loin eye area was also considered as a live animal measure due to the possibility of sonaray techniques.

The statistical analyses consisted of obtaining pooled phenotypic correlations among all traits and stepwise regression using total lean and percent lean cuts of both live and carcass weight as dependent variables. The following 14 traits were considered as independent variables in the regression analysis: slaughter weight, shoulder probe, rib probe, average probe, carcass weight, carcass length, shoulder backfat, rib backfat, average backfat, loin eye area, ham-loin index, and weights of the trimmed hams, loins and shoulders.

The results of the phenotypic correlation study verified most reports in the literature that average live probe was more closely associated with most traits than was average carcass backfat. However, average carcass backfat was more closely associated with carcass weight, dressing percentage and carcass length than was average live probe. Rump probe was essentially equal to average probe in its association with all traits. For example, the correlations between rump probe and percent lean cuts of live and carcass weight were -.42 and -.52, respectively; while average probe had correlations of -.43 and -.54 with the same two traits. The correlation between rump probe and carcass backfat at the last lumbar vertebra was 0.60, while the correlation between average probe and average carcass backfat was 0.58. Shoulder and last rib probes were less closely associated with most traits than were rump or average probe. Average probe and carcass backfat were more closely correlated with percent lean cuts of carcass weight (-.54 and -.52 respectively) than percent lean cuts of live weight (-.43 and -.36 respectively) or total lean (-.26 and -.23 respectively).

Carcass length accounted for less than 12% of the variation for any trait and was essentially not associated with loin eye area. Although loin eye area has been widely used as an indicator of muscling, correlations from this study of 0.43, 0.52 and 0.57 with percent lean cuts of carcass weight, percent lean cuts of live weight and total lean, respectively, indicate that the trait should not be over emphasized simply because it is easy to measure. The three measures of lean cut yields were highly correlated with each other, but total lean was more closely associated with most than were percent lean cuts of live or carcass weight. However, probe and carcass backfat were more closely associated with percent lean cuts of carcass weight.

The stepwise regression analysis revealed that equations involving weights of the trimmed hams, loins and shoulders accounted for the most variation in yield of lean cuts. These wholesale cuts with slaughter weight accounted for 90.1% of the variation in percent lean cuts of live weight with a standard error of estimate of 0.501%. The same equation with carcass weight instead of slaughter weight accounted for 95.2% of the variation in percent lean cuts of carcass weight. The standard error of estimate was 0.413%. The best equation excluding wholesale cuts accounted for 71.6% of the variation in total lean with a standard error of estimate of 1.919 lbs. The variables involved in that equation were: carcass weight, average probe, loin eye area, average backfat and length. Loin eye area, slaughter weight and average probe accounted for 55.6% of the variation in total lean with a standard error of estimate of 2.392 lbs., which was the most precise equation using all live animal measurements. When loin eye area was used alone it accounted for 32.1% of the variation in total pounds of lean with a standard error of estimate of 2.952 pounds.

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APPENDIX

TABLE XXXI

MEANS AND STANDARD DEVIATIONS FOR ALL TRAITS

Trait		Mean	Std. Dev.
Slaughter Wt.	X_1	204.872	5.846
Shoulder Probe	X_2	1.670	0.203
Rib Probe	X_3	1.126	0.154
Average Probe	X_4	1.306	0.143
Carcass Wt.	X_5	147.763	4.891
Length	X_6	29.437	0.634
1st Rib B.F.	X_7	1.618	0.172
Last Rib B.F.	X_8	1.072	0.151
Average B.F.	X_9	1.240	0.126
Loin Eye Area	X_{10}	4.812	0.530
Wt. of Ham	X_{11}	31.686	1.680
Wt. of Loin	X_{12}	27.334	1.549
Wt. of Shoulder	X_{13}	24.226	1.347
Ham-Loin Index	X_{14}	102.805	10.931
Percent Ham & Loin (C.Wt.)	X_{15}	39.909	1.510
Rump Probe	X_{16}	1.114	0.135
Dressing Percent	X_{17}	71.967	1.543
Last Lumbar B.F.	X_{18}	1.031	0.147
Percent Lean Cuts (L.Wt.)	Y_1	40.231	1.604
Percent Lean Cuts (C.Wt.)	Y_2	56.362	1.903
Total Lean	Y_3	83.190	3.633

TABLE XXXII

POOLED PHENOTYPIC CORRELATIONS FOR ALL TRAITS*

		X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	X_{21}
Slaughter Wt.	(X_1)	1.00																				
Shoulder Probe	(X_2)	.19	1.00																			
Rib Probe	(X_3)	.19	.56	1.00																		
Rump Probe	(X_4)	.21	.58	.78	1.00																	
Average Probe	(X_5)	.22	.85	.86	.86	1.00																
Carcass Wt.	(X_6)	.74	.14	.22	.20	.21	1.00															
Dressing %	(X_7)	-.09	-.01	.09	.04	.04	.55	1.00														
Length	(X_8)	.21	-.21	-.20	-.25	-.24	.19	.01	1.00													
1st Rib B.F.	(X_9)	.11	.31	.27	.34	.34	.14	.09	-.18	1.00												
Last Rib B.F.	(X_{10})	.17	.42	.51	.50	.53	.23	.13	-.30	.42	1.00											
Last Lumbar B.F.	(X_{11})	.15	.43	.49	.60	.56	.19	.11	-.25	.40	.55	1.00										
Average B.F.	(X_{12})	.17	.48	.51	.58	.58	.22	.13	-.30	.78	.80	.80	1.00									
LEA	(X_{13})	.16	-.12	-.20	-.18	-.18	.32	.28	-.00	-.06	-.01	-.09	-.07	1.00								
Total Lean	(X_{14})	.49	-.21	-.24	-.26	-.26	.65	.36	.34	-.15	-.17	-.24	-.23	.57	1.00							
% Lean Cuts (L.Wt.)	(X_{15})	-.12	-.34	-.39	-.42	-.43	.21	.50	.21	-.23	-.30	-.36	-.36	.52	.77	1.00						
% Lean Cuts (C.Wt.)	(X_{16})	-.09	-.41	-.51	-.52	-.54	-.11	-.05	.25	-.35	-.42	-.48	-.52	.43	.68	.81	1.00					
Wt. of Ham	(X_{17})	.41	-.20	-.15	-.19	-.21	.56	.34	.25	-.14	-.10	-.18	-.17	.43	.80	.63	.50	1.00				
Wt. of Loin	(X_{18})	.40	-.11	-.18	-.19	-.17	.50	.23	.32	-.11	-.10	-.16	-.15	.49	.79	.58	.56	.48	1.00			
Wt. of Shoulder	(X_{19})	.35	-.15	-.20	-.21	-.21	.47	.28	.19	-.07	-.17	-.18	-.17	.39	.73	.57	.49	.44	.35	1.00		
Ham-Loin Index	(X_{20})	-.00	-.30	-.32	-.34	-.37	.29	.44	.11	-.19	-.16	-.25	-.25	.77	.71	.80	.65	.77	.45	.39	1.00	
% Ham & Loin (C.Wt.)	(X_{21})	-.06	-.37	-.46	-.47	-.48	-.09	-.05	.26	-.32	-.36	-.43	-.46	.42	.61	.72	.89	.56	.64	.17	.68	1.00

*$r > .12$, $P < .01$ (d.f. = 458)
$r > .09$, $P < .05$

TABLE XXXIII

PHENOTYPIC CORRELATIONS BY YEAR, SEASON AND SEX FOR ALL TRAITS WITH PERCENT LEAN CUTS OF LIVE WEIGHT

Year and Season[1]	No. B[2]	No. G[3]	Sls. Wt. B	Sls. Wt. G	Probe Shoulder B	Probe Shoulder G	Probe Rib B	Probe Rib G	Probe Rump B	Probe Rump G	Probe Avg. B	Probe Avg. G	Carcass Wt. B	Carcass Wt. G	Dressing % B	Dressing % G	Length B	Length G	Carcass Backfat 1st Rib B	Carcass Backfat 1st Rib G
69F	58		-.20		-.66		-.56		-.58		-.67		-.09		.23		.40		-.26	
68F	60		-.22		-.38		-.33		-.42		-.44		.32		.59		-.03		-.12	
68S	48		-.16		-.32		-.30		-.34		-.35		.04		.41		.13		-.56	
67F	30	20	.22	-.53	-.04	-.16	-.42	-.40	-.47	-.38	-.26	-.36	.35	-.24	.29	.33	.23	.11	-.23	-.09
67S	60		.08		-.09		-.20		-.23		-.19		.37		.66		-.02		.05	
66F	28	33	.12	-.02	-.12	-.49	-.43	-.62	-.32	-.63	-.32	-.61	.56	.10	.57	.21	.20	.38	.19	-.41
66S	24	27	-.37	-.26	-.01	-.22	-.21	-.32	-.45	-.48	-.26	-.39	.32	.38	.69	.77	.22	.60	-.14	-.45
65F		24		-.42		-.50		-.68		-.68		-.75		.20		.79		.07		.04
65S	17	16	.18	.07	-.37	-.10	-.25	.02	.04	-.33	-.25	-.13	.62	.31	.74	.38	.06	.24	-.41	-.21
64F	17	14	-.46	.06	-.57	-.69	-.47	-.71	-.55	-.62	-.53	-.65	-.22	.64	.32	.46	.63	.27	-.80	-.29
Pooled	342	134	-.10	-.21	-.52	-.42	-.35	-.49	-.38	-.54	-.39	-.55	.21	.19	.50	.50	.18	.28	-.23	-.34
Overall Pooled	476		-.12		-.34		-.39		-.42		-.43		.21		.50		.21		-.23	

Year and Season[1]	Carcass Backfat Last Rib B	Last Rib G	Last Lumbar B	Last Lumbar G	Avg. B	Avg. G	LEA B	LEA G	Total Lean B	Total Lean G	% Lean Cuts (C.W.) B	% Lean Cuts (C.W.) G	Weight of Ham B	Ham G	Loin B	Loin G	Shoulder B	Shoulder G	Ham-Loin Index B	Ham-Loin Index G	% Ham & Loin (C.W.) B	% Ham & Loin (C.W.) G
69F	-.35		-.49		-.44		.35		.75		.95		.76		.64		.47		.88		.90	
68F	-.31		.06		-.14		.63		.75		.68		.68		.49		.37		.77		.62	
68S	-.37		-.48		-.59		.36		.50		.81		.34		.44		.44		.68		.72	
67F	-.21	-.22	-.30	-.19	-.30	-.19	.33	.27	.79	.48	.65	.69	.76	.56	.44	.30	.39	-.07	.71	.75	.62	.75
67S	-.11		-.13		-.08		.57		.80		.81		.72		.56		.66		.81		.67	
66F	-.04	-.42	-.36	-.51	-.09	-.55	.57	.65	.90	.78	.72	.87	.77	.67	.77	.53	.72	.59	.89	.86	.68	.81
66S	-.20	-.53	-.28	-.66	-.25	-.68	.41	.43	.82	.86	.77	.80	.58	.53	.44	.63	.63	.82	.72	.74	.44	.58
65F		-.35		-.53		-.26		.53		.83		.89		.67		.60		.83		.88		.83
65S	-.64	-.28	-.25	-.30	-.65	-.31	.70	.59	.79	.79	.69	.62	.75	.68	.78	.47	.64	.85	.86	.86	.73	.47
64F	-.65	.10	-.67	-.68	-.86	-.39	.66	.80	.90	.98	.96	.98	.52	.28	.82	.91	.78	.86	.79	.92	.74	.98
Pooled	-.30	-.28	-.31	-.49	-.35	-.40	.51	.54	.75	.82	.80	.86	.66	.54	.57	.61	.53	.70	.79	.63	.71	.76
Overall Pooled	-.30		-.36		-.36		.52		.77		.81		.63		.58		.57		.80		.72	

[1] F = Fall
S = Spring

[2] B = Barrow

[3] G = Gilt

TABLE XXXIV

PHENOTYPIC CORRELATIONS BY YEAR, SEASON AND SEX FOR ALL TRAITS WITH PERCENT LEAN CUTS OF CARCASS WEIGHT

Year and Season[1]	No. B[2]	No. G[3]	Sla. Wt. B	Sla. Wt. G	Probe Shoulder B	Probe Shoulder G	Probe Rib B	Probe Rib G	Probe Rump B	Probe Rump G	Probe Avg. B	Probe Avg. G	Carcass Wt. B	Carcass Wt. G	Dressing % B	Dressing % G	Length B	Length G
69F	58		-.20		-.65		-.63		-.62		-.71		-.21		-.07		.37	
68F	60		.04		-.33		-.48		-.44		-.47		-.13		-.18		.06	
68S	48		.05		-.42		-.30		-.40		-.62		-.03		-.17		.14	
67F	30	20	-.03	-.54	-.20	-.37	-.51	-.45	-.49	-.55	-.40	-.31	-.22	-.62	-.33	-.29	.28	.15
67S	60		.07		-.13		-.40		-.37		-.32		.05		.16		.09	
66F	28	33	.25	-.10	-.43	-.43	-.59	-.57	-.54	-.66	-.59	-.60	.01	-.23	-.17	-.30	.27	.34
66S	24	27	-.29	-.43	-.26	-.17	-.56	-.36	-.66	-.55	-.58	-.41	-.18	-.12	.08	.23	.33	.53
65F		26		-.20		-.54		-.65		-.65		-.72		.22		.33		.03
65S	17	16	.21	-.01	-.65	-.26	-.75	-.62	-.38	-.66	-.67	-.63	.33	-.36	.28	-.49	-.01	.45
64F	17	14	-.41	.02	-.48	-.65	-.42	-.68	-.51	-.61	-.48	-.67	-.41	.60	-.02	.32	.63	.28
Pooled	342	136	-.05	-.20	-.60	-.44	-.49	-.56	-.49	-.61	-.51	-.60	-.10	-.13	-.06	-.02	.24	.29
Overall Pooled	476		-.09		-.41		-.51		-.52		-.54		-.11		-.05		.25	

Year and Season[1]	Carcass Backfat 1st Rib B	Carcass Backfat 1st Rib G	Carcass Backfat Last Rib B	Carcass Backfat Last Rib G	Carcass Backfat Last Lumbar B	Carcass Backfat Last Lumbar G	Carcass Backfat Avg. B	Carcass Backfat Avg. G	LEA B	LEA G	Total Lean B	Total Lean G	% Lean Cuts (C.W.) B	% Lean Cuts (C.W.) G	Weight of Ham B	Weight of Ham G	Weight of Loin B	Weight of Loin G	Weight of Shoulder B	Weight of Shoulder G	Ham-Loin Index B	Ham-Loin Index G	% Ham & Loin (C.W.) B	% Ham & Loin (C.W.) G
69F	-.30		-.41		-.53		-.50		.29		.70		.95		.73		.60		.43		.84		.94	
68F	-.25		-.49		-.25		-.45		.34		.63		.68		.48		.56		.24		.40		.87	
68S	-.57		-.40		-.53		-.62		.38		.56		.81		.32		.52		.54		.50		.86	
67F	-.50	-.25	-.49	-.52	-.46	-.40	-.59	-.43	.65	.52	.57	.54	.65	.69	.44	.32	.44	.30	.26	-.03	.70	.70	.88	.94
67S	-.25		-.39		-.28		-.37		.46		.71		.81		.56		.56		.58		.65		.83	
66F	-.10	-.44	-.35	-.54	-.67	-.44	-.46	-.57	.38	.45	.72	.62	.72	.87	.55	.54	.68	.39	.55	.50	.69	.67	.95	.91
66S	-.47	-.23	-.50	-.45	-.62	-.69	-.61	-.57	.26	.30	.63	.54	.77	.80	.36	.24	.28	.58	.58	.52	.47	.49	.69	.87
65F		-.05		-.33		-.55		-.40		.59		.85		.89		.64		.67		.84		.80		.83
65S	-.26	-.25	-.61	-.71	-.48	-.72	-.73	-.66	.63	.34	.73	.46	.69	.62	.69	.52	.64	.18	.68	.46	.75	.47	.91	.92
64F	-.82	-.28	-.57	.13	-.56	-.75	-.78	-.40	.72	.77	.88	.97	.96	.98	.60	.34	.85	.91	.73	.87	.84	.89	.84	.97
Pooled	-.38	-.27	-.44	-.37	-.46	-.35	-.53	-.69	.42	.47	.67	.69	.80	.84	.53	.42	.57	.56	.46	.57	.63	.70	.88	.92
Overall Pooled	-.35		-.42		-.48		-.52		.43		.68		.81		.50		.56		.49		.65		.89	

[1] F = Fall, S = Spring

[2] B = Barrow

[3] G = Gilt

TABLE XXXV

PHENOTYPIC CORRELATIONS BY YEAR, SEASON AND SEX FOR ALL TRAITS WITH TOTAL POUNDS OF LEAN

Year and Season[1]	No. B[2]	No. G[3]	Sls. Wt. B	Sls. Wt. G	Probe Shoulder B	Probe Shoulder G	Probe Rib B	Probe Rib G	Probe Rump B	Probe Rump G	Probe Avg. B	Probe Avg. G	Carcass Wt. B	Carcass Wt. G	Dressing % B	Dressing % G	Length B	Length G
69F	58		.50		-.42		-.33		-.29		-.40		.54		.23		.43	
68F	60		.47		-.19		-.14		-.21		-.23		.69		.33		.13	
68S	48		.78		.13		.06		.06		.11		.80		-.02		.42	
67F	30	20	.65	.36	-.15	.11	-.22	-.14	-.38	-.06	-.26	-.03	.67	.55	.25	.38	.43	.11
67S	60		.53		-.04		-.21		-.15		-.13		.72		.53		.14	
66F	28	33	.54	.61	-.22	-.32	-.42	-.43	-.29	-.54	-.34	-.42	.70	.62	.43	.28	.23	.24
66S	24	27	.22	.31	.06	-.17	-.18	-.17	-.38	-.26	-.19	-.23	.67	.77	.59	.77	.33	.60
65F		24		.17		-.38		-.42		-.64		-.61		.66		.63		.16
65S	17	16	.65	.66	-.22	.06	-.22	.11	.09	-.17	-.14	.02	.88	.66	.66	.35	.43	.57
64F	17	14	-.13	.09	-.41	-.69	-.51	-.76	-.39	-.66	-.38	-.69	.06	.75	.22	.39	.76	.37
Pooled	342	134	.52	.36	-.17	-.32	-.20	-.34	-.20	-.44	-.21	-.41	.66	.62	.33	.46	.34	.53
Overall Pooled	476		.49		-.21		-.24		-.26		-.26		.65		.36		.34	

Year and Season[1]	Carcass Backfat 1st Rib B	1st Rib G	Last Rib B	Last Rib G	Last Lumbar B	Last Lumbar G	Avg. B	Avg. G	LEA B	LEA G	% Lean Cuts of Carcass Wt. B	Carcass Wt. G	Live Wt. B	Live Wt. G	Weight of Ham B	Ham G	Loin B	Loin G	Shoulder B	Shoulder G	Ham-Loin Index B	Ham-Loin Index G	% Ham & Loin (C.W.) B	% Ham & Loin (C.W.) G
69F	-.04		-.18		-.22		-.17		.91		.75		.70		.82		.87		.74		.74		.65	
68F	-.11		-.12		.01		-.08		.98		.75		.63		.81		.73		.52		.62		.58	
68S	-.30		-.02		-.19		-.21		.57		.50		.56		.84		.82		.84		.54		.50	
67F	-.28	.20	-.29	-.03	-.35	.11	-.37	.12	.43	.45	.79	.48	.57	.34	.79	.83	.67	.65	.57	.47	.58	.64	.54	.42
67S	.10		-.11		.01		.00		.54		.80		.71		.82		.78		.73		.70		.62	
66F	.10	-.18	-.12	-.15	-.38	-.40	-.16	-.30	.55	.66	.90	.78	.72	.62	.90	.83	.75	.72	.86	.77	.85	.75	.65	.56
66S	-.02	-.42	-.05	-.38	-.23	-.51	-.11	-.55	.38	.58	.82	.84	.68	.54	.71	.76	.63	.75	.67	.85	.60	.79	.30	.41
65F		.12		-.26		-.54		-.28		.61		.82		.85		.84		.87		.82		.80		.74
65S	-.41	-.37	-.51	-.27	-.06	-.16	-.53	-.32	.82	.57	.79	.79	.73	.46	.94	.94	.94	.79	.84	.78	.89	.88	.78	.67
64F	-.82	-.32	-.46	.15	-.56	-.66	-.75	-.38	.67	.78	.90	.98	.88	.97	.72	.30	.94	.95	.75	.88	.82	.91	.82	.97
Pooled	-.15	-.17	-.17	-.16	-.28	-.39	-.21	-.30	.55	.61	.75	.81	.67	.69	.84	.70	.79	.80	.71	.78	.68	.79	.61	.64
Overall Pooled	-.15		-.17		-.24		-.23		.57		.77		.68		.80		.79		.73		.71		.61	

[1] F = Fall, S = Spring [2] B = Barrow [3] G = Gilt

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