ACCURACY AND REPEATABILITY OF SEVERAL SUBJECTIVE LIVE ANIMAL ESTIMATES OF BEEF CATTLE AND SWINE CARCASS DESIRABILITY

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ABSTRACT

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By Patrick D. Vitlo

This study was made to estimate the accuracy and repeatabilities of judges in estimating carcass traits. The judges estimated loin-eye area to the nearest 0.1 inch and percent preferred cuts (percent trimmed round and loin) to the nearest 0.1%. Bulls were evaluated twice by each judge, the evaluations being four days apart. All of the judges worked independently. There were 16 bulls in 1963 and and 27 in 1964. The only prior information known to the judges were the bulls live weights and loin-eye area and percent preferred averages from bulls slaughtered the previous years. Analysis of variance showed judges did not differ significantly in their estimates of loin-eye area or percent preferred cuts for either year, except for percent preferred in 1963. Simple correlations between each judge's estimates and actual values of loin-eye area for individual bulls were highly significant each year. The simple correlations for the judges between actual and estimated percent preferred cuts were quite variable. In 1964 all but one judge showed a negative, non-significant correlation, one judge showing a positive highly significant correlation. In 1963 all judges showed non-significant correlations, some positive and some negative. The repeatability of judges in their estimates of loin-eye

area was highly significant (0.70 - 0.85) each year. The repeatability of judges in estimating percent preferred cuts was lower. Two judges in 1963 and three in 1964 had highly significant repeatability estimates ranging from 0.61 to 0.85. This study indicated that judges were more accurate in estimating loin-eye area than percent preferred cuts. The loin-eye area estimates were also more highly repeatable.

A similar study was carried out with swine. Here four judges estimated backfat thickness, length, and percent ham to the nearest 0.1 unit. There were two replications on the live animal and one estimate on the carcass. All judges worked independently and knew nothing about the background of the swine involved. Analysis of variance showed the major sources of variation in backfat thickness estimates to be due to the individual pigs, the judges, and the interaction between the two. The same was true for estimates of percent ham, whereas variation in estimates of length could be accounted for by the pigs and the judges but there were no interaction effects. This indicates that the judges essentially ranked the pigs similarly.

Judges did poorest in estimating backfat thickness in the live animal but were more consistent in these estimates as they moved from the live animal to the carcass. Backfat thickness was more accurately evaluated in the carcass, however the reverse was true in estimating percent ham. Estimates of length were equally accurate in the carcass and live animal. On the live animal, judges were most accurate in predicting length and were least accurate in predicting backfat thickness. Repeatability of live estimates was quite high for all judges, save judge D, and ranged from 0.10 to 0.96 with a mean value of 0.62.

Rank correlation was calculated between live placings and carcass placings. It was found that judges were better able to place light-weight swine than heavy-weight swine but in neither case were the correlations significant. In fact the correlations (-.02 and 0.48) indicated that judges were not able to rank the live pigs on carcass merit.

Correlations between carcass index and the factors constituting the index were generally found to be moderately high (0.80) with meat quality playing essentially no role. Percent ham was by far the most important single factor determining carcass merit, followed by loin-eye area. Standard partial regression coefficients of index on index factors suggested that each factor did not contribute its allotted share of the variation to the overall index.

Simple correlation coefficients between firmness of the loin-eye and loin-eye area, backfat thickness, and length indicated that loin-eye area was the most highly related of the three to the firmness, the correlation being -.44.

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INTRODUCTION

For many years the livestock producer has been selecting his breeding stock on a system that requires a subjective live animal score. Although this score is relatively easily obtained, once the stockman has had ample experience in the field of evaluation, there is still some doubt as to the degree of the correlation of this score with actual carcass values on an individual animal basis. In the past it has seemed that at best these predictions have fallen short of having a high correlation with the carcass values.

There is much research in this field concerning the use of live animal measures in predicting carcass value, but these measurements too have had highly questionable accuracy. Measures which have been used are length and width of round, loin,rib, and/or rump, creatine determinations, radioisotope readings and length of sound waves. However it is interesting to note that none of these measures thus far has shown to be any more reliable than has visual appraisal.

For the producer of superior livestock to improve his animals by selection it is necessary that he base his selection on those traits that seem to be at least moderately heritable (0.30 or more). Only through the selection for these traits can the stockman make major improvements in the genetic composition of his livestock.

Arthaud et al. (1964) reported several heritability estimates for beef carcass traits as follows; plumpness of round and fullness of loin, 0.42; loin-eye area, 0.52; and live grade, 0.43. There have also been many heritability estimates of carcass traits in swine. Carroll et al. (1962) have presented average estimates of several workers for heritabilities of carcass traits in swine. These estimates include the following: carcass length 0.59, loin-eye area 0.48, backfat thickness 0.49, and percent ham 0.58.

The past research indicates that most of the carcass characteristics on which breeders have based their swine selection seem to be quite highly heritable.

The primary objective of this research is to estimate the accuracy and repeatability with which carcass traits can be evaluated in the live animal. In conjunction with this, a study was initiated to evaluate the accuracy of predicting percent ham, average backfat thickness, and length from swine carcass evaluation.

Since the overall value of the carcass is the most important factor in determining an animals merit, a study was carried out to determine the correlation of live placing with carcass placing. An overall carcass score or index value, based on several factors, was determined for each swine carcass. The factors included were carcass length, average backfat thickness, percent ham, loin-eye area at the tenth rib and quality. The quality grade consisted of a composite of three factors, color, firmness, and marbling, all of which recieved equal emphasis.

To determine whether the official carcass measures actually accounted for the amount of emphasis each was supposed to contribute to the overall index value, a standard partial regression analysis was utilized. Carcass score was based on 100 points. Five variables, each accounting for a certain percentage of the overall value, were used in this study. Percent ham along with average backfat thickness and loin-eye area were each allotted a maximum value of 25 points. Length contributed 10 points and overall quality 15 points.

Data from 87 barrows entered in the 1965 Spring Barrow Show were analyzed for evaluating the relationships between firmness of loin-eye and length, average backfat thickness and loin-eye area.

LITERATURE REVIEW

Subjective evaluation of livestock has been used for many years in the selection of livestock and most likely will be used for many years yet to come. However it is dubious that the experienced livestock judge is effective in detecting real differences in carcass characteristics from live animal appraisal. Variation in the evaluation by judges is quite common since quantitative trait predictions are based on some qualitative measure such as score.

Gregory et al. (1962) concluded that experienced judges were reasonably accurate in predicting the means of groups of steers for several traits including, carcass weight (given live weight), fat thickness, loin-eye area, percent kidney fat, cutability, and grade, providing the judges had some previous knowledge of the feeding program.

Simple correlations between estimated and actual carcass weights were quite high for all judges (0.97 to 0.98) while the correlation between the estimated and the actual percent kidney knob were less for individual steers (-.01 to -.16). This seems to indicate that the graders could accurately rank live cattle on the basis of carcass weight providing they were given the live weight, but were unable to rank the steers on the basis of percent kidney knob.

Simple correlations between the estimated and the actual fat thickness at the twelth rib were in the range of 0.3 to 0.5. Similar results were obtained for live cutability estimates and estimated cutability from carcass measures.

The preceding research indicated that although the judges were quite accurate in grading the groups of cattle they were rather poor in their estimates of carcass grade on individual steers with correlations ranging from 0.12 to 0.18.

Correlations between estimated cutability and actual cutability using the average estimates of the three graders, involving two or more traits that are used as indicators of cutability, are of the same magnitude as those involved in estimating the cutability by individual graders (0.37 to 0.51). Simple correlations between cutability and the individual estimates of those traits involved in cutability were in the range of -.17 to -.42. The correlations were negative (-.25) between estimates of loin-eye area and cutability because of the relatively high positive correlation that exists between carcass weight and loin-eye area. When carcass weight was added to loin-eye area in the multiple correlation equation a positive multiple correlation was obtained (0.49) between loin-eye area + carcass weight and cutability. Thus, some additional precision was gained by increasing the number of independent variables evaluated, however the contribution of percent kidney knob was negligible. It was further found that conformation grades based on cutability estimates were more accurately predicted than were carcass quality grades, the correlation between estimated cutability live and actual cutability was 0.52 as opposed to 0.29 between estimated carcass grade and actual carcass quality grade.

Wilson _et al_. (1964) found the correlation between live estimates of fat thickness and a single fat thickness measurement to be 0.51. This suggests that overall fatness of the beef carcass may be predicted with reasonable accuracy. The correlation between the actual cutability and the live estimates of cutability averaged 0.44. Based on a prediction equation (live weight and an estimate of loin-eye area, fat thickness, and percent kidney knob) a multiple correlation coefficient of 0.51 was obtained between carcass cutability and the predicted cutability on a live animal basis. Estimated fat thickness alone was found to be able to account for 21 percent of the variation in carcass cutability which suggests that fat thickness plays a relatively important role in the determination of cutability. Hence, it can be concluded from this study that a single estimate of fat thickness is practically as good an indicator of cutability as the equation containing the four independent variables.

In a study involving the evaluation of yearling steers by three judges Gregory et al. (1964) found that judges were able to estimate group means for cutability and carcass grade quite accurately. However visual appraisal was not nearly an accurate enough indicator of the actual carcass traits of individual steers to be of significant value. These results would be expected since some of the errors made in the estimates of any individual steers would tend to cancel each other, making the estimated group means coincide more closely with the actual group means.

They also found that the live estimates were more accurate than were several carcass measurements in estimating cutability. Group means from live estimates of cutability were closer to the actual group values than were the means that were obtained from the regression equation according to Murphey et al. (1960)[1] using several cooler measurements and estimates.

Kidwell (1955) found a highly significant correlation between live grade and carcass grade (0.60). Cook (1951) and Yao (1953) reported values of 0.69 and 0.71 respectively, which were quite close to those reported by Kidwell.

Wilson et al. (1964) found a simple correlation coefficient of 0.25 between the estimated grade and the actual quality grade. It was felt that the prediction of percent yield was more accurate than was the prediction of overall quality grade (0.44 versus 0.25). Quality grade, being composed of both a conformation grade and a meat quality grade, would seem to be more difficult to estimate since quality has been found to be quite difficult to estimate on the live animal.

Wheat and Holland (1960) in a study involving the estimation of carcass grades, under differing conditions, obtained correlations of 0.56, 0.38, and 0.22 between the estimated carcass grade and conformation, quality grade before ribbing, and quality grade after ribbing, respectively. There were no differences in the ability of the 12 judges.

Good et al. (1961) found that meat quality grade is most responsible for the error between live animal estimates and carcass estimates of overall grade. Correlations between live muscling scores and actual muscling (based on loin-eye area alone) were significant at the 0.05 level.

[1] Cutability = 52.66 - 5.33(estimated fat thickness, in.) + 0.665 (estimated L.E.A., sq. in.) - 0.0065(estimated carcass weight, lb.)

Davis *et al.* (1964) in a study comparing ultrasonic measurements and visual appraisals of total muscling in beef steers found that graders could be ranked according to their ability to assign individual steers to three different muscling groups. The muscling groups being designated as light, medium, and heavy. The three muscling groups were based solely on the mean loin-eye area[1] as the indicator of total muscling. Analysis indicated that there was a 0.99 square inch increase in loin-eye area for every 100 pounds increase in live weight and a decrease of 1.04 square inches for each 0.1 inch increase in fat thickness. Thus if the graders were able to accurately appraise the steer's live weight and fat thickness in relation to the other steers they could accurately rank the cattle into one of three muscling groups using loin-eye area as the indicator of total muscling. However current research indicates that loin-eye area is not a good indicator of total muscling in the beef steer.

Davis *et al.* (1964) using ultrasonics and other live animal estimates for lambs, showed that there was a correlation of 0.59 between live subjective estimates and actual loin-eye area. A correlation of 0.25 was found between live estimates of fat thickness and actual fat thickness. Ultrasonic estimates of fat thickness were more accurate than were subjective estimates, but the reverse was true in estimating loin-eye area.

Thus it seems that most of the research in this field indicates that carcass conformation can be more accurately evaluated on the live

[1]Adjusted Mean L.E.A. = Actual L.E.A. adjusted for live weight and fat thickness.

animal by competent judges than can the overall carcass quality grade and that fat thickness is the most important single criterion in determining carcass cutability.

Orme (1958) conducted a study to estimate the merit of several live estimates and measurements of steers for various traits. Correlations were obtained between two subjective measures of evaluation. One measure was an unadjusted live animal score which was determined by subjective evaluation of individual steers. The second measure was called an adjusted score. It was made by evaluations of each steer while his legs were obscured from view. The author was working on the premise that if the legs could not be seen the various estimates of the individual traits, as well as the overall score, would not be highly correlated between the adjusted and unadjusted evaluations. However this was not the case.

Correlation coefficients between adjusted and unadjusted scores for live animal traits were as follows; type score (0.84), estimated carcass grade (0.87), dressing percent (0.90) fat covering (0.79) and loin-eye area (0.89).

For both adjusted and unadjusted evaluations, correlations between the actual carcass grade and live animal scores were determined. The highest relationships were obtained between actual carcass grade and estimated grade, dressing percent, fat thickness, and loin-eye area.

In order to determine the utility of visual appraisal in estimating various carcass measures correlation coefficients were calculated between carcass measures and unadjusted live animal scores. Subjective live animal scores were significantly correlated with their corresponding carcass measures. It seemed quite evident that the carcass width measures were more accurately estimated from the live steer than were other carcass measures (0.53 to 0.71 versus -.32 to 0.54).

The author concluded that good agreement in score for the various factors evaluated was found between the adjusted and unadjusted methods. Also a large share of the estimated live animal traits were found to be highly related to the actual carcass grade.

Gregory et al. (1962) obtained correlation coefficients ranging from 0.04 to 0.43 between live muscling scores and specific variables in the carcass. Overall results indicated that the graders were able to account for about 20% to 25% of the variation in carcass traits based on live animal scores.

Holland and Hazel (1958) presented correlation coefficients between live animal condition scores, based on fatness alone, and percent lean cuts and percent fat cuts in swine (-.25 and 0.22 respectively). The authors felt that live evaluation scores were not highly correlated with percent lean or percent fat cuts.

Bratzler and Margerum (1953) studied the relationships between live swine scores and carcass measures. They found that judges were least accurate in their evaluation of percent preferred cuts on a live weight basis. In addition, estimates made on heavy-weight swine were less accurate than those made on lighter swine. The highest correlation coefficients were those for estimated body length and backfat. These estimates were highly significant for the light and medium-weight hogs. They concluded that visual scores for swine were not highly related with yields of fat and lean cuts.

Zoellner *et al.* (1963) found that judges varied in their subjective scores for swine. The correlation between judges for total desirability scores (0.60) was higher than the correlations between judges for individual items of meatiness (0.32) and finish (0.52).

Repeatability of live animal scores is one important phase involved in the selection of livestock. If the judge is highly repeatable in his estimates he most probably will be better able to select his livestock, as the sources of error in subjective measures will tend to decrease.

Wheat and Holland (1960) found the correlation between slaughter grades per animal by different judges to be 0.50.

Ternan *et al.* (1959) found the repeatability of conformation scores to fall between 0.50 and 0.76.

Zoellner *et al.* (1963), in a study involving two scoring systems found, by comparing the total correlations with the intra-season correlations, that judges were consistent in their scoring of swine from one season to the next. This indicates, according to the author, that the judges' picture of the ideal did not change and that one judge scored the swine the same way as did the other judges from season to season. Pooling of the scores for each pig resulted in a correlation of 0.76 between the two scoring systems used, which indicated that the pooled scores would be highly repeatable.

From this review of literature it seems, that cutability of beef cattle is more accurately estimated in the live steer, providing the live weight is known and the judges are aware of some of the managing procedures, than is carcass grade. It also seems that fat thickness is the most important single factor in determining cutability and that it is as good a predictor of cutability as any other single criterion. In fact, from work by Wilson _et al_. (1964) it appears that fat thickness alone is essentially as good an indicator of cutability as is any equation that was developed utilizing several factors. Repeatability of live estimates of carcass traits also seems to be moderately high.

The work of Gregory _et al_. (1964) points out that groups of cattle can be more accurately evaluated for cutability, loin-eye area and grade than can individual steers.

Subjective methods of live evaluation of swine do not seem to be reliable estimators of percent lean or percent fat cuts. Backfat thickness seems to be the easiest live trait to estimate in swine.

DATA

Cattle Evaluation

Cattle used in this study were yearling Hereford bulls from the research herd located at the Lake City Experiment Station. The data were obtained from 16 bulls in 1963 and 27 bulls in 1964. These bulls were part of a breeding project currently being carried out at Michigan State University and were progeny from bulls selected either on tenderness or leanness. The 1963 bulls represented four sires, two selected on tenderness and two selected on leanness. Bulls evaluated in 1964 represented five sires. Twelve were from the foundation sires and fifteen from bulls either in the tender line or leanness line.

Evaluation of the bulls was carried out two weeks prior to slaughter and each bull was appraised twice by each of four judges, the appraisals being four days apart. Bulls from both years were evaluated individually by each judge and all judges worked independently. Prior knowledge concerning the bulls was restricted to live weight, percent preferred averages and loin-eye averages of bulls from prior years.

Live estimates included percent preferred cuts, to the nearest 0.1%, and loin-eye area estimates to the nearest 0.1 square inch. Actual values for these measures were obtained on the bulls following a 48 hour chilling period. Loin-eye area at the 12th rib, for each side of the carcass, was traced on acetate paper. Two planimeter readings of loin-eye area were obtained for each side of the carcass. The average of the four readings was then used as the actual loin-eye area. Percent preferred cuts were calculated by separating the round and loin from each half of the carcass and trimming them to no more than 3/8 of an inch of fat. The percentage was then calculated as the ratio of the preferred cuts to the total carcass weight.

Swine Evaluation

Two groups of swine were used in this phase of the experiment. The swine used represented several breeds and on occasion crossbreds. Thirteen head were used initially and were obtained from swine entered in the 1964 Farmers Week Contest held at Michigan State University. The second group of swine came from entries in the 1965 Farmers Week Contest. The data from these swine were subdivided into two categories, heavy-weight barrows (215 - 235), and light-weight barrows (190 - 214). There were 14 heavy-weights and 16 light-weights.

Swine from the 1964 contest were evaluated by four experienced livestock judges, two of the judges are well known carcass judges and the remaining two are well known live animal judges. All of the judges have had prior experience in evaluating both carcasses and live animals, thus all four participated in both evaluation phases.

The swine were appraised twice by each judge prior to slaughter and the carcasses were evaluated once by each judge after a 48 hour chill. Judges did not know any of the live weights nor did they have any previous knowledge of the animals to be judged. Each judge worked independently and estimated the following characters in both live and carcass evaluation; percent ham to the nearest 0.1%, average backfat thickness to the nearest 0.1 inch, and length to the nearest 0.1 inch as measured from the first rib to the aitch bone.

The actual carcass measurements of backfat were the average of three measurements from opposite (1) the first rib, (2) the last rib, (3) the last lumbar vertabra. The length of the carcass was measured from the leading edge of the first rib to the leading edge of the aitch bone. The ham was removed from the carcass and was trimmed to 3/8 of an inch of fat. The percentage of ham was calculated as the ratio of the ham weight to the carcass weight.

Data from the 1965 Farmers Week Contest swine were analyzed to estimate the correlation between live placing in the ring and carcass placing. Two experienced swine judges ranked the live animals basing their judgements on live estimates of carcass desirability. Two main factors were considered by the judges in arriving at the final placing, overall fatness and muscling. Estimates of leanness were based on turn of the top (curvature over the loin edge), trimness of jowl, underline and shoulder, firmness at the base of the ham and overall firmness of the animal. The basis for the muscling estimates depended on width through the center of the ham, depth of ham, length of rump and ham, turn of the top, and muscle movement in the stifle region when walking. Length did not become a factor unless the estimated length fell below 29.0 inches. Two groups of swine were placed separately. The heavy-weight hogs were ranked from 1 to 14 and the light-weight hogs from 1 to 16.

Carcass placing was determined by the use of an index value based on overall carcass desirability, the maximum value being 100. The index value was determined by several factors including, percent ham, length, backfat thickness, loin-eye area and meat quality. These factors and the points assigned to them are presented in appendix table 8.

Evaluation of the Index

The third phase of this study was concerned with the evaluation of the carcass score that is currently being used at Michigan State University for placing swine carcasses entered in competition. Use of an index is valuable in determining the overall merit of swine carcasses. However it is important that the factors that contribute to the overall variation of the index are actually accounting for the amount of the variance that they were originally designed to contribute. For this reason data were collected from several sources over a period of time to try to establish what variance the individual components were actually responsible for and if this portion was the actual amount that was assigned to them in setting up the index. Thirty pigs entered in the 1965 Farmers Week Contest and thirty-three barrows entered in the Spring Barrow Show were used in this study.

Eighty-seven additional barrows entered in the Spring Barrow Show and slaughtered at Farmer Peets were used to estimate the degree of relationship between firmness of the loin-eye and length, backfat thickness, and loin-eye area.

METHODS OF ANALYSIS

All analyses, save the variance ratios, computed on the Control Data Corporation 3600 computer at Michigan State University. Correlation coefficients were used to estimate the judges' ability or accuracy.

Cattle

Simple correlation coefficients were obtained from both groups of cattle and all judges. Correlations calculated were as follows: each judge's first estimate with his second estimate (repeatability), each judge's first and second estimates with the actual carcass values, the average of each judge's first and second estimates, the average of all judges' first and second estimates with the actual carcass values, and the average of all estimates with the actual carcass values. Simple correlations were also calculated for actual loin-eye area with actual percent preferred cuts as well as for estimated loin-eye area with estimated percent preferred cuts.

Means and standard deviations for each of the judge's estimates of the cattle were calculated and compared with the actual group means and standard deviations for both years. This included each judge's mean estimates and the mean of all the judges' estimates.

Significance of simple, partial and multiple correlations as well as standard partial regression coefficients were obtained according to Snedecor (1956).

Partial correlation coefficients were computed according to the following formula supplied by Snedecor (1956).

$$r_{12\cdot 3} = \sqrt{(b'_{12\cdot 3})(b'_{21\cdot 3})}$$

A three by three completely randomized randon-effects model was used in the analysis of variance. This was performed on all of the bull data each year to test the significance of the different sources of variation. The three way interaction term was used as the denominator in the F test for testing interaction effects. The expected mean square for bulls (A) times judges (B) interaction is $\sigma^2_{ABC} + c\sigma^2_{AB}$ and the expected mean square for bulls (A) times Judges (B) times replications (C) is σ^2_{ABC} hence by using ABC interaction as the denominator in the variance ratio the only variance remaining in the AB interaction term is that which is due to $c\sigma^2_{AB}$, which is the variance component we are interested in.[1]

To obtain a variance ratio for the effects due to bulls, judges, or replications the following formula was used.

$$F'(a-1,\lambda) = \frac{MS_A}{MS_{AB} + MS_{AC} - MS_{ABC}}$$

This formula was used because no exact F test exists for testing the direct effects for a three factor model such as was employed for this problem. Thus an approximate procedure due to Satterthwaite [2] was used.

1 Guenther, Analysis of Variance. p. 130.

2 Ibid. p. 131.

Since $MS_{AB} + MS_{AC} - MS_{ABC}$ and MS_A both have the same expected values, $\sigma^2_{ABC} + c\sigma^2_{AB} + b\sigma^2_{AC}$, under the null hypothesis, if the variance ratio exceeds 1.0 the excess will be that variance due to factor A. The degrees of freedom for the denominator used were approximated by using the following formula also due to Satterthwaite.

$$\lambda = \frac{(MS_{AB} + MS_{AC} - MS_{ABC})^2}{\frac{(MS_{AB})^2}{(a-1)(b-1)} + \frac{(MS_{AC})^2}{(a-1)(c-1)} + \frac{(MS_{ABC})^2}{(a-1)(b-1)(c-1)}}$$

Swine

Simple correlations were also calculated for the judge's first and second replications of live swine estimates with the actual carcass values. Correlations between estimates made by judges from carcass observations and the actual carcass values were computed. Simple correlations were calculated between the carcass values and the averages of each judge's two live estimates and the average of eight (four judges X two replications) live estimates.

Analysis of variance was performed on the live estimates of carcass traits. The method employed for the analysis of the bull data was also used for the analysis of the swine data.

Rank correlations between carcass placing and live placing for light and heavy-weight swine was performed according to the formula as applied by Spearman[1], where d is the difference between the two ranks assigned to an individual.

$$r_s = \frac{6\Sigma d^2}{n(n^2-1)}$$

[1] Snedecor, G. W., Statistical Methods. p.

The value of the swine carcass index was evaluated on data collected from three different sources. To evaluate whether each component of the index was contributing its expected portion, based on the amount of points assigned to it, of the total index, standard partial regression coefficients were calculated.

Using some of the data from the above experiment the individual relationships between firmness of the loin-eye with carcass length, backfat thickness, and loin-eye area were estimated by the use of standard partial regression coefficients. Simple correlations were also calculated. Multiple correlations were also employed for this phase of the analysis. The standard partial regression coefficients are presented as path coefficients.

RESULTS AND DISCUSSION

The results of the various phases of this experiment may most advantageously be presented in tabular form accompanied with appropriate comments and discussion where nedded.

Table 1 shows the mean live estimates of loin-eye area and percent preferred cuts to be quite close to the actual mean values of the bulls reported in the carcass data. Mean loin-eye area was more accurately predicted in both years than was the mean percent preferred cuts. The reason for these results may be seen in the following table.

Table two shows that in both 1963 and 1964 the simple correlation between actual loin-eye area and actual percent preferred cuts was essentially negative or zero, whereas in both years the estimated loin-eye area and estimated percent preferred cuts were moderately correlated, with loin-eye area accounting for about 30% of the variation in percent preferred cuts. Thus it appears that the judges estimates of percent preferred cuts was based to some extent on their estimates of loin-eye area. In general those bulls with the highest estimated loin-eye area received the higher percent lean cut values when in fact this should not have been the case since actual values showed no correlation of any significance.

Table 3 indicates that all judges had some competence in predicting the loin-eye area of bulls in both years. However, in predicting the percent preferred cuts all judges, save judge 4 in 1964, could not accurately predict percent preferred cuts in either year.

Table 1. Means and Standard Deviations for Actual and Estimated Values of Loin-eye Area and Percent Preferred Cuts for Bulls.

	1963		1964	
Trait or Judge	Mean	St. Dev.	Mean	St. Dev.
Loin-eye Area				
Actual	10.01	0.78	10.06	0.58
1	10.59	0.63	10.14	0.76
2	9.46	0.98	10.13	0.94
3	10.10	0.84	9.97	1.24
4	9.98	1.00	10.17	0.80
Ave.	10.08	0.86	10.10	0.99
Percent Pref.				
Actual	38.87	1.27	39.78	1.00
1	40.18	0.57	38.58	0.92
2	38.19	1.31	38.84	1.03
3	39.05	0.79	38.83	1.01
4	39.36	0.87	38.63	0.98
Ave.	39.20	0.88	38.72	0.99

Table 2. Simple Correlation Coefficients Between Actual and Estimated Carcass Traits.

	1963	1964
Actual L.E.A. with Actual Percent Preferred	0.13	-.21
Estim. L.E.A. with Estim. Percent Preferred.	0.52*	0.67**

Table 2 may help to explain why estimates of loin-eye area were more accurate than were estimates of percent preferred cuts. Since percent preferred estimates were based to some extent on estimates of loin-eye area and since the judges overestimated this relationship, correlations between estimated and actual percent preferred cuts were lower than the correlations between actual and estimated loin-eye area.

Table 3 also shows that judge 4 apparently readjusted his sights in 1964 as only he was able to register a highly significant correlation between estimated and actual percent preferred cuts.

Table 4 shows the standard partial regressions of actual loin-eye area on estimated loin-eye area with carcass weight held constant. Also included in this table are the simple correlations between estimated and actual loin-eye areas. The correlations indicate that the judges were able to predict, with reasonable accuracy, the loin-eye areas of the bulls. However it seems that the judge's estimates were based to a large extent on weight as the regressions of actual on estimated loin-eye areas, with carcass weight held constant, were of small magnitude. Thus, with the exception of judge 3 in 1963, judges were unable to predict the loin-eye area with any significant degree of accuracy when the carcass weight was held constant.

Figure 1 shows the path coefficient diagram of the relationship of actual loin-eye area with carcass weight and estimated loin-eye area. The numerical values are for judge 4 in 1964. The reason for the -.88 may best be explained by remembering that the numerator of the standard partial regression (path coefficient) is equal to the correlation between the estimated and actual loin-eye area minus the

Table 3. Mean Correlation Coefficients of Live Bulls Estimates with Actual Carcass Values.

Trait or Judge	1963 Mean[a]	1964 Mean[a]
Loin-eye Area		
1	0.45	0.58**
2	0.70**	0.50**
3	0.75**	0.53**
4	0.64**	0.45**
Ave.[b]	0.67**	0.53**
Percent Pref.		
1	-.09	-.25
2	-.12	-.23
3	-.05	-.33
4	0.09	0.52**
Ave.[b]	-.09	-.09

[a] Mean = Average of each judge's two replications.
[b] Ave. = Arithmetic average of the four judges.

Table 4. Simple Correlations Between Estimated and Actual Loin-eye Area and Standard Partial Regression Coefficients Between Estimated and Actual Loin-eye Area, Carcass Wt. held Const.

	1963		1964	
Rep. 1	b'	r	b'	r
Judge 1	0.03	0.40	0.05	0.52**
2	0.38	0.52*	0.03	0.55**
3	0.65*	0.71**	0.10	0.57**
4	0.63	0.60*	-.03	0.55**
Rep. 2				
Judge 1	0.10	0.44	0.34	0.60**
2	0.42	0.51*	-.43	0.39**
3	0.68*	0.61*	-.30	0.48**
4	0.62	0.59	-.88**	0.34

Table 5. Simple Correlations Between Estimated and Actual Percent Preferred and Standard Partial Regression Coefficients Between Estimated and Actual Percent Preferred, Carcass Wt. held Const.

	1963		1964	
Rep. 1	b'	r	b'	r
Judge 1	-.06	-.14	-.05	-.19
2	0.21	-.04	0.13	-.29
3	0.42	0.05	-.08	-.38
4	0.10	0.07	0.46	0.47*
Rep. 2				
Judge 1	0.17	0.12	-.17	-.22
2	-.08	-.24	0.35	-.13
3	0.32	-.14	0.32	-.26
4	0.22	0.11	0.40	0.47*

Figure 1. Path Coefficient Diagram Showing the Relationships Between Carcass Wt., Actual Loin-eye Area and Est. Loin-eye Area for Judge 4 (1964).

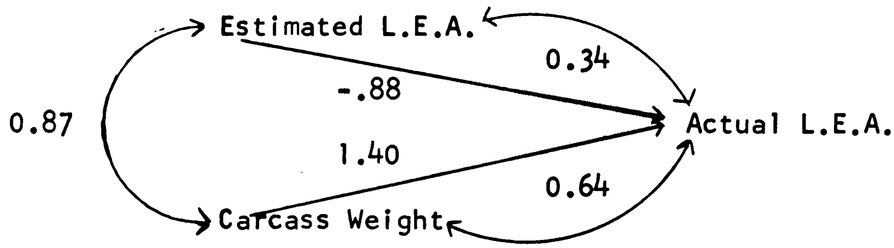

Table 6. Repeatability Estimates Between Judges Replications for 1963 and 1964.

		1963	1964
Est. Loin-eye Area (1) with Est. Loin-eye Area (2)			
	Judge 1	0.76**	0.86**
	2	0.60*	0.77**
	3	0.55*	0.90**
	4	0.75**	0.83**
	Ave.	0.66**	0.83**
Est. Percent Pref. (1) with Est. Percent Pref. (2)			
	Judge 1	-.36	0.33
	2	0.66**	0.71**
	3	0.68**	0.80**
	4	0.55*	0.61**
	Ave.	0.38	0.61**

product of the correlations of estimated loin-eye area with carcass weight and actual loin-eye area with carcass weight. Thus in this case, the correlation between the estimated and the actual loin-eye area would have had to exceed 0.56 (product of 0.64 X 0.87) in order for the standard partial regression of actual on estimated loin-eye area to be positive. Since the correlation was only 0.34 the standard partial regression coefficient was negative.

The relationships between estimated and actual percent preferred cuts are presented in table 5. It seems quite obvious that percent preferred cuts were more difficult to estimate on live bulls than was loin-eye area. Except for judge 4 in 1964, all simple correlations and standard partial regressions were non-significant, some were even negative. Comparing the correlations to the regressions however indicates that some of the judges were more accurate in their estimates when carcass weight was held constant.

Considering both tables 4 and 5 it can be postulated that estimates of carcass weight played a double role in affecting those estimates of loin-eye area and percent preferred cuts. From past experiance the judges realized that carcass weight was positively correlated with loin-eye area. Therefore when the affects of carcass weight were removed statistically, a major portion of the correlation between it and loin-eye area was also removed. Hence the correlations between estimated and actual loin-eye area were substantially reduced. Since the judges initially overestimated the relationship between carcass weight and loin-eye area some of the correlations dropped to the negative side.

The fact that the judges expected a moderately high positive correlation between loin-eye area and percent preferred cuts, in addition to the positive correlation between loin-eye area and carcass weight, caused the estimates of the percent preferred cuts to be positively correlated with the carcass weight. The estimates of percent preferred cuts was then interdependent on carcass weight through its relationship with the estimated loin-eye areas of the bulls. In reality the relationship between the actual percent preferred cuts and the actual carcass weight was negative rather than positive. Thus removing the effect of carcass weight increased the relationship between the estimated and the actual percent preferred cuts, thereby causing the correlation to be positive rather than negative.

Table 6 indicates that the judges were highly repeatable in their estimates of loin-eye area and most judges were also highly repeatable in estimating percent preferred cuts.

Analysis of variance (tables 7 and 8) showed that in 1963 and 1964 there was a highly significant difference between bulls for estimated loin-eye area. In 1963, differences in loin-eye area estimates made by judges were also highly significant but in 1964 this was not the case. Apparently by 1964 all the judges had readjusted their sights in the loin-eye area prediction and the average estimate of all of the bulls mean loin-eye area for each judge were in closer agreement. Although in 1963 there was a significant difference between the average of all judges' estimates of each bull and also between the average estimate of each judge's prediction on all bulls, there were no significant differences due to the interaction between bulls and judges. Thus the

Table 7. Analysis of Variance for Loin-eye Area (1963).

Source	D.F.	Mean Square	F
Bulls	15	3.24	7.57**
Judges	2	3.64	32.50**
Bulls X Judges	30	.24	1.67
Replications	1	.01	.07
Bulls X Replications	15	.36	2.51
Judges X Replications	2	.02	.14
Bulls X Judges X Reps.	30	.14	
Total (after the mean)	95		

Table 8. Analysis of Variance for Loin-eye Area (1964).

Source	D.F.	Mean Square	F
Bulls	26	6.45	14.70**
Judges	3	.47	.54
Bulls X Judges	78	.27	2.11**
Replications	1	.13	.14
Bulls X Replications	26	.30	2.32**
Judges X Replications	3	.74	5.75**
Bulls X Judges X Reps.	78	.13	
Total (after the mean)	215		

judges tended to rank the bulls in the same order but the estimates of the means for the bulls was different among judges. There was a significant interaction between bulls and judges in 1964. Thus in this year the judges tended to rank the bulls in a different order on loin-eye area. In 1964 the estimates of loin-eye area for each bull was different from one replication to the next, also the judges average estimates of the mean loin-eye area were not in the same order for the two replications.

Differences among judges was the only significant source of variance in estimated percent preferred cuts in 1963. That is, there was a significant difference between the average estimate of each judges evaluation on all bulls. In 1964 the sources of variance in estimates of percent preferred cuts were essentially the same as for loin-eye area except the average estimates of all four judges for each bull was not significantly different from one replication to another. As can be seen in Table 9 only three judges were included in the analysis of variance. Judge two was excluded from this phase of the study because on an examination of the data it was established that he had dropped his estimates of percent preferred cuts a full five points for all bulls involved in the analysis. By doing this the judge introduced unwarranted variation into the problem. Since the primary interest was in determining which sources were contributing to the variation, his readjustment of percent preferred ctus to sub-normal level caused an unexplainable interaction effect which in turn affected the analysis. Hence his estimates were deleted from the analysis of variance.

Table 9. Analysis of Variance for Percent Preferred Cuts (1963).

Source	D.F.	Mean Square	F
Bulls	15	2.42	2.48
Judges	2	10.27	6.82*
Bulls X Judges	30	1.02	1.28
Replications	1	.04	.05
Bulls X Replications	15	.75	.94
Judges X Replications	2	1.28	1.62
Bulls X Judges X Reps.	30	.79	
Total (after the mean)	95		

Table 10. Analysis of Variance for Percent Preferred Cuts (1964).

Source	D.F.	Mean Square	F
Bulls	26	4.08	2.81**
Judges	3	.47	.06
Bulls X Judges	78	1.23	2.90**
Replications	1	1.07	.16
Bulls X Replications	26	.64	1.50
Judges X Replications	3	6.32	15.00**
Bulls X Judges X Reps.	78	.42	
Total (after the mean)	215		

Live and Carcass Evaluation in Swine

The analysis listed in table 11 shows the judges were able to estimate the average for length more accurately than for either backfat thickness or percent ham. The relative standard deviations of the judges estimates as compared to the actual standard deviations of the pigs indicate that the pigs actually varied more than the judges estimates. Carcass estimates of backfat seemed to be better indicators of actual backfat than did live estimates. However, the live estimates of percent ham were closer to the true values than were carcass estimates. The judges' live estimates of percent ham seemed to vary more than their estimates of percent ham on a carcass basis. This is shown by the relative sizes of the standard deviations.

Correlations listed in table 12 indicate that the variance of the average of all judges was associated with about 50% of the total variance in length and percent ham but only 21% of the variance in backfat. Generally speaking the judges second replication was closer to the actual value than was the first. Judge D seemed to have reset his sights considerably between replications.

Repeatability of live estimates (table 13) was high for all except judge D. This is due to the fact that he had readjusted his sights between replications. Backfat estimates tended to be more highly repeatable than were estimates of percent ham or length.

Analysis of variance for live estimates of backfat thickness indicated the major sources of variance to be the estimates among pigs, judges, and the interaction between the two sources. Thus the average of all judges estimates differed among pigs. Effects due to judges

Table 11. Means and Standard Deviations for Actual, Live Estimates and Carcass Estimates of Backfat, Length and Percent Ham for Four Judges.

Trait or Judge	Live		Carcass	
	Mean	S.D.	Mean	S.D.
Backfat				
Actual	1.35	0.24	1.35	0.24
A	1.59	0.11	1.40	0.17
B	1.42	0.22	1.45	0.07
C	1.56	0.18	1.33	0.17
D	1.42	0.09	1.36	0.16
Mean	1.50	0.15	1.38	0.14
Length				
Actual	29.6	0.99	29.6	0.99
A	29.8	0.32	29.5	0.52
B	29.2	0.59	29.4	0.43
C	29.5	0.47	29.5	0.54
D	29.9	0.43	30.0	0.54
Mean	29.6	0.45	29.6	0.51
Percent Ham				
Actual	19.7	1.48	19.7	1.48
A	20.0	1.20	19.2	1.15
B	19.1	0.80	19.0	0.39
C	19.9	1.26	19.1	0.82
D	18.3	0.47	18.8	0.67
Mean	19.3	0.93	19.0	0.76

Table 12. Simple Correlation Coefficients Between Live Estimates and Carcass Values in Swine by Judge and Replication.

Trait or Judge	Replication (1)	(2)	(1 + 2)/2
Estimated Backfat			
A	0.26	0.28	0.28
B	0.39	0.35	0.37
C	0.48	0.48	0.48
D	0.09	0.54	0.39
Mean	0.30	0.41	0.39
	Average Estimate of 8 = 0.46		
Estimated Length			
A	0.56*	0.44	0.67*
B	0.52	0.43	0.50
C	0.56*	0.74**	0.68**
D	0.06	0.59*	0.53
Mean	0.42	0.55*	0.59*
	Average Estimate of 8 = 0.70**		
Estimated Percent Ham			
A	0.49	0.50	0.52
B	0.12	0.54	0.36
C	0.79**	0.60*	0.71**
D	0.09	0.60*	0.43
Mean	0.37	0.55*	0.51
	Average Estimate of 8 = 0.71**		

Table 13. Repeatability of Live Estimates in Swine for Four Judges.

	Judges			
Trait	A	B	C	D
Est. B.F. (1) with Est. B.F. (2).	0.86**	0.96**	0.96**	0.22
Est. Lgh. (1) with Est. Lgh. (2).	0.13	0.73**	0.88**	0.10
Est. %Ham (1) with Est. %Ham (2).	0.81**	0.72**	0.87**	0.23

Table 14. Analysis of Variance for 1964 Farmers Week Live Estimates of Backfat Thickness.

Source of Variation	D.F.	Mean Square	F
Pigs	12	.135	5.4**
Judges	3	.212	10.1**
Pigs X Judges	36	.023	7.6**
Replications	1	.007	2.3
Pigs X Replications	12	.005	1.6
Judges X Replications	3	.001	0.3
Pigs X Judges X Reps.	36	.003	
Total (after the mean)	103		

Table 15. Analysis of Variance for 1964 Farmers Week Live Estimates of Percent Ham.

Source of Variation	D.F.	Mean Squares	F
Pigs	12	4.47	4.18**
Judges	3	16.74	10.40**
Pigs X Judges	36	1.11	4.26**
Replications	1	.01	.01
Pigs X Replications	12	.22	.85
Judges X Replications	3	.76	2.90
Pigs X Judges X Reps.	36	.26	
Total (after the mean)	103		

Table 16. Analysis of Variance for 1964 Farmers Week Live Estimates of Length.

Source of Variation	D.F.	Mean Square	F
Pigs	12	1.128	3.9**
Judges	3	2.967	44.3**
Pigs X Judges	36	.190	1.4
Replications	1	.005	.04
Pigs X Replications	12	.237	1.76
Judges X Replications	3	.012	.09
Pigs X Judges X Reps.	36	.135	
Total (after the mean)	103		

were also significant and this shows that the judge's average estimates of the group mean for backfat thickness were not the same. The significance of the interaction of pigs X judges suggests that the judges could not agree on a general ranking of the pigs based on the backfat thickness alone.

The analysis in table 15 indicates much the same story for percent ham estimates as table 14 did for backfat estimates, whereas table 16 indicates that the judges could agree on ranking the swine based on length alone. Though the judges ranked the pigs the same the average of all pigs from judge to judge was significantly different.

Although the judges did poorest in the live estimates of backfat thickness, they were most consistent in these estimates as they moved from the live evaluation phase of the study to the carcass evaluation phase. These results are illustrated in table 17. This table also shows that the pooled live estimates of all four judges more nearly approached the true values for all three traits than did the average estimates of any one judge with the exception of judge C on backfat thickness estimates.

The coefficients in table 18 show that the correlations between estimated backfat thickness and the other two traits were generally higher than the corresponding correlations among actual carcass traits.

The correlations between carcass estimates and actual values are shown in table 19. These correlations suggest the variance in the judges estimates are associated with about 64% of the variance in actual backfat thickness. In comparison to the live estimates reported in table 12, backfat thickness can be more accurately evaluated in the

Table 17. Simple Correlations Between Estimated Live Values and Estimated Carcass Values.

Trait	Judges A	B	C	D
Est. B.F. (1+2)/2 with Est. C. B.F.	0.55*	0.60*	0.67*	0.21
Est. Lgh. (1+2)/2 with Est. C. Lgh.	0.51	0.48	0.61*	0.48
Est. %Ham (1+2)/2 with Est. C. %Ham.	0.51	0.37	0.37	0.47

Est. B.F. (ave. of 8) with Est. C. B.F. (ave. of 4) = 0.64*

Est. Lgh. (ave. of 8) with Est. C. Lgh. (ave. of 4) = 0.63*

Est. %Ham (ave. of 8) with Est. C.%Ham. (ave. of 4) = 0.55*

Table 18. Simple Correlation Coefficients Between Carcass Traits and Between Estimates of Carcass Values.

Trait	Judges A	B	C	D
Actual Backfat with Actual Length	-.09	-.09	-.09	-.09
Estim. Backfat with Estim. Length	-.33	-.40	-.57*	-.07
Actual Backfat with Actual % Ham	-.43	-.43	-.43	-.43
Estim. Backfat with Estim. % Ham	-.73**	-.68**	-.93**	-.20

Table 19. Simple Correlation Coefficients Between Carcass Estimates and Actual Carcass Values in Swine by Judges.

Trait or Judge	Simple Correlations
Estimated Backfat	
A	0.81**
B	0.68**
C	0.66*
D	0.87**
Mean	0.75
	Average Estimate of Four Judges = 0.83**
Estimated Length	
A	0.71**
B	0.81**
C	0.50
D	0.49
Mean	0.63*
	Average Estimate of Four Judges = 0.75**
Estimated % Ham	
A	0.66*
B	0.36
C	0.67*
D	0.43
Mean	0.53
	Average Estimate of Four Judges = 0.65*

carcass than it can by subjective live animal evaluation. Subjective evaluations of both the live animal and the carcass were equally effective in evaluations of length and percent ham.

Rank Correlation and Index Evaluation

The rank correlation was calculated between live placing and carcass placing on both heavy and light-weight swine. These correlations showed that there was little if any relationship between the live placing and the carcass placing of either group of swine. The correlation between heavy-weight swine placings was -.02 and that for the light-weight swine 0.48. Although the correlation coefficient for light-weight swine was not significant, it does indicate that judges tend to be more nearly correct with regard to carcass merit in their live placings of light-weight swine than in their placings of the heavier swine.

The material in table 20 illustrates that index values placed on the swine carcasses were responsible for their placings. Since carcass placings are graduated in units of one from place to place and index values do not follow the same pattern but instead graduate quite differently and sporadically the correlation would not be expected to be perfect. In addition if two pigs were to have the same index value the tie would be broken by awarding the higher place to that pig which cut the higher percent ham. This too would tend to decrease the correlation.

The coefficients in table 20 also show that there exists quite a difference in the amount of emphasis each component part of the index

Table 20. Simple Correlation Coefficients Between Carcass Placing and Index Factors and Between Index and Index Factors, 1965 Farmers Week Swine.

Factor	Swine: Within Lights[a]	Within Heavies[b]	Overall[c]
Carcass Placing with			
Index	-.71**	-.93**	-.92**
Backfat	0.63**	0.39	0.78**
Length	0.05	-.43	-.01
Percent Ham	-.54*	-.85**	-.79**
Loin-eye Area	-.76**	0.15	-.35
Quality Points	0.08	-.16	-.16
Backfat Points	-.55*	-.50	-.69**
Length Points	-.48	-.10	-.01
% Ham Points	-.64**	-.87**	-.89**
Loin-eye Area Points	-.75**	0.07	-.42*
Index with			
Backfat	-.76**	-.61*	-.76**
Length	0.28	0.41	0.16
Percent Ham	0.50*	0.87**	0.70**
Loin-eye Area	0.60*	-.26	0.34
Quality Points	0.02	0.21	0.13
Backfat Points	0.93**	0.60*	0.83**
Length Points	0.63**	0.13	0.30
% Ham Points	0.89**	0.88**	0.83**
Loin-eye Area Points	0.85**	-.09	0.52**

a 14 D.F.
b 12 D.F.
c 28 D.F.

plays in the index values and thus in the overall carcass placing, for light-weight pigs compared to heavy-weight pigs. This indicates that variation in the factors in the two classes of swine is quite different. For example quality points played a heavier role in placing the heavy pigs than the light pigs. This suggests that quality in the heavy pigs was more variable between pigs and hence played a more important role in determining the final placing, whereas bacfat thickness seemed to assume a similar role in the placing of light-weight pigs. When the data for light and heavy-weight swine were combined, on the whole, percent ham and backfat thickness recieved more emphasis than any of the other factors. Quality and length played essentially no role.

Tables 21, 22, and 23 show the multiple correlation coefficients between the index values and between the carcass placing and the various contributing factors. In all cases the multiple correlation coefficients of the various independent factors with the dependent index values all have values which are highly significant. The same is true concerning the carcass placings and the independent factors.

The partial correlation coefficients of index with actual carcass values are not 1.0 because each unit of difference in the carcass values is not awarded 1 unit in overall index value. That is, for example, backfat thickness values of 1.37 inches and 1.40 inches both recieve the same number of backfat thickness points. However, the multiple correlation shows that the majority of the variation in index values is accounted for by the actual values of the component parts.

Table 21. Partial[a] and Multiple Correlation Coefficients for 1965 Farmers Week Heavy Weight Swine.

Variable	Partial Correlation	
Index with		
Backfat Thickness	0.61*	
Length	0.05	
Percent Ham	0.86**	
Loin-eye Area	0.45	
Quality	0.60	
		R = 0.94**
Backfat Points	1.00**	
Length Points	1.00**	
% Ham Points	1.00**	
Loin-eye Area Points	1.00**	
Quality	1.00**	
		R = 1.00**
Carcass Placing with		
Backfat Points	-.57	
Length Points	-.16	
% Ham Points	-.90**	
Loin-eye Area Points	-.66*	
Quality	-.52	
		R = 0.94**

a Partial correlations were calculated on each variable with all other variables held constant.

Carcass data from both light and heavy-weight pigs were pooled for further analysis and the partial and multiple correlations are shown in table 23. Standard partial regression coefficients were also calculated on the pooled data and are presented in tables 24 through 27. These measure the amount of emphasis that is placed on each of the factors considered in the overall evaluation of the index. Each component part should contribute its allotted share of emphasis to the overall index value. Loin-eye area was assigned a maximum point value of 25 yet, in tables 25, 26, and 27, the direct effects of loin-eye area accounted for only about 18% of the index value. Percent ham was the only variable that could consistently account for at least its allotted share of the index value on a point basis. This is shown most clearly in table 27 where percent ham points for the combined data was contributing over 55% of the emphasis in the carcass placing.

Additional information gathered during the Spring Barrow Show was analyzed in the same manner. These results are presented in tables 28 and 29. Generally speaking these tables show much the same result as the previous tables. Index values, hence carcass placings, seem to be more dependent on percent ham then on any other factor, with the direct effects of quality points contributing next to nothing in the overall ranking.

Factors Affecting the Firmness of the Loin-Eye

Simple correlations show that backfat thickness, length, and loin-eye area are all related to the firmness of the loin-eye muscle in pigs with loin-eye area displaying the most marked relationship

Table 24. Standard Partial Regression Coefficients of Index on Actual Carcass Values. 1965 Farmers Week Swine.

Variable	Std. Part. Reg. Coef. (A)	$(A)^2$
Backfat Thickness	-.43	0.19
Length	0.28	0.08
Percent Ham	0.42	0.18
Loin-eye Area	0.36	0.13
Quality	0.32	0.10
		0.68

Table 25. Standard Partial Regression Coefficients of Index on Index Point Factors. 1965 Farmers Week Swine.

Variable	Std. Part. Reg. Coef. (A)	$(A)^2$
Backfat Points	0.36	0.13
Length Points	0.22	0.05
Percent Ham Points	0.56	0.31
Loin-eye Area Points	0.29	0.09
Quality Points	0.22	0.05
		0.63

Table 26. Standard Partial Regression Coefficients of Carcass Placing on Carcass Values. 1965 Farmers Week Swine.

Variable	Std. Part. Reg. Coef. (A)	$(A)^2$
Backfat Thickness	0.39	0.15
Length	-.12	0.02
Percent Ham	-.56	0.32
Loin-eye Area	-.26	0.07
Quality	-.38	0.15
		0.71

Table 27. Standard Partial Regression Coefficients of Carcass Placing on Index Point Factors. 1965 Farmers Week Swine.

Variable	Std. Part. Reg. Coef. (A)	$(A)^2$
Backfat Points	-.13	0.02
Length Points	-.06	0.00
Percent Ham Points	-.76	0.57
Loin-eye Area Points	-.27	0.07
Quality Points	-.20	0.04
		0.70

Table 28. Standard Partial Regression Coefficients of Index on Actual Carcass Values. 1965 Spring Barrow Show.

Variable	Std. Part. Reg. Coef. (A)	$(A)^2$
Backfat Thickness	0.11	0.01
Length	-.36	0.13
Percent Ham	0.54	0.29
Loin-eye Area	0.27	0.07
Quality	0.06	0.00
		0.50

Table 29. Standard Partial Regression Coefficients of Index on Index Point Factors. 1965 Spring Barrow Show Swine.

Variable	Std. Part. Reg. Coef. (A)	$(A)^2$
Backfat Points	0.18	0.03
Length Points	0.42	0.18
Percent Ham Points	0.50	0.25
Loin-eye Area Points	0.38	0.15
Marbling Points	0.10	0.01
Color Points	0.14	0.02
Firmness Points	0.11	0.01
		0.65

Table 30. Simple Correlations Between Loin-eye Firmness and Backfat Thickness, Length and Loin-eye Area.

Variable	Firmness
Backfat Thickness	0.38**
Length	0.22*
Loin-eye Area	-.44**

which was negative (table 30). This indicates that as the area of the loin-eye increased the firmness of the muscle decreased. Correlation coefficients were calculated between firmness and backfat thickness, length, and loin-eye area. Loin-eye area and backfat thickness were the most highly related of the three, the correlations being -.44 and 0.38 respectively. Length had the least effect (0.22).

Figure 2 is a path coefficient diagram showing the effects of length, backfat thickness, and loin-eye area on firmness. Although these factors do contribute to the variance in firmness between pigs their average effects can only account for about 19% of the variation, thus about 81% of the variation is dependent on other factors.

The coefficients in table 31 show the relationship of the different factors when the other two are held constant. Loin-eye area seems to be the major contributor to the overall variance in this case as well.

Figure 2. Relationship Between Firmness of Loin-eye and Backfat Thickness, Length, and Loin-eye Area.

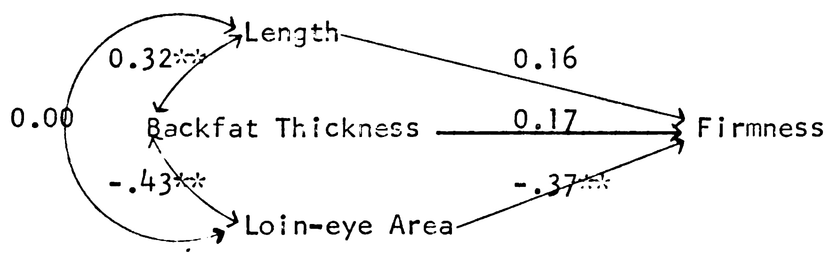

Table 31. Partial[a] and Multiple Correlation Coefficients for Backfat Thickness, Length, and Loin-eye Area with Firmness.

Variable	Partial Correlation
Firmness with	
Backfat Thickness	0.17
Length	0.17
Loin-eye Area	0.36*
	R = 0.52**

a Partial correlations were calculated on each variable with all other variables held constant.

CONCLUSION

It is apparent that live evaluation of beef cattle is a necessary part of selecting beef bulls and cows for breeding purposes. This study dealt with the accuracy and repeatability of judges in predicting the loin-eye area and percent preferred cuts of beef bulls, both of which are significantly heritable. Judges were able to accurately predict the mean loin-eye area and percent preferred cuts of groups of bulls, providing the live weight was known. On evaluating each individual bull the judges were not nearly as accurate in predicting percent preferred cuts as loin-eye area. Judges assumed that as the loin-eye area increased the percent preferred cuts also increased ($r = 0.50$), whereas in reality the carcass data indicated a negative relationship. Repeatability of loin-eye area estimates were considerably higher than were estimates of percent preferred cuts.

A similar study was performed on swine since live evaluation is also an important guide in the selection of swine breeding stock. Live evaluation of swine indicated that the four judges were least accurate in estimating the backfat thickness and most accurate in predicting length both on the individual animal and on groups as a whole. However repeatability of backfat thickness estimates was the highest ($r = 0.90$ average). Percent ham was intermediate between length and backfat thickness in accuracy of prediction.

Carcass evaluation of swine showed that judges were better able to predict backfat thickness and less able to estimate percent ham in the carcass as compared to live animal estimates. In live evaluation as compared to carcass evaluation, correlations between backfat thickness estimates were the highest. It seems that judges can quite accurately predict percent ham and length on the live animal but can not accurately predict the backfat thickness.

Rank correlation between live placing and carcass placing indicated that judges, on the whole, can not rank swine carcasses by live evaluation (r = 0.48 and -.02).

Evaluation of an index used to place swine carcasses based on backfat thickness, length, percent ham, loin-eye area, and quality of meat showed that by far the most important single factor in placing swine carcasses was percent ham (b' = 0.36). Multiple correlation coefficients between the index and the index factors were all highly significant.

Relationships between firmness of the loin-eye and loin-eye area, length, and backfat thickness indicated that loin-eye area and backfat thickness were by far the most important factors concerned with the firmness. The correlation was negative and significant (-.44) for loin-eye area and positive and significant (0.38) for backfat thickness.

As an overall conclusion one could say that judges were able to accurately predict group means for several carcass traits in both cattle and swine but were not able to estimate these parameters on an individual animal basis. Carcass evaluation of swine was about as good as was live evaluation, being more accurate in predicting backfat thickness but less accurate in predicting percent ham. The correlation between live placing and carcass placing indicated that judges were not able to accurately estimate the overall carcass merit of swine by live animal evaluation. The index used for placing swine carcasses appears to be adequate for this purpose but it is apparent that the individual factors did not all contribute their allotted share of emphasis to the overall index value on this rather superior sample of swine. Loin-eye area was significantly related to firmness of the loin-eye muscle in swine, as was backfat thickness, whereas length was not. The relationship between loin-eye area and firmness was negative and could account for about 20% of the variation in the firmness of the loin-eye. Backfat thickness could account for about 15% of the variation in the firmness.

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APPENDIX

Table 1. Judges Estimates of Loin-eye Area and Percent Preferred Cuts, Two Replications, 1963.

	Judge 1				Judge 2			
	L. E. A.		% Pref.		L. E. A.		% Pref.	
Bull	(1)[a]	(2)[a]	(1)	(2)	(1)	(2)	(1)	(2)
1	10.3	10.5	41.0	39.0	10.5	9.0	40.0	37.0
2	10.5	11.5	41.5	39.5	10.0	10.0	40.0	37.0
3	11.0	10.5	42.0	39.3	11.0	10.0	42.0	37.0
4	10.5	10.8	39.0	41.0	10.0	8.3	37.0	34.0
5	11.5	10.8	41.5	40.5	10.0	9.0	39.5	36.0
6	11.5	11.3	40.0	40.0	11.0	10.5	41.0	36.0
7	10.5	10.3	41.5	39.0	9.5	8.0	38.0	33.0
8	10.0	9.5	39.5	39.5	10.0	8.0	40.0	35.0
9	11.0	11.5	41.0	39.5	11.0	9.5	41.0	36.0
10	10.5	10.5	39.0	40.0	10.5	8.5	40.5	34.0
11	11.0	10.0	40.0	40.5	10.0	8.0	39.0	34.0
12	11.3	11.0	39.0	40.0	10.5	9.5	40.0	36.0
13	9.5	9.8	39.0	39.0	9.5	8.0	38.0	35.0
14	10.0	10.3	42.0	39.8	9.0	8.0	37.0	34.0
15	11.0	11.3	40.5	40.5	10.0	9.5	38.0	35.0
16	9.0	9.0	38.0	39.8	7.0	8.0	38.0	35.0
	Judge 3				Judge 4			
1	10.3	10.5	39.0	40.5	11.0	10.5	41.5	40.5
2	10.0	11.2	38.8	40.0	10.0	11.5	39.5	40.0
3	11.3	11.5	40.5	40.5	10.5	10.5	40.0	40.0
4	11.0	10.0	39.8	39.0	9.8	10.0	37.5	40.0
5	11.0	10.5	40.0	39.0	10.8	10.5	42.5	42.0
6	10.8	11.0	39.8	39.5	11.3	11.0	39.5	40.0
7	10.5	8.7	39.0	38.0	9.0	9.0	36.5	39.5
8	9.0	8.5	38.0	38.0	9.7	9.0	40.5	39.5
9	11.0	11.0	40.0	39.5	11.0	11.5	41.0	39.0
10	10.0	10.0	39.0	39.0	10.0	9.5	40.0	40.0
11	9.8	10.0	38.5	38.5	9.0	9.0	41.0	41.0
12	9.0	10.7	38.3	39.5	10.4	10.0	39.5	39.0
13	8.8	9.5	37.8	38.0	8.5	9.5	38.5	39.0
14	9.8	9.5	38.5	38.5	9.5	9.0	37.0	39.0
15	9.5	10.0	38.0	39.0	9.5	10.0	38.0	39.5
16	8.5	8.5	37.5	38.0	8.3	8.5	39.5	39.0

[a] Replication.

Table 2A. Judges Live Estimates of L.E.A. and Percent Preferred (1964).

	Judge 1				Judge 2			
	L.E.A.		%Pref.		L.E.A.		%Pref.	
Bull	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
1	11.5	10.8	39.0	41.0	10.9	11.0	40.0	40.0
2	9.5	9.8	37.5	40.0	11.0	10.5	40.0	39.8
3	10.8	10.0	38.8	38.0	11.0	11.0	40.1	40.0
4	9.0	9.8	37.0	38.8	9.5	9.3	38.7	38.5
5	10.8	10.0	38.8	38.5	10.0	10.0	40.7	38.0
6	11.0	10.8	37.5	39.0	11.6	11.4	40.0	39.0
7	10.2	10.5	38.5	39.5	10.0	10.5	39.0	39.0
8	10.2	10.5	38.0	41.0	11.0	9.5	38.0	37.0
9	9.5	9.0	37.5	37.5	8.9	10.0	38.0	37.0
10	10.0	9.8	38.0	38.0	9.8	8.5	37.0	37.0
11	10.0	10.0	38.0	39.0	10.5	9.0	39.0	38.0
12	9.2	9.0	36.5	36.5	9.5	9.5	38.8	38.4
13	9.0	9.0	38.8	37.5	9.0	8.8	37.5	38.0
14	10.2	10.2	38.2	38.5	9.7	8.9	39.2	38.0
15	11.0	10.5	41.0	38.2	11.0	10.0	39.0	38.0
16	9.0	9.8	37.5	38.0	10.8	10.8	38.0	39.0
17	10.8	10.5	38.8	40.0	11.5	11.8	40.2	41.0
18	11.0	11.2	39.0	40.0	11.0	11.0	40.2	39.0
19	9.0	9.2	37.0	37.0	7.9	8.5	38.0	37.5
20	10.0	10.2	39.0	38.0	9.8	9.0	39.0	38.0
21	11.5	11.5	40.5	40.0	11.0	11.0	40.0	39.0
22	9.8	10.2	37.0	38.5	10.2	9.0	38.0	37.5
23	9.0	9.2	37.0	38.5	9.4	9.1	37.0	37.5
24	11.5	11.5	40.8	39.0	11.8	12.0	41.0	40.0
25	10.0	10.2	38.5	39.0	10.9	10.0	39.7	40.0
26	9.0	9.8	38.0	38.8	9.3	8.8	40.0	38.0
27	11.0	11.0	38.8	39.8	10.9	11.0	40.0	39.0

Table 7B. Judges Live Estimates of L.E.A. and Percent Preferred (1964).

	Judge 3				Judge 4			
	L.E.A.		%Pref.		L.E.A.		%Pref.	
Bull	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
1	11.2	11.0	40.0	40.5	10.9	11.4	40.0	40.1
2	9.8	10.6	38.0	39.3	10.2	9.9	40.0	40.0
3	10.7	11.2	39.0	40.0	10.8	11.0	39.2	37.4
4	8.5	9.0	36.8	38.5	9.7	9.8	37.2	37.2
5	10.0	10.7	38.2	38.8	10.2	10.9	39.4	39.0
6	11.2	12.0	39.8	40.8	10.2	11.2	38.1	37.4
7	9.7	10.5	38.0	39.5	9.8	10.8	38.0	39.1
8	10.5	10.8	38.3	39.6	10.0	9.7	37.8	36.8
9	8.0	8.7	37.0	37.5	9.0	9.1	39.4	39.3
10	9.3	8.4	37.8	38.6	9.8	9.4	39.2	37.8
11	9.3	9.0	37.5	39.2	9.8	9.2	38.2	37.4
12	8.8	9.2	37.8	38.0	10.1	9.6	38.1	37.6
13	8.3	8.5	37.7	38.8	9.1	9.3	40.0	40.2
14	9.5	9.3	38.2	38.5	9.5	9.2	37.3	39.0
15	11.0	11.5	39.2	40.2	10.3	11.0	38.6	38.7
16	9.0	9.8	37.7	39.3	9.4	11.1	39.0	40.0
17	11.0	11.5	39.5	41.0	11.3	12.0	41.0	40.2
18	11.2	11.3	39.0	39.8	10.9	11.2	38.0	37.9
19	8.0	8.0	37.7	37.0	8.8	9.1	40.0	39.5
20	10.0	8.3	38.3	38.7	9.2	9.6	38.1	37.8
21	11.2	12.0	40.2	40.8	10.7	11.4	37.7	37.3
22	9.0	8.9	37.0	39.2	9.7	9.4	37.4	37.0
23	9.0	8.4	37.8	37.5	9.9	9.4	38.9	40.0
24	11.5	12.5	40.5	40.7	11.5	12.0	39.5	38.2
25	10.8	10.3	38.5	39.8	10.3	10.7	38.0	38.3
26	8.5	8.5	37.0	38.8	9.5	9.2	40.0	37.8
27	11.2	12.0	39.6	40.5	10.9	11.1	39.3	37.3

Table 3. Actual L.E.A. and Percent Preferred Cuts (1963 and 1964).

Bull	L.E.A.[a]	Percent Preferred[a]
1	11.0	38.8
2	11.1	39.0
3	11.3	38.7
4	9.8	40.8
5	-	-
6	10.1	36.5
7	10.5	39.5
8	9.4	41.3
9	-	-
10	10.6	39.5
11	9.8	38.9
12	9.7	39.5
13	8.8	37.5
14	9.5	38.2
15	9.3	37.6
16	9.2	38.2
1	10.8	38.9
2	10.6	40.7
3	9.8	38.9
4	9.8	39.1
5	9.1	39.2
6	10.2	39.7
7	10.0	40.1
8	9.8	39.4
9	9.3	39.4
10	9.3	38.8
11	10.2	39.8
12	10.4	38.4
13	9.9	42.2
14	10.2	39.2
15	10.1	39.7
16	9.0	40.9
17	10.0	40.3
18	10.0	38.5
19	9.2	41.1
20	10.7	39.9
21	10.9	38.5
22	10.2	40.3
23	9.8	40.8
24	11.3	39.8
25	10.0	39.2
26	9.9	42.0
27	11.0	39.3

[a] 14 bulls in 1963 and 27 bulls in 1964.

Table 4. 1964 Farmers Week Live Estimates of Backfat, Length and %Ham.

	Judge A						Judge B					
	Backfat		Length		%Ham		Backfat		Length		%Ham	
Pig	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
1	1.4	1.4	30.0	30.5	21.0	21.5	1.2	1.3	29.5	29.5	18.5	18.5
2	1.7	1.7	29.5	29.5	19.0	19.5	1.6	1.6	28.5	28.5	18.5	18.5
3	1.7	1.7	29.5	29.5	19.0	19.5	1.6	1.6	28.5	28.5	18.5	18.5
4	1.5	1.5	30.0	30.0	19.5	22.0	1.4	1.4	29.5	29.0	18.5	18.5
5	1.5	1.6	29.5	30.5	20.5	21.0	1.3	1.4	29.5	29.0	18.5	19.0
6	1.6	1.6	30.0	29.5	21.5	21.5	1.6	1.6	29.0	28.5	19.0	18.5
7	1.5	1.5	29,5	30.0	22.0	22.0	0.8	0.8	29.0	30.0	21.0	21.5
8	1.5	1.6	29.5	29.5	21.0	20.0	1.4	1.4	29.5	30.5	20.0	20.0
9	1.5	1.6	29.5	29.5	19.0	19.5	1.2	1.3	29.5	29.5	19.5	19.5
10	1.6	1.5	30.0	30.0	20.5	19.5	1.4	1.3	29.0	29.5	19.0	19.5
11	1.7	1.7	31.0	30.0	18.5	18.5	1.6	1.6	30.0	30.5	19.0	18.5
12	1.5	1.6	30.0	29.5	19.5	20.5	1.5	1.6	29.5	29.0	18.5	19.0
13	1.8	1.8	30.0	29.0	18.0	18.5	1.6	1.7	28.5	28.0	20.5	18.5
	Judge C						Judge D					
1	1.3	1.2	30.0	30.6	21.5	21.5	1.3	1.3	30.0	30.5	17.0	18.5
2	1.7	1.7	28.8	28.9	19.0	19.0	1.4	1.3	30.9	30.1	18.2	18.9
3	1.6	1.7	29.4	29.3	19.5	17.5	1.4	1.6	30.0	29.1	18.0	17.6
4	1.4	1.5	29.5	29.7	21.0	20.0	1.5	1.4	30.2	30.5	18.5	18.6
5	1.4	1.4	30.0	30.0	21.5	21.0	1.5	1.3	29.7	30.0	18.0	18.0
6	1.6	1.6	29.5	29.5	20.0	20.5	1.5	1.3	29.8	29.0	18.5	18.5
7	1.4	1.4	29.2	29.4	22.0	22.0	1.4	1.4	30.2	29.8	19.5	19.0
8	1.5	1.5	29.8	29.9	20.0	20.0	1.6	1.6	29.8	31.0	18.0	18.5
9	1.4	1.5	29.7	29.5	21.0	20.5	1.2	1.4	29.3	30.1	19.0	19.0
10	1.5	1.5	29.6	29.4	20.5	19.5	1.3	1.4	29.8	29.2	18.3	17.8
11	1.7	1.7	30.5	30.2	19.0	19.0	1.5	1.4	30.0	31.2	18.0	18.0
12	1.8	1.8	29.3	29.2	18.5	18.5	1.5	1.5	30.0	30.1	19.0	18.0
13	1.9	1.9	28.9	28.9	18.0	18.0	1.4	1.6	29.9	29.0	18.5	17.0

Table 5. Judges Estimates of Carcass Traits for 1964 Farmers Week.

Pig	B.F.	Lgh.	%Ham	B.F.	Lgh.	%Ham
	Judge A			Judge B		
1	1.2	30.5	18.0	1.5	30.0	18.5
2	1.5	30.0	19.0	1.5	29.0	19.2
3	1.4	29.0	19.5	1.6	28.5	19.0
4	1.3	29.5	19.0	1.4	29.0	19.5
5	1.5	30.0	19.0	1.4	29.5	18.5
6	1.2	30.0	21.0	1.3	29.5	19.5
7	1.1	29.5	21.5	1.4	29.0	19.0
8	1.3	29.5	19.5	1.4	29.5	19.0
9	1.6	29.0	19.6	1.5	29.5	19.5
10	1.4	29.0	18.5	1.4	29.5	18.7
11	1.5	30.0	20.0	1.5	30.0	18.5
12	1.6	29.0	18.0	1.5	29.0	19.0
13	1.6	29.0	17.5	1.4	29.5	18.5
	Judge C			Judge D		
1	1.2	29.8	18.0	1.1	30.1	18.0
2	1.5	30.0	19.0	1.4	30.0	18.0
3	1.4	28.2	19.5	1.4	29.0	19.1
4	1.4	30.1	19.0	1.3	29.9	18.0
5	1.3	29.8	20.0	1.4	30.8	18.9
6	1.1	29.5	20.0	1.2	30.7	20.0
7	1.1	28.7	20.5	1.1	29.8	19.8
8	1.1	30.0	19.5	1.3	30.1	18.8
9	1.5	29.5	19.0	1.6	29.8	19.2
10	1.3	29.9	19.0	1.4	30.2	18.4
11	1.4	29.5	19.0	1.5	31.0	18.9
12	1.5	29.3	18.5	1.6	29.8	18.9
13	1.6	29.5	17.5	1.5	29.5	18.0

Table 6. 1964 Farmers Week Pigs, Carcass Values.

Pig	Live Wt.	B.F.	Length	%Ham
1	214	1.10	32.0	20.2
2	212	1.30	29.5	19.2
3	210	1.33	28.1	20.5
4	208	1.30	29.6	20.2
5	214	1.27	29.2	19.4
6	223	.97	29.6	20.0
7	209	1.03	28.8	22.3
8	225	1.53	30.1	20.2
9	218	1.30	29.0	20.6
10	214	1.73	29.4	21.1
11	224	1.50	31.0	19.0
12	213	1.70	29.0	17.5
13	212	1.50	29.4	16.6

Table 7. Live Placing, Carcass Placing, Actual Values and Point Values, 1965 Farmers Week Swine.

L. Pl.	C. Pl.	Index	B.F.	Pts.	Lgh.	Pts.	%Ham	Pts.	L.E.A.	Pts.	Quality
Light Weights											
1	6	85	1.37	21	29.7	10	25.0	25	5.16	24	5
2	8	85	1.17	24	28.8	5	20.0	20	4.58	22	14
3	4	86	1.23	23	29.4	10	20.3	20	4.53	22	11
4	5	85	1.17	24	28.8	5	23.2	25	4.48	21	10
5	11	80	1.37	21	28.9	5	20.9	22	4.40	21	11
6	3	88	1.23	23	29.0	10	21.5	24	4.69	22	9
7	1	92	1.13	24	29.6	10	21.9	24	4.77	23	11
8	10	84	1.33	21	30.5	10	20.3	20	4.01	20	13
9	7	85	1.33	21	30.0	10	20.7	22	4.28	21	11
10	15	76	1.40	21	30.5	10	20.1	20	3.91	15	10
11	14	78	1.40	21	28.5	5	20.4	20	4.43	21	11
12	9	84	1.40	21	29.7	10	20.4	20	4.13	20	13
13	12	80	1.33	21	28.8	5	20.7	22	4.09	20	12
14	2	91	1.20	24	29.5	10	20.9	22	4.64	22	13
15	16	40	1.63	8	28.4	2	18.6	9	3.74	10	11
16	13	80	1.10	25	31.4	10	20.0	20	3.79	15	10
Heavy Weights											
1	12	67	1.40	21	29.6	10	18.6	9	4.80	23	4
2	9	69	1.43	21	28.8	5	18.4	9	4.33	21	13
3	1	91	1.30	23	30.6	10	21.1	23	4.00	20	15
4	13	66	1.37	21	30.0	10	18.5	9	3.85	15	11
5	2	84	1.37	21	30.5	10	21.1	23	4.14	20	10
6	6	73	1.50	21	30.3	10	19.9	17	3.95	15	10
7	10	68	1.57	18	29.5	10	18.9	9	4.53	22	9
8	3	78	1.43	21	31.4	10	20.3	20	4.44	21	6
9	4	77	1.53	18	29.8	10	20.9	22	3.92	15	12
10	14	60	1.67	8	30.5	10	18.2	9	4.40	21	12
11	7	71	1.53	18	30.8	10	18.1	9	4.52	22	12
12	8	69	1.53	18	29.1	10	18.1	9	4.16	20	12
13	11	68	1.57	18	29.0	10	18.0	9	4.00	20	11
14	5	74	1.60	18	29.6	10	19.4	13	4.78	23	10

Table 8. Michigan Quality Pork Score Card (Index = 100).

Loin-eye Area (25)		Percent Ham (25)	
5.25 and up	(25)	22.0 and up	(25)
5.00 - 5.24	(24)	21.5 - 21.9	(24)
4.75 - 4.99	(23)	21.0 - 21.4	(23)
4.50 - 4.74	(22)	20.5 - 20.9	(22)
4.25 - 4.49	(21)	20.0 - 20.4	(20)
4.00 - 4.24	(20)	19.5 - 19.9	(17)
3.75 - 3.99	(15)	19.0 - 19.4	(13)
3.50 - 3.74	(10)	18.0 - 18.9	(9)
3.25 - 3.49	(3)	17.0 - 17.9	(4)
3.00 - 3.24	(1)	16.0 - 16.9	(1)
2.99 & down	(0)	15.9 & down	(0)

Carcass Length (10)		B.F. Thickness (25)	
29.0 and up	(10)	up to 1.10	(25)
28.5 - 28.9	(5)	1.10 - 1.20	(24)
28.0 - 28.4	(2)	1.21 - 1.30	(23)
27.9 & down	(0)	1.31 - 1.50	(21)
		1.51 - 1.60	(18)
		1.61 - 1.70	(8)
		1.71 - 1.80	(1)
		1.81 and up	(0)

Quality

Marbling (5)		Color (5)		Structure (5)	
Mod. & up	(5)	Grayish Pink	(5)	Firm & Dry	(5)
Small	(4)	Dark or Light	(4)	Mod. Firm & Dry	(4)
Slight	(3)	Two-toned	(3)	Sl. Firm & Dry	(3)
Traces	(2)	Pale	(1)	Soft & Watery	(1)
Devoid	(0)	Very Pale	(0)	V. Soft & Watery	(0)

Table 9. Carcass Placing, Actual Carcass Values and Point Values for the 1965 Spring Barrow Show Entries Slaughtered at Michigan State University.

C. Pl.	Index	B.F.	Pts.	Lgh.	Pts.	%Ham	Pts.	L.E.A.	Pts.	Col.	Mar.	Fns.
1	92	1.13	24	30.2	10	21.3	23	4.75	23	5	3	4
2	90	1.37	23	29.8	10	21.5	24	4.31	21	5	3	4
3	89	1.20	24	29.0	10	21.8	24	4.79	23	4	1	3
4	88	1.40	21	32.3	10	22.4	25	6.65	25	5	1	1
5	86	1.17	24	31.0	10	20.9	22	4.95	23	3	3	1
6	84	1.10	25	30.5	10	21.7	24	6.28	25	0	0	0
7	83	1.33	21	32.3	10	20.3	20	5.03	24	4	1	3
8	83	1.30	23	30.0	10	21.0	23	3.88	15	5	3	4
9	82	1.40	21	30.5	10	21.8	24	5.56	25	1	0	1
10	82	1.37	21	29.0	10	21.3	23	5.69	25	1	1	1
11	82	1.47	21	30.0	10	21.1	23	4.78	23	1	1	3
12	82	1.37	23	29.8	10	19.9	17	4.86	23	5	1	3
13	80	1.17	24	30.0	10	19.6	17	4.48	21	4	1	3
14	79	0.90	25	28.2	2	21.5	24	4.52	22	4	1	1
15	79	1.47	21	29.7	10	19.2	13	5.45	25	4	3	3
16	79	1.37	21	30.5	10	19.0	13	5.11	24	4	3	4
17	78	1.27	23	28.7	5	22.3	25	5.69	25	0	0	0
18	78	1.27	23	28.7	5	20.5	22	5.41	25	1	1	1
19	78	1.33	21	31.2	10	20.9	22	4.09	20	1	1	3
20	76	1.30	23	30.0	10	20.1	20	4.95	23	0	0	0
21	75	1.37	21	32.5	10	19.4	13	4.12	20	4	3	4
22	74	1.43	21	30.2	10	19.9	17	3.98	15	5	3	3
23	73	1.53	18	29.8	10	19.7	17	4.35	21	3	1	3
24	72	1.50	21	28.6	5	20.2	20	5.18	24	1	0	1
25	70	1.50	21	31.2	10	18.6	9	4.51	22	4	3	1
26	69	1.33	21	30.8	10	19.1	13	5.64	25	0	0	0
27	67	1.43	21	30.8	10	18.2	9	4.16	20	3	3	1
28	67	1.40	21	28.8	5	19.7	17	3.87	15	5	1	3
29	65	1.33	21	29.8	10	18.6	9	4.09	20	3	1	1
30	64	1.60	18	29.6	10	18.4	9	4.73	22	3	1	1
31	54	1.50	21	32.5	10	17.4	4	3.67	10	5	1	3
32	53	1.77	1	28.5	5	19.2	13	4.59	22	5	4	3
33	28	1.73	1	30.3	10	17.0	4	3.36	3	4	3	3

Table 10. Actual Values for Backfat, Length, Loin-eye Area and Firmness. 1965 Spring Barrow Show Pigs Slaughtered at Farmer Peets.

Pig	B.F.	Lgh.	L.E.A.	Fns.	Pig	B.F.	Lgh.	L.E.A.	Fns.
1	1.13	31.3	6.31	3	45	1.13	29.7	4.30	3
2	1.27	29.8	4.48	3	46	1.40	30.5	4.08	3
3	1.13	30.0	5.91	2	47	1.50	31.5	4.12	4
4	1.20	29.5	5.09	3	48	1.50	31.7	4.72	3
5	0.97	29.5	4.92	3	49	1.40	30.0	4.18	3
6	1.03	30.5	6.16	3	50	1.57	33.0	4.85	3
7	1.30	29.4	6.21	2	51	1.30	30.7	3.75	3
8	1.27	29.0	5.30	3	52	1.43	31.1	4.05	2
9	1.30	29.0	5.48	4	53	1.43	29.9	4.30	3
10	1.23	29.5	5.80	4	54	1.37	29.6	3.95	4
11	1.20	31.4	5.64	2	55	1.47	30.5	4.48	4
12	1.30	30.7	4.90	3	56	1.70	30.1	4.03	4
13	1.37	30.5	4.10	4	57	1.37	30.3	4.51	4
14	1.13	31.0	6.85	2	58	1.50	30.5	4.57	4
15	1.43	32.0	4.68	4	59	1.30	29.8	5.00	3
16	1.30	32.5	5.15	4	60	1.33	29.0	5.41	3
17	1.13	30.2	6.00	3	61	1.47	29.0	3.71	3
18	1.37	29.6	5.68	4	62	1.30	30.4	5.02	3
19	1.13	29.8	4.10	3	63	1.30	27.5	4.38	1
20	1.33	30.0	4.56	3	64	1.17	28.6	4.72	3
21	1.30	30.4	4.05	4	65	1.43	30.0	4.05	4
22	1.27	30.5	5.23	4	66	1.23	30.8	5.15	4
23	1.07	30.6	5.60	3	67	1.13	30.5	4.95	2
24	1.03	29.5	4.92	3	68	1.13	28.5	4.14	2
25	0.97	29.7	5.33	3	69	1.13	30.0	4.21	3
26	1.17	29.8	6.95	2	70	1.27	29.9	4.56	2
27	1.20	30.5	5.20	3	71	1.27	29.2	4.02	3
28	1.07	29.7	5.26	3	72	1.20	30.0	4.75	4
29	1.23	30.0	5.66	3	73	1.07	27.3	3.67	4
30	1.20	29.0	6.56	2	74	1.43	28.7	4.62	4
31	1.13	30.0	6.35	2	75	1.20	30.2	4.85	3
32	1.43	30.1	4.50	4	76	1.23	29.0	6.43	3
33	1.27	30.8	4.85	4	77	1.57	31.7	4.43	4
34	1.23	29.5	4.05	3	78	1.43	29.5	4.04	4
35	1.07	28.8	4.48	3	79	1.27	30.1	5.35	3
36	1.07	30.0	4.71	2	80	1.27	29.7	4.23	5
37	1.03	30.0	4.92	3	81	1.27	31.2	4.37	5
38	1.27	28.1	4.46	3	82	1.10	29.8	6.13	3
39	1.20	28.8	5.57	1	83	1.30	29.0	5.43	3
40	1.60	30.4	3.77	3	84	1.23	28.2	5.75	3
41	1.30	29.5	3.95	5	85	1.10	30.5	5.75	2
42	1.50	30.1	3.61	5	86	1.17	28.6	5.38	2
43	1.27	29.9	5.45	2	87	1.20	29.0	6.41	2
44	1.30	30.0	5.50	2					