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Evaluation of a Scoring System for Meat Type Hogs

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SUMMARY

A total of 377 boars, gilts and barrows of three different breeding groups were scored for seven different traits by three judges to study a scoring system for evaluating meat type hogs. The reliability of this method and its usefulness was tested.

Although the judges differed significantly in assigning scores to the same pigs, this difference was consistent and the correlations between the scores by the judges for the same pigs were highly significant. The intra-class correlations for the seven scores by the three judges ranged from .154 to .667.

Slaughter data on 72 crossbred Landrace x Poland pigs were correlated with the various scores derived by averaging those for all three judges. In general, the correlation coefficients for the various scores were larger with the percentage of fat cuts than with the percentage of the five primal cuts. The coefficients of determination (r^2) showed that the total market score (combination of all 7 individual scores) accounted for approximately 31.58 percent of the variations in the percentage of fat cuts, but only 14.59 percent of the total variation in the percentage of the five primal cuts.

The percentages of heritability for differences in body length, finish, conformation and total market scores were 41.8, 7.3, 8.1, and 10, respectively. The low heritability of total market score suggested that the anticipated progress in successive generations would be small in spite of rigorous selection.

Significant differences between the sexes (boars barrows and gilts) indicated the possible existence of a significant role of the male hormone in the production of meat type hogs.

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J. F. Lasley, L. F. Tribble and V. Rathnasabapathy

INTRODUCTION

The changes in consumer diet, due in part to the awareness of the health aspect of obesity and also the lower price of lard as compared to prices of live hogs, have in recent years resulted in development of grade standards with a more rigid specification for the meat type of hog. Although body measurements and back fat probes are usually more accurate in predicting the market desirability of individuals than visual scores, they are often time consuming and tedious for an average breeder or farmer.

Scoring by means of visual inspection is fairly effective for characteristics that are visible during the life of the animal, such as meatiness, type and conformation. This method has been used extensively in all classes of livestock. Since scores are only qualitative, a better and more composite picture is possible when the final score for an economic characteristic is based on a number of traits in the individual, each contributing either positively or negatively toward the characteristic and also when the averages of a group of judges, usually three to five, are employed.

The major objectives of this study were (1) to evolve a scoring system that might be useful in the selection of meat type hogs to suit both market preferences and breeding purposes, (2) to test the reliability of this method as measured by the consistency in the evaluation by different judges, (3) to correlate scores in the live hog with the percentage of fat cuts and five primal cuts in the carcass and (4) to determine heritability estimates for the different traits as evaluated by scores with a view of estimating the progress that might be expected in successive generations by proper selection of breeding stock.

REVIEW OF LITERATURE

A close relationship between type score and weight at market maturity has been reported by several authors. Molln (1942) found a correlation coefficient of .49 between scores and 180-day weight while analyzing the data on 613 pigs from the 1941 spring pig crop at the Iowa Experimental Station. When the animals were scored at about 225 pounds body weight, the correlation coefficient between scores and weight was .68. The

six items making up a total score gave somewhat similar results when studied separately.

Arthaud and Dickerson (1952) observed that higher yields of lean and loin equivalent and lower yields of fat were correlated with higher live scores for body length, leg length, trimness of jowl, smoothness of shoulder, quality, breeding, market quality, and balance, but with lower scores for body width, depth, and flatness of back. Their study was made on a within-season-and-breeding-group basis. They also found that the estimation of carcass composition from live animal scores was considerably more accurate between than within strain crosses.

A close correlation of live scores for finish and length with carcass measurements and close agreement between judges in predicting the carcass value was reported by Bratzler and Margerum (1953). The judges were, however, least accurate in estimating the percentage of preferred cuts.

Heritability of conformation in pigs, as evaluated by scoring, was worked out by Stonaker and Lush (1942). They estimated that 20 percent of the variation between scores of gilts which were mated to the same boar in a Poland China herd were due to differences in the additive effects of genes. With the differences in scores being 20 percent heritable and with the parents scoring 3.55 points higher than average, they expected that the average score of the population would be increased by about .71 points per generation.

Whatley and Nelson (1942) estimated the intra-sire and intra-dam regression of offspring on dam and sire for market score at about 225 pounds body weight in a Duroc herd. The herd consisted of 193 litters of 1067 pigs from four inbred lines and crosses between the lines. Their estimates of intra-sire and intra-dam regression were + .060 and + .272, respectively. Combining the results, they estimated the heritability of the individual differences in market score as 33 percent.

On a within-strain and within-season basis, Hetzer *et al.* (1944) found the heritability of scores for type in Poland China swine to be 38 percent, against the earlier figure of 32 by Hetzer and Zeller (1943). But the heritable portion of the intra-season variance between pigs in different strains was considerably higher, 92 percent. They concluded that heritability of type was apparently high enough for progress from selection for type to be rather rapid within individual herds. However, a shift of the desired breeder type can usually be made more rapidly by selecting breeding animals from herds in which type is more extreme in the desired direction than in a breeder's own herd.

The market desirability of the pigs in Minnesota No. I and No. II

lines was considerably improved by selection of breeding stock on the basis of scores, according to Fine and Winters (1953). The average annual selection differentials in score for the two herds were .70 points and .60 points, respectively, on the basis of 9 points being a perfect score. The scores for market desirability were based on six items: (1) Vigor, health and thrift, (2) quality, (3) length of body, (4) conformation, (5) animal as a whole, and (6) grade.

The above studies indicate how scores have been employed in the past in grading market hogs and selecting breeding stock to change the type of the herd toward the desired objective. Scoring methods designed for the specific purpose of evaluating the leanness of pork in individuals are rare, however, in the literature.

MATERIALS AND METHODS

Pigs used in this series of trials were purebred Landrace, purebred Poland, Landrace x Poland and Landrace x Poland x Duroc crossbreds. They were from lines and crosses maintained by the Missouri Agricultural Experiment Station, in cooperation with the Regional Swine Breeding Laboratory, during the years of 1953 and 1954. All individuals were scored when they reached approximately 200 pounds of live body weight.

System of Scoring: Each animal was scored for seven different traits. The total score for market desirability was computed by adding the scores for all the desirable traits for leanness of pork and subtracting this total from the scores of undesirable traits. The items scored were: (1) body length, (2) meatiness, (3) quality, (4) finish, (5) type, (6) shape of back, and (7) trimness of middle. Of these, the scores for finish and shape of back were considered unfavorable.* Hence, they were subtracted from the sum of the other scores, which were taken as favorable or as indicating the meatiness of hogs in the estimation of the final market score for the individual. The scores ranged from one to nine with the latter being the maximum for a single trait. Each trait was scored by three different judges.

Description of Traits: "Body length" denotes the length of the trunk from behind the shoulders to the front of the hind legs. "Meatiness" refers to the firmness of the flesh and an overall impression of muscling, especially in the region of the hams and loins. Smooth hair, skin free from wrinkles, and a body devoid of boney projections gave high scores for "quality" of the individual. "Finish" and "shape of back" are traits that indicate the fatness of the animal and hence are considered unfavorable for meat type hogs. The former refers to the general over-all fatness and the latter to the thickness of adipose tissue in the region of

*Considered unfavorable because they indicated too much fat. It is realized, however, that not enough fat is unfavorable but this is not as much a problem as too much fat when hogs are full fed to market weights.

the back. "Type" includes a combination of characters and indicates the muscularity of the ham, shoulder, and thigh regions. "Trimness" refers to the condition of the abdominal wall, with a paunchy abdomen resulting in a low score for this trait.

Method of Slaughter and Obtaining Carcass Yields: Seventy-two hogs were scored for the seven different traits, then slaughtered in order to study the relationship between the scores and the yield of the five primal cuts and the percentage of fat.

When the hogs reached a weight of approximately 200 pounds, they were fasted for 24 hours, reweighed, and slaughtered. All animals were dressed packer style—head off, jowl and feet on, and leaf fat and kidneys in. To equalize all hogs in regard to fill at the time slaughter weights were obtained, the following procedure was used to derive a value called the "adjusted live weight." The digestive tract (including stomach, spleen, intestinal fat, small and large intestines) was removed and weighed to the nearest half pound. The digestive tract weight was subtracted from the live-hog weight. Contents of the digestive tract were removed and the tract was then reweighed. The weight of the empty tract, plus three and one-half pounds, was added to the weight of the live hog. In this manner, all animals had an equal fill.

After a 48-hour chill, each carcass was cut into standard wholesale cuts and trimmed as outlined in the *Proceedings of the 1952 Reciprocal Meat Conference.* Weights were recorded for skinned hams, picnics, Boston butts, loins, bellies, lean trim, backfat, leaf fat, fat trimmings, jowl, feet, tail and kidneys, spare ribs, and neck bones.

Two bases of gross carcass evaluation were used in this study:

1. Percentage of "adjusted live weight" in fat (back fat, leaf fat and the fat trimmings).
2. Percentage of "adjusted live weight" in five primal cuts (trimmed loins, skinned hams, bellies, picnics, and Boston butts).

Analysis of Data: The Scores for each trait and the total market score of the individuals were subjected to statistical analysis by methods described by Snedecor (1955). The repeatability of scores by the judges was estimated by the intra-class correlation, directly from the table of analysis of variance, by using the formula $r_i = \frac{Mx - M}{Mx + (k-1)M}$, where Mx and M represent the mean squares for the sub-sample means and for the individuals, respectively, and k, the number of classes (Snedecor, 1955). The intra-sire regression of the offsprings' score on the dam's score was employed to calculate the heritability estimates.

RESULTS

The averages of scores for the different traits, together with their standard deviation and the total calculated market scores for the individuals by breeds, sex and judges, appear in Tables 1 to 3. Table 1 indicates that the Landrace breed scored higher than the Polands in all the items considered favorable for meat type, namely "body length," "quality," "type" and "trimness," and the Poland breed scored higher than the L x P x D cross. The situation was completely reversed in the three breeds on qualities which were indicative of the fatness of hogs, such as "finish" and "shape of back," with the crossbred pigs scoring the highest, followed by the Polands and the Landrace. Landrace gilts averaged 22.3 ± 3.7 in the final score for market desirability, the Polands 18.7 ± 3.7 and the L x P x D crosses 17.1 ± 4.3.

Table 2 shows that the boars scored higher than the gilts in "body length," "meatiness," and "type" and the same as the gilts in "quality" and "trimness". The gilts were consistently superior to the barrows in all of the favorable traits. The rank of these three classes in average scores for undesirable traits were barrows first, gilts second and boars last. The average final scores for market desirability were: for boars, 20.8 ± 3.6; for gilts, 19.0 ± 4.0; and for barrows, 15.2 ± 3.9.

Analysis of variance of scores showed that breed and sex were significant sources of variation in all of the items included in the market score (Table 4). The three judges differed from one another significantly in assigning scores for each of the traits but seemed to agree more closely in the final total score for market desirability (Table 3). The average market scores given by the three judges on all pigs were 18.4 ± 5.5, 17.8 ± 3.8 and 18.2 ± 3.9.

Although the judges differed significantly in assigning scores for each individual trait, they looked upon the differences among individuals in a similar manner. This was evident from the highly significant intraclass correlation of the scores of the three judges (Table 5). The repeatability was the highest for the final market score. Next in order were body length (.639), type (.469), meatiness (.433), quality (.362), finish (.341), trim (.271), and shape of back (.154).

The correlation and regression coefficients for the various scores with the five primal cuts and the percentage of fat cuts are shown in Table 6. The score for quality was the only score that was not correlated significantly with the percentage of fat cuts. All other correlation coefficients were negative with the exception of those for finish and shape of back. This was not unexpected since these scores were designed to estimate the amount of fat that might be carried by the live animal. Of the seven

TABLE 1 -- AVERAGE SCORES OF DIFFERENT TRAITS IN PIGS BY BREEDS

Number of Pigs	44 Landrace		57 Poland		204 L x P x D		305 All	
	Mean ± S.D.	C.V.	Mean ± S.D.	C.V.	Mean ± S.D.	C.V.	Mean S.D.	C.V.
Body Length	7.2 + 1.0	13.9	6.1 + 0.9	14.8	6.1 + 0.9	14.8	6.3 + 1.0	15.9
Meatiness	7.7 + 0.9	11.7	6.6 + 0.9	13.6	6.3 + 1.0	15.9	6.6 + 1.1	16.7
Quality	6.4 + 1.4	21.9	6.4 + 0.8	12.5	6.2 + 0.8	12.9	6.3 + 0.9	14.3
Finish	5.5 + 0.9	16.4	6.2 + 1.0	16.1	6.7 + 1.1	16.4	6.4 + 1.1	17.2
Type	6.3 + 1.0	15.9	5.8 + 1.0	17.2	5.8 + 1.0	17.2	5.8 + 1.0	17.2
Shape of back	5.7 + 1.0	17.5	5.9 + 0.8	13.6	6.3 + 0.9	14.3	6.2 + 0.9	14.5
Trimness of Middle	5.7 + 1.0	17.5	5.9 + 0.9	15.3	5.5 + 1.1	20.0	5.6 + 1.1	19.6
Total Score	22.3 + 3.7	16.6	18.7 + 3.7	19.8	17.1 + 4.3	25.1	18.1 + 4.5	24.9

TABLE 2 -- AVERAGE SCORES FOR DIFFERENT TRAITS IN PIGS OF DIFFERENT SEXES

Number of Pigs	46 Boars		174 Gilts		85 Barrows		305 All	
Score	Mean S.D.	C.V.	Mean S.D.	C.V.	Mean S.D.	C.V.	Mean S.D.	C.V.
Body Length	6.8 + 1.0	14.7	6.3 + 1.0	15.9	5.9 + 0.9	15.3	6.3 + 1.0	15.9
Meatiness	7.3 + 1.0	13.7	6.8 + 1.0	14.7	6.0 + 1.0	16.7	6.6 + 1.1	16.7
Quality	6.4 + 1.3	20.3	6.4 + 0.8	12.5	6.1 + 0.8	13.1	6.3 + 0.9	14.3
Finish	5.7 + 0.9	15.8	6.3 + 1.1	17.5	7.0 + 1.0	14.3	6.4 + 1.1	17.2
Type	6.1 + 1.0	16.4	6.0 + 1.0	16.7	5.5 + 0.9	16.4	5.8 + 1.0	17.2
Shape of Back	5.8 + 0.9	15.5	6.0 + 0.9	15.0	6.5 + 0.9	13.8	6.2 + 0.9	14.5
Trim	5.8 + 1.0	17.2	5.8 + 1.0	17.2	5.3 + 1.1	20.8	5.6 + 1.1	19.6
Total Score	20.8 + 3.6	17.3	19.0 + 4.0	21.1	15.2 + 3.9	25.7	18.1 + 4.5	24.9

TABLE 3 -- AVERAGE SCORES FOR DIFFERENT TRAITS IN PIGS BY DIFFERENT JUDGES

	Judge I		Judge II		Judge III		All	
Body Length	6.1 + 1.0	16.4	6.2 + 1.0	16.1	6.5 + 1.0	15.4	6.3 + 1.0	15.9
Meatiness	6.7 + 1.3	19.4	6.4 + 1.0	15.6	6.7 + 0.8	11.9	6.6 + 1.1	16.7
Quality	6.3 + 1.0	15.9	6.0 + 0.7	11.7	6.6 + 0.7	10.6	6.3 + 0.9	14.3
Finish	6.0 + 1.2	20.0	6.2 + 0.9	14.5	7.0 + 1.0	14.3	6.4 + 1.1	17.2
Type	5.8 + 1.1	19.0	5.8 + 0.8	13.8	6.0 + 1.0	16.7	5.8 + 1.0	17.2
Shape of Back	5.7 + 1.0	17.5	5.9 + 0.6	10.2	6.8 + 0.8	11.8	6.2 + 0.9	14.5
Trim	5.2 + 1.2	23.1	5.6 + 0.9	16.1	6.1 + 0.9	14.8	5.6 + 1.1	19.6
Total Score	18.4 + 5.5	29.9	17.9 + 3.8	21.3	18.2 + 3.9	21.4	18.1 + 4.5	24.9

TABLE 4 -- MEAN SQUARES AND TEST OF SIGNIFICANCE IN THE ANALYSIS OF VARIANCE OF SCORES FOR THE DIFFERENT TRAITS MEAN SQUARES

Source of Variation	Between Breeds or Crosses	Between Sexes	Between Judges	Between Individuals
Degrees of freedom	2	2	2	776
MEAN SQUARES				
Body Length	59.3**	21.8**	10.7**	.8
Meatiness	76.4**	78.0**	8.6**	.7
Quality	2.4**	8.6**	86.8**	.6
Finish	71.0**	80.0**	71.5**	.7
Type	13.9**	27.6	2.9**	.9
Shape of Back	19.5**	30.0**	83.0**	.6
Trim	8.0**	21.7**	61.8**	1.0
Final Score	1269.8**	1740.5**	22.7**	12.3

*Significant at .05 level of probability.
**Significant at .01 level of probability.

TABLE 5 -- REPEATABILITY AND HERITABILITY OF SCORES FOR DIFFERENT TRAITS IN PIGS AT MARKET MATURITY

No. of Observations	261	158
Trait in the Individual	Repeatability of Score*	Heritability
Body Length	.639**	.418
Meatiness	.433**	-.002
Quality	.362**	-.031
Finish	.341**	.073
Type	.469**	.081
Shape of back	.154**	----
Trim	.271**	----
Final Market score	.677**	.100

*Three Different Judges.
**Significant at .01 level of probability.

TABLE 6 -- CORRELATION AND REGRESSION COEFFICIENTS FOR CERTAIN BODY SCORES IN LIVE HOGS AND THE PERCENTAGE OF FAT CUTS AND 5 PRIMAL CUTS IN THE CARCASS

Item Scored	Percent of Fat Cuts		Percent of 5 P. Cuts	
	"r"	"b"	"r"	"b"
Body Length	-.273*	-.734	.140	.281
Meatiness	-.397**	-1.170	.291*	.638
Quality	-.195	-.508	.155	.301
Finish	.527**	1.089	-.281*	-.433
Type	-.251*	-.544	.314**	.506
Shape of back	.397**	.704	-.156	-.207
Trimness of Middle	-.621**	-.710	.372**	.426
Total Score	-.562**	-.261	.382**	.132

*Probability of Chance Occurence less than .05
**Probability of Chance Occurence less than .01

scores, the one for trimness of middle was the most highly correlated with the percentage of fat in the carcass. Since the correlation coefficient was negative, this means that the less paunchy animals with trim middles were the leanest. The score for finish was significantly correlated with the percentage of fat cuts with more highly finished individuals being the fattest. Evidently, then, this score was a fair estimate of the amount of fat the animals were carrying.

The total score, which included all seven individual scores, also was highly correlated in a negative manner with the percentage of fat in the carcass. The magnitude of this coefficient of correlation was just a little less than that for the score for trimness of middle.

The correlation coefficients for the various scores and the percentage of five primal cuts were, in general, not as large as the ones for percentage of fat cuts. The individual scores giving the highest coefficients of correlation were total score, trimness of middle, conformation, and finish, in that order. All of these were positively correlated with the percentage of five primal cuts, except the score for finish.

The coefficients of determination (r^2) showed that total score accounted for approximately 31.58 percent of the variations in the percentage of fat cuts but only 14.59 percent of the total variation in the percentage of the five primal cuts.

The heritability estimates of scores for the different items were calculated on the basis of intra-sire regression of offspring on dam using the co-variance technique. The 158 offspring used in calculating heritability estimates were obtained from 44 litters sired by 13 different boars. Due to the non-availability of the dams' scores for "shape of back" and "trimness," the calculations of heritability of differences in scores for these two items were omitted. The heritability coefficients for body length, finish, type and market desirability were .418, .073, .081 and .100, respectively. The regression coefficients for meatiness and quality score were negative and, therefore, were of no value in calculating heritability estimates.

DISCUSSION

The objective of the present study was to devise and test a scoring system for the evaluation of carcass quality in hogs; one that could be used in selecting breeding and market animals for superior carcass quality at the usual market weights of 200 to 225 pounds. No doubt, actual measurements of characteristics in the live hog such as body length and backfat thickness would be more accurate in estimating yields of fat and the five primal cuts than estimates by the eye, but it is recognized that there are certain characteristics in the live animal that cannot be measured with

a ruler or steel tape. Most of the scores used in this study were for those qualitative traits that could only be measured with the eye. Actual body measurements as related to carcass value will be reported elsewhere.

Seven different traits were scored in each individual by three different judges. The final score for market desirability was obtained by combining these in such a manner that the favorable and unfavorable scores would both be considered. In arriving at the final score, the individual scores for "finish" and "shape of back," which were suggestive of the fatness of the animal, were deducted from the sum of the other five scores, which were indicative of the meatiness.

If scoring is to be a good tool for grading or evaluating hogs for the market and for breeding purposes, it must be repeatable by different judges. The results of this study showed that the three different judges differed significantly in assigning scores for the various traits (Table 3). In spite of this fact, however, the judges were consistent in noticing differences in the qualities they scored, as evidenced by the highly significant intra-class correlation between scores by the different judges for each trait (Table 5). In other words, Judge 3 (Table 3) consistently scored all of the pigs higher than Judge 2 and Judge 2 consistently higher than Judge 1. In a matter of grading or selection, consistency is of the utmost importance in the differentiation of the individual's merits. The reliability of the particular combination of scores used for determining the market desirability in this study was further enhanced by the fact that the judges agreed very closely with one another in the final total market score which was a combination of the seven individual scores. The average total market scores for all pigs, established by the three judges, were 18.4 $\pm$ 3.8, 17.8 $\pm$ 3.8 and 18.2 $\pm$ 3.9. The intra-class correlation between the total market scores by the three judges was .677 and was highly significant.

Another objective of this study was to determine how closely the various scores were correlated with carcass quality. Slaughter data on 72 Landrace x Poland pigs were studied to determine these relationships. In general, the scores were of more value in predicting the degree of fatness in the slaughtered pigs than in predicting the degree of lean. Perhaps this was because much of the fat in the pig at market time is in a layer covering the outermost portion of the body, whereas the muscles or lean are covered by layers of fat and cannot be detected too well by visual inspection. The results of this portion of the study indicated that the total market score was of some value in evaluating hogs on the hoof since the correlation coefficients were significant for both the percentage of fat cuts and the percentage of five primal cuts. It seems likely, however, that the scores might be of more value in combination with some actual measure-

ments of those traits, such as backfat thickness and body length, which can be measured quite accurately.

Selection on the basis of individuality, to be effective, must be made at the age when economic traits are visible in the animal. For carcass quality, this is about 200 to 225 pounds of live body weight, which is near the usual market weight. This has been supported by the work of Winters and Green (1944) who found little correlation and predictability between scores taken at earlier ages and weights and the scores taken at 200 to 250 pounds. Hammond (1932) further called attention to the fact that the animal changes in body proportions as it grows, and that different strains or breeds change proportions at different rates. For these reasons, it was thought that heritability estimates for differences in scores for the various traits would be of some value in estimating the genetic improvement that might be possible in successive generations of selection. The results, however, were not encouraging. The heritability of differences in scores for body length was 41.8 percent; for total market score, 10 percent; for conformation, 8.1 percent; and for finish, 7.3 percent. Of these, it seems that body length scores were the only ones in which one could expect to make much improvement through a selection program.

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