THE RELATION OF CERTAIN LIVE ANIMAL SCORES AND MEASUREMENTS TO CARCASS MEASUREMENTS IN SWINE

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INTRODUCTION

There are two general methods available for altering the composition of the hog; improvements in environmental factors such as management and feeding practices and improvements or alterations through breeding. Both of these methods have been used effectively in altering swine type.

With the increased interest in production of leaner pork much attention has focused upon the importance of developing methods for predicting leanness in the live hog. Also, the evaluation of potential breeding animals is becoming an increasingly important problem due in part to the fact that the price of lard in recent years has not been commensurate with prices of live hogs.

Although body measurements and backfat probes are usually more accurate in predicting the market desirability of individuals than visual scores, they are time consuming and require a certain amount of skill in technique for extensive use by the average breeder or farmer.

The major objectives of this study were to evaluate a scoring system that might be useful in the selection of meat type hogs for breeding purposes, to correlate scores and measurements in the live hog with corresponding carcass measurements and to test the reliability of these scores as determined by the repeatability in the scores of different judges.

REVIEW OF LITERATURE

The need for a simplified method of evaluating pork carcasses has long been recognized. Backfat thickness has been used as a measure of carcass fatness for many years, although proof of the existance of such a relationship was lacking until Hankins and Ellis (1934) showed that backfat thickness and percentage of ether extract in the carcass was correlated (.84).

Warner, Ellis and Howe (1934) studied relationships between the percentage yields of fat in the edible portion of the carcass and the percentage yields of the fat and the lean meat cuts. Their results revealed that the combined cutting weight of fat, backfat and the belly expressed as percentage of the entire cold carcass gave a relatively good indication of the fat in the edible portion of the carcass.

From studying the composition of the body of the pig at various stages of growth from birth to 200 pounds, McMeekan (1941) found that changes in form and composition of the animal are the result of orderly changes in the proportions of differentially growing parts. He noted that the skeleton proportionally increased the least during the first seven months following birth; muscle and fat increased the most. Also, the skeleton developed first, followed by muscle and later by fat.

McMeekan (1940) and McMeekan and Hammond (1939) noted that rapid rate of growth early in life when frame and muscle are developing gives the type of pork carcass which is in greatest demand, one which has thick, well-developed muscles and a small proportion of bone. These workers, however, do not say that feeding methods can overcome limits imposed by the breed but that breed characters can be modified by feeding. They suggest that breed selection could be done best in the nutritional environment which develops the characters in the desired direction, for then only is the development limited by the breed alone.

Brunstad and Fowler (1959) reported that gilts selected from a background of full feeding showed more muscling than those selected from a background of limited feeding. Gilts from the background of full feeding averaged over one-half square inches greater development of loin eye. They concluded that better selection for meat type hogs, as based on muscular development, can be accomplished under full feeding, where the muscling is allowed to express itself to the fullest extent by selection time. However, the full fed gilts averaged .32 inches more backfat than gilts receiving 70 percent full feed.

Hankins and Ellis (1945) determined the composition and nutritive value of pork by chemical analyses. They stated that the average difference between a 17.3 pound ham and a 13.9 pound ham in edible meat content was less than one percent. However, the lighter ham contained 59.3 percent of lean meat and the heavier one 55.8 percent. The former had more protein per pound of total edible meat, whereas the latter was the fatter and had the higher caloric value. These same two investigators further reported that regardless of the weight of hog, the weight increases of ham, shoulder, bacon and backfat are approximately equal, with the loin increase being somewhat less. With increasing weight the bacon and the entire dressed carcass increased at about the same rate in separable fat content. The shoulder and ham differ little in this respect. The loin contains the greatest proportion of lean meat while the head contains the least. The ham, shoulder, carcass, and bacon are intermediate. Bacon has the greatest proportion of total edible meat while the ham and shoulder are next and differ little.

Conversely, the backfat is extremely high in ether extract content, while the loin and ham are relatively low in this component. The shoulder contains about 5 percent more fat than the ham. With an increase in live weight of the hog, the bacon increases the most rapidly in fat content. The following cuts are listed in decreasing order of their value for caloric content: backfat, bacon, shoulder, ham, and loin. The loin and ham yielded the most protein and the backfat the least. The foregoing statements by Hankins and Ellis (1945) apply to 225 pound hogs and are considered typical of the average weight, composition and nutritive value of the cuts from barrows and gilts marketed in the United States.

Hankins (1940) studied the differences in carcass characteristics in relation to type in 217 hogs. These consisted of 78 large, 110 intermediate and 29 small type hogs. They were slaughtered at approximately the same weight, 225 pounds. Refractive index values showed that there was little difference between types in firmness. Differences in dressing percentage between the three types were relatively large and highly significant. Striking differences were noted in body length, leg length, depth from backfat to spinal column canal and total depth. In all instances there was less difference between large and intermediate than between intermediate and small types. The small type had a consistently thicker covering of fat and much plumper ham. The intermediate type, therefore, most nearly meets current requirements and probably embodies the greatest possibilities for modification to meet future changes in hog type.

McMeekan (1939) found that external measurements of the carcass did not provide reliable indications of quality of bacon hogs. He suggested that concentration on internal measurements was desirable if further improvement in prediction was desired. He also found that the length of hind leg was highly correlated with total amount of bone in the carcass, but the combined weight of the cannon bones provided a better index of total skeletal weight. Bone, muscle and fat in the bacon hog carcass could be estimated with a high degree of accuracy from the weights of these tissues in either the loin or the leg. The total composition of these two cuts provided an even higher correlation than either the loin or leg alone.

Hazel and Kline (1952) have reported the use of a probing technique for measuring leanness and fatness of live hogs. Based on records for 96 hogs, these workers reported a correlation of -.50 between percent of five primal cuts and the average of four live hog backfat measurements. The corresponding correlation involving the average of four carcass backfat measurements was -.45. Using the same technique, but employing measurements at eight different locations, Hazel and Kline (1953) subsequently reported the locations behind the shoulder, over the loin and the top of the ham to have the greatest accuracy if used to measure fatness and leanness. DePape and Whatley (1954), studying the accuracy of live hog probes involving 72 pigs, reported a correlation of -.67 between percent primal cuts and the average of six live hog backfat measurements.

The development of the live probe technique for measuring backfat thickness has been widely accepted as an aid in selection of swine for breeding purposes. More recently the leanmeter, the operation of which is based on the difference in electrical conductivity between fat and lean tissues, was developed. Thus, the leanmeter has in part supplemented the live probe for measuring backfat thickness. Pearson et al (1957) compared the usefulness of the live probe and the leanmeter from the standpoint of both physical carcass measurements and carcass cut-outs. They found that there was little difference in the usefulness of the two methods in regard to estimating backfat thickness and percent of either lean or primal cuts. However, the higher relationship for the live probe with both loin lean area (-.58 compared to -.40) and with fat trim (.67 compared to .52) indicated live probe to be a more reliable measure for estimating carcass leanness.

Holland and Hazel (1958) reported that the average of three backfat probes was the most accurate single indicator of percent lean cuts and percent fat cuts among all measurements taken on the live hog. They found that it was also more accurate than backfat measurements taken on the carcass. Hetzer et al (1956) stated that, with the possible exception of barrows, measurements of backfat thickness on the live hog seem to be as accurate for predicting percent preferred cuts as are measurements of backfat thickness on the carcass. DePape and Whatley (1956) reported a correlation between the average of six backfat probes and percent primal cuts larger than the correlation between carcass backfat thickness and percent primal cuts.

Hetzer et al (1956) reported lower correlations between the probe behind the shoulder and percent preferred cuts and percent fat cuts than between the two carcass characteristics and probes at the middle of the back and at the middle of the loin on hogs at 225 pound live weight. Holland and Hazel (1958) found the probe behind the shoulder to be the poorest location for measuring backfat thickness, which is contrary to the findings of Hazel and Kline (1952). The differences in accuracy of measurements in various studies may be due to differences in probing techniques of the various investigators.

In a study of the variation of muscle, fat and bone of 30 swine carcasses, Aunan and Winters (1949) found significant correlations between average backfat thickness and the following carcass characteristics; dressing percentage (.66), yield of five primal cuts (-.58), total lean meat in the whole carcass (-.63) and total fat content of the whole carcass (.79). They found the total lean component was also positively correlated with area of the "kernel of lean" in the loin and with the content of lean in the loin, and the latter in turn was correlated with the percentage of lean in other primal cuts.

McMeekan (1941) states that the loin is the most valuable part of the carcass. It is the shape rather than the cross-section area of the muscle which determines its suitability for the high quality trade. Thus, the total width of the eye muscle on both sides of the spinal column, plus its mean depth, gave a correlation of .93 with total lean. By taking the total length of the carcass into account (from the aitch bone to the first rib) on the basis that the total muscle development is related to the linear as well as cross-section surface of the muscle, a similar high correlation is obtained. McMeekan was of the opinion that in animals showing more variation in length than those with which he worked, the inclusion of carcass length may be desirable in determining total lean in the carcass. An approximation of the surface area of the loin eye showed a fairly high association with the total weight of the loin muscle.

McMeekan also reported a correlation of .81 between the psoas major muscle weight and total carcass muscle (lean) weight. (Psoas major muscle is the small tenderloin muscle of the loin arising from the posterior end of the spine.) The relationship is sufficiently high to merit consideration of this muscle as a measure of muscle development.

His correlations between various measures of the backfat thickness and total fat weight in the carcass were particularly strong and for the most part closely approached unity. Fat at the shoulder gave the weakest, while fat at the rump gave the strongest, correlation coefficient of the single measurements. The latter is exceeded by the mean backfat thickness (mean of 5 measurements) with a correlation of .95. McMeekan contends that these relationships will, because of their biological basis, apply in principle to all hogs of the same body weight (200 pounds) whatever their origin, breed or type.

These relationships are consistent with respect to growth. Since fat is associated with the late developing adipose tissue it is best correlated with measurements taken on the later developing regions. This explains why a higher correlation was found between the fat measurement over the loin and the total carcass fat than between the fat measurement over the shoulder and the total carcass fat.

Loin area at the tenth and last ribs, percent lean cuts and percent loin from both right and left side were studied on 23 swine carcasses by Kline and Hazel (1955). The loin area at the last rib averaged .43 square inches greater than at the tenth rib, a large and highly significant difference. However, there was no difference among the correlations between percent lean cuts and loin area at the tenth and last ribs, although the latter area was slightly more closely related to percent loin. Because of the high correlation between loin areas on the same carcass, they concluded that there would be little increase in accuracy of predicting lean cuts from measuring the loin area in more than one place.

Pearson et al (1956) investigated the fat-lean ratio in the cross-section of the rough loin as a possible measure of carcass leanness. Correlation coefficients of approximately -.60 between the fat-lean ratio and several measures of carcass cut-out indicated the relationship may be high enough to be useful when it is impossible to obtain cut-out information. However, the area of loin at the tenth rib or last rib was only slightly less reliable than the ratio of fat to lean for estimating cut-out values.

Zobrisky et al (1959) found the cross section area of the loin eye, cross section area of the ham lean and dressing percent to be significantly correlated with the yield of total lean. The single variable most highly associated with the yield of total lean was the cross section area of the loin eye. This variable was also highly correlated with the yield of the four lean cuts and five primal cuts.

Fredeen *et al* (1955) reported the planimeter area of a cross-section of the loin muscle taken at the last rib to be highly associated with the percent lean in the ham. This measure of carcass lean, when combined with the percent area of lean in the proximal (open) face of the ham, accounted for 72 percent of the variance in percent lean in the ham. As an over-all measure of carcass lean, percent area of lean in the proximal face of the ham was somewhat more reliable than loin area.

Whiteman *et al* (1953) reported very high correlations between the specific gravity of the ham and specific gravity of the half carcass (.95), and between the percent lean cuts and specific gravity of the whole carcass (.86). They also showed similar correlations for planimeter readings of the loin area and total lean and length times width of loin area and total lean of .68 and .60, respectively.

Aunan and Winters (1952) compared the relationship between fat and lean of the pork carcass with the quantity of fat and lean in core samples taken at various locations. A correlation of .79 was found between the lean content of the carcass and the lean content of the core taken approximately midway between the fifth and sixth ribs. The correlation between the five primal cuts and the lean of the same core was .61. The fat content of the carcass was most highly correlated with the fat content of the core taken between the eleventh and twelfth ribs (.54). The fat in the core from the fifth and sixth ribs was correlated .52 with the total fat.

Hiner and Hankins (1939) reported on the significance of variation in ham conformation. In their study of four ham muscles, they found that these muscles did not consistently change in weight with an increase in ham plumpness. They found a positive correlation between separable fat and ham plumpness, and a negative correlation between separable lean and ham plumpness. The correlation between separable fat and separable lean was negative and very high.

Willman and Krider (1943) found little association between fatness and area of loin eye muscle, or the lean area in the butt end of the ham. Contrary to the report by Hiner and Hankins (1939) these workers reported a coefficient of determination of 33 percent between ham lean area and ham circumference.

Cummings and Winters (1951) studied carcass slaughter data obtained from 741 hogs. They reported that the "T" factor, where $T = \frac{\text{average backfat thickness}}{\text{length of carcass}}$, showed high correlations with yield of the five primal cuts and the index of fat cuts. In their study, an increase of one inch in the average backfat thickness indicated a decrease of 5 percent in yield of the five primal cuts and an increase of 7 percent in the index of fat cuts. A decrease in the "T" factor indicated an increase in the percent yield of the five primal cuts and a decrease in the fat cuts. They suggested that the "T" factor, rather than backfat thickness alone, be used for predictive purposes because carcass value is also influenced by its length. They further reported that the length of the carcass does not show a high degree of relationship to the percent yields of the five primal cuts or the fat cuts. Nevertheless, length is a valuable characteristic in the carcass. Yields of the five primal cuts and the fat cuts were strongly correlated with carcass weight and live weight. The best carcasses came consistently from hogs that made the fastest gain from birth to slaughter time. These investigators also stated that the use of simple carcass measurements to predict yields apparently has limitations. Modifications in analysis of certain groups of different breeding may be required. It is essential that exact and consistent cutting procedures be used in all cases. The most reliable results should be obtained by work with hogs of similar weight and other likeness.

Wiley et al (1951) reported on the variations among individual hogs and their carcasses in carcass yield, degree of finish, and conformation. The relationship of yields of pork cuts obtained and the value of these cuts was also studied. These workers stated that backfat thickness tended to increase with weight, but that the average thickness among hogs of the same weight, differed as much as two inches. The difference in the percentage of lean cuts among hogs of the same weight amounted to 18 percent while the range in body and leg length was ten and eight inches respectively.

Wiley further stated that as backfat thickness and weight increased, the percentage of lean cuts decreased. Considering weight and average backfat thickness, the percentage of lean cuts increased when either body or leg length increased. They also noted that as carcass weight increased the average cut-out value decreased due to the price discount for heavy cuts. Cuts from hogs that were too lean for top quality were down-graded due to a lack of firmness and other quality attributes. Backfat thickness, when considered with weight, was fully as good a criterion for carcass value as the percentage of lean cuts, and it had the advantage of being much more easily determined. The optimum percentage of lean for maximum cut-out value was higher for 180 to 220 pound hogs than for any other weight group.

Hetzer et al (1950) reported the results of their work on 141 hogs fed in Record of Production trials at Beltsville, Md.. Eight live hog measurements were studied. For barrows and gilts, depth of middle was the most important item in determining the yield of the five primal cuts, whereas width of ham was most related to percentage of lean in hams. They concluded that the predictive value of the measurements studied was not as high as might be desired, although certain body measurements offered possibilities of being a valuable tool in estimating carcass yields from live animals.

Bennett and Coles (1946) found a negative correlation between length of side and thickness of shoulder fat, while Crampton (1940) reported no relationship between the two measurements. Both groups worked with the same breed of hogs.

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 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 estimated 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 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 regressions 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 +.068 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) estimated the heritability of scores for type in Poland China swine to be 38 percent, as compared to an earlier figure of 32 percent obtained by Hetzer and Zeller (1943). 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 to 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, repectively, 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.

Molln (1942) found a correlation coefficient of .49 between scores and 180-day weight in 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.

Summary of Review of Literature

A study of the literature indicates that the probed backfat thickness is the most accurate measure available for the evaluation of fatness of the live hog. An average of several probe measurements will give a more reliable indication of the fat content of the animal than any one single probe measurement. The low correlation between the lean content of the carcass and probed backfat thickness places a limitation on the value of the probe for measuring muscling in the live animal.

However, the correlation between the fat content of the carcass and probed backfat thickness is sufficiently high to measure fatness with a high degree of accuracy.

Several experiments have been conducted with swine carcasses in an attempt to find a measurement or a combination of measurements that will predict the lean content of the carcass with a high degree of accuracy. Besides being much more readily obtained than many other measures, the loin lean area at the tenth rib or last rib gives about as high a correlation to the lean content of the carcass as any other single measurement. However, at the present time there is no external measurement on the live hog which will predict loin lean area with a high degree of accuracy. A more accurate method, readily obtainable from the live animal, needs to be developed for measuring the leanness in the carcass.

For a number of years visual scores have been used to evaluate animals for market and breeding purposes. In general, most of the visual scores have had limited value in determining carcass merit.

EXPERIMENTAL

The 238 hogs and carcasses used in this study were from the Swine Breeding Project conducted at the Oklahoma Experiment Station in co-operation with the Regional Swine Breeding Laboratory. The data included the following lines of breeding:

TABLE I

COMPOSITION OF EXPERIMENTAL SWINE HERD

Station	Line of Breeding	Description
Stillwater		
	OK 8	Duroc Line (4% inbred)
	OK 9	Beltsville No. 1 Line (22% inbred)
	8x9	Duroc boars mated to Beltsville No. 1 females
	9x8	Beltsville No. 1 boars mated to Duroc females
Ft. Reno		
	OK 3	Duroc Line (9% inbred)
	OK 14	Hampshire Line (4% inbred)
	14x8-9	Hampshire boars mated to Duroc-Beltsville No. 1 females
	C	Control Line (unselected crossbred stock)

One-hundred-seventeen of the pigs were farrowed in the spring of 1958 and 121 were farrowed in the fall of 1958. They were composed of 220 barrows and 18 gilts. No attempt was made to adjust for sex differences in analyzing the data.

TABLE II

MEANS OF LIVE ANIMAL SCORES AND MEASUREMENTS AND CARCASS MEASUREMENTS BY LINES FOR 1958 SPRING PIGS

Line of Breeding	Number	Probed Backfat, inches	Carcass Backfat, inches	Length Score (in inches)	Carcass Length, inches	Meatiness Score (in sq. inches)	Loin Lean Area, sq. in.
OK 8	9	1.87	1.93	28.9	28.5	2.67	2.78
OK 9	6	1.30	1.43	30.6	30.2	4.42	4.06
8x9 & 9x8	46	1.46	1.55	30.0	30.1	3.72	3.47
OK 14	7	1.56	1.61	29.1	29.6	3.57	3.38
OK 3	8	1.73	1.78	29.0	28.4	3.12	2.79
C Line	19	1.63	1.65	29.7	29.4	3.55	3.34
14x8-9	22	1.56	1.63	29.8	29.9	3.66	3.30
Total/Mean	117	1.56	1.62	29.7	29.7	3.58	3.34

TABLE III

MEANS OF LIVE ANIMAL SCORES AND MEASUREMENTS AND CARCASS MEASUREMENTS BY LINES FOR 1958 FALL PIGS

Line of Breeding	Number	Probed Backfat, inches	Carcass Backfat, inches	Length Score (in inches)	Carcass Length, inches	Meatiness Score (in sq. inches)	Loin Lean Area, sq. in.
OK 8	10	1.77	1.72	28.8	28.5	3.00	3.36
OK 9	8	1.52	1.50	30.3	30.3	4.38	4.43
8x9 & 9x8	30	1.54	1.54	29.8	29.8	3.78	4.22
OK 14	10	1.64	1.48	29.5	29.6	3.40	3.56
OK 3	11	1.84	1.72	28.9	28.6	2.73	3.19
C Line	18	1.68	1.60	29.7	29.7	3.39	3.40
14x8-9	34	1.56	1.51	29.6	29.9	3.47	3.46
Total/Mean	121	1.62	1.56	29.6	29.6	3.48	3.68

TABLE IV

MEANS OF LIVE ANIMAL SCORES AND MEASUREMENTS AND CARCASS MEASUREMENTS BY LINES FOR 1958 SPRING AND FALL PIGS

Line of Breeding	Number	Probed Backfat, inches	Carcass Backfat, inches	Length Score (in inches)	Carcass Length, inches	Meatiness Score (in sq. inches)	Loin Lean Area, sq. in.
OK 8	19	1.82	1.82	28.9	28.5	2.84	3.09
OK 9	14	1.42	1.47	30.4	30.3	4.39	4.27
8x9 & 9x8	76	1.49	1.55	30.0	30.0	3.74	3.77
OK 14	17	1.61	1.53	29.4	29.6	3.47	3.48
OK 3	19	1.80	1.75	28.9	28.5	2.90	3.02
C Line	37	1.66	1.62	29.7	29.6	3.47	3.37
14x8-9	56	1.56	1.56	29.7	29.9	3.54	3.40
Total/Mean	238	1.59	1.59	29.7	29.7	3.53	3.51

Tables II and III give the distribution and means of the various measurements and scores by line within each season. Table IV gives the summary of the data by lines.

All pigs were weaned when they were between seven and eight weeks of age.

At weaning all pigs were allotted according to age, line of breeding and sire group. The Stillwater spring and fall pigs and the Ft. Reno fall pigs were fed in confinement. Thirty of the Ft. Reno spring pigs were fed in confinement and 26 were fed on pasture. The Stillwater and Ft. Reno spring pigs were self-fed the same free-choice ration of shelled corn and a protein-mineral supplement which is included in the appendix (Table XVII). The Stillwater fall pigs were self-fed a pelleted ration and the Ft. Reno Fall pigs were self-fed a ground mixed ration. Both of these rations are included in the appendix (Tables XVIII and XIX).

All pigs were weighed at weaning and at two-week intervals when they were approaching 200 pounds. Pigs were removed from the lots as each pig weighed over 200 pounds on these bi-weekly weigh days. At this time, each pig was probed at four locations along the back with a leanmeter. Each probe was made approximately one inch on each side of the midline at about the fifth rib and fourth lumbar vertebrae. The average of these four probes was used as the measurement for probed backfat thickness.

Each pig was also scored for length, meatiness and soundness of legs by a committee of three, and the committee average was used as the evaluation of each trait. The scoring system was as follows:

TABLE V

LIVE ANIMAL SCORING SYSTEM

Score	Length (inches)	Meatiness (sq. in. of loin area)	Legs (description)
9	31.0	5.5	Straight legs, well balanced toes
8	30.5	5.0	strong pasterns, free from knots
7	30.0	4.5	and enlargements on legs.
6	29.5	4.0	Slightly crooked legs, uneven
5	29.0	3.5	toes, slightly weak pasterns, or
4	28.5	3.0	slight knots or enlargements.
3	28.0	2.5	Crooked legs, uneven toes, weak
2	27.5	2.0	pasterns, large knots on legs,
1	27.0	1.5	enlarged knees or hocks, etc.

The committee's average score for length was converted to inches and the average meatiness score was converted to square inches of loin area for analysis.

All hogs used in this study were killed and processed by Wilson & Company at its plant at Oklahoma City, Oklahoma. Carcass length, average carcass backfat thickness and loin lean area at the tenth rib was obtained on these 238 hogs. Carcass length was the average of measurements on the right and left side of the carcass from the first rib to the anterior edge of the aitch bone. Thickness of backfat was measured on both sides of the split carcass at the first rib, seventh rib, last rib and last lumbar vertebrae. The average of these eight measurements was designated as the carcass backfat thickness. The loin lean area was measured at the tenth rib by tracing the outline of the longissimus dorsi as exactly as possible. All other muscles were excluded. Three planimeter readings were made on each tracing to obtain an average figure for each area.

All data was analyzed by methods described by Snedecor (1956). The analysis of variance for the scores and measurements is a pooled analysis of variance computed on a within station basis. All possible simple correlation coefficients were calculated.

An additional study was conducted with the Stillwater fall pigs to check the amount of error in repeated scoring of length, meatiness and soundness of legs on the same pig. Three men scored three groups of 16 pigs. Each pig was scored for each item by each man on two different days. Repeatability estimates were calculated according to Snedecor (1956).

RESULTS AND DISCUSSION

This section is divided into two parts: the Evaluation of the Scoring System and the Repeatability of Scores. The Evaluation of the Scoring System will be discussed with respect to average probe, length score and meatiness score taken on the live animal and related to the carcass backfat thickness, carcass length and loin lean area measurements taken on the carcass. The amount of error in repeated scores will be discussed under the Repeatability of Scores.

Evaluation of the Scoring System

In the present study hogs were scored by three men for length of body and meatiness. Probed backfat measurements were also made on these animals. The hogs were slaughtered and carcass measurements of backfat thickness, length, and loin lean area at the tenth rib were obtained.

The following discussion deals with the relationship of certain carcass traits to scores and measurements of similar traits on the live hog. The degrees of association were obtained by computing simple correlation coefficients as described by Snedecor (1956).

The phenotypic correlations, presented in Tables VI and VII, measure the relationship between two traits as expressed in the same individual. As such, they are composed of both genetic and environmental influences which may or may not be working in the same direction. These correlations are based on measurements made on 220 barrows and 18 gilts from the Ft. Reno and Stillwater stations.

TABLE VI

CORRELATIONS OF CERTAIN CARCASS MEASUREMENTS AND LIVE ANIMAL SCORES AND MEASUREMENTS

	Probed Backfat	Carcass Backfat	Length Score	Carcass Length	Meatiness Score
Carcass Backfat	+0.72				
Length Score	-0.20	-0.44			
Carcass Length	-0.44	-0.45	+0.67		
Meatiness Score	-0.73	-0.64	+0.65	+0.52	
Loin Lean Area	-0.31	-0.36	+0.35	+0.30	+0.46

All correlation coefficients are highly significant ($P < .01$)

TABLE VII

INTRA-LINE CORRELATIONS OF CERTAIN CARCASS MEASUREMENTS WITH LIVE ANIMAL SCORES AND MEASUREMENTS

	Probed Backfat	Length Score	Meatiness Score
Carcass Backfat	+0.64		
Carcass Length		+0.52	
Loin Lean Area			+0.24

All correlation coefficients are highly significant ($P < .01$)

Backfat Thickness:

The average depth of backfat on the carcasses and live animals was 1.59 inches at the four sites measured. Although this is near the accepted optimum for fatness, there was considerable variation between individuals, particularly with reference to line differences.

Probed backfat thickness was found to be highly correlated with carcass backfat thickness (.72). When the computations were made on an intra-line basis to eliminate line differences in fatness and conformation, the degree of association was slightly reduced to .64.

The correlations of .72 and .64 between the average backfat thickness on the carcass and the average of four probes are in essential agreement with the correlation of .81 reported by Hazel and Kline (1952) between average carcass backfat and four probes and the correlation of .72 reported by Hetzel et al (1956) between average carcass backfat and three probes. Probed backfat thickness and carcass backfat thickness gave similar negative correlation coefficients with carcass length (-.44 and -.45). This was in accordance with the findings of Aunan and Winters (1949) and DePape and Whatley (1954). However, carcass backfat thickness was slightly more highly correlated with loin lean area (-.36) than was probed backfat thickness (-.31). There has, however, been some disagreement concerning the relation of carcass backfat measurements and loin lean area. Hazel and Kline (1952) reported a negative correlation of -.41 while Aunan and Winters (1949) reported a positive correlation of .15 and Bennett and Coles (1946) found the correlation to be essentially zero.

The analyses of variance of probed backfat thickness and carcass backfat thickness was computed on a within station basis and are presented in Tables VIII and IX.

The highly significant difference between lines could be readily expected from examining the means (Tables II, III and IV) for the different lines of breeding. However, the difference between seasons is not as easily explained. This might be due to the faster rate of gain for the fall pigs or the differences in sires, as an entirely different group of sires was used to sire the fall pigs than was used to sire the spring pigs. Another possible explanation of the highly significant season effect is that a different person probed the spring pigs than did the fall pigs. The difference in probing technique might be the most logical explanation of the seasonal difference in probed backfat thickness, but it would not account for the seasonal difference in carcass backfat.

Probe measurements of backfat thickness can be utilized extensively for selecting swine replacement stock for fat content of the animal because these measurements far exceed other live animal measurements and condition scores as indicators of fat in the carcass.

One logical alternative to selecting individual pigs for probed backfat is that of slaughtering samples of pigs and selecting full brothers and sisters or parents of those having the largest loin eye area and other desirable carcass traits.

Selecting individual pigs for probed backfat thickness has the disadvantage of being an indirect measure of muscling. The other alternative of slaughtering samples of pigs has an equally serious disadvantage since selection must be practiced indirectly in selecting the brothers and sisters or parents of the sampled pigs. Other disadvantages which seem likely to lower the effectiveness of this method are that the slaughtered pigs may be biased samples of the group they represent, that the slaughtering reduces the intensity of selection which might otherwise be practiced, and that the information may not be immediately available when selection usually will be practiced.

TABLE VIII

ANALYSIS OF VARIANCE OF PROBED BACKFAT THICKNESS

Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	237	9.0879		
Between Stations	1	0.4485		
Within Stations	236	8.6395		
Line	5	2.6700	0.5340	21.44**
Season	2	0.1703	0.0852	3.42*
Line X Season	5	0.2282	0.0456	1.83
Error	224	5.5710	0.0249	

** Highly Significant ($P < .01$)
* Significant ($P < .05$)

TABLE IX

ANALYSIS OF VARIANCE OF CARCASS BACKFAT

Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	237	8.3193		
Between Stations	1	0.0193		
Within Stations	236	8.3000		
Line	5	1.9750	0.3950	15.25**
Season	2	0.3131	0.1566	6.05**
Line X Season	5	0.2156	0.0431	1.66
Error	224	5.7963	0.0259	

** Highly Significant ($P < .01$)

The crossbreds were intermediate between the parent lines in backfat thickness. This would suggest that the genes influencing backfat deposition act largely in an additive manner.

Carcass Length:

Each pig was scored by a committee of three observers for carcass length. The scoring system ranged from 1 to 9 with the score of 1 for pigs estimated to yield 27-inch carcasses and the score of 9 for pigs estimated to yield carcasses 31 inches long or longer. Thirty-one inches was considered to be superior for this trait. The analyses of variance, which is presented in Tables X and XI, show that the line of the animal had a highly significant effect upon length score of the live hog and carcass length.

TABLE X

ANALYSIS OF VARIANCE OF LENGTH SCORE ON THE LIVE HOG

Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	237	89.1093		
Between Stations	1	5.8793		
Within Stations	236	83.2300		
Line	5	34.0459	6.8092	31.79**
Season	2	0.2195	0.1098	0.51
Line X Season	5	0.9710	0.1942	0.91
Error	224	47.9936	0.2142	

** Highly Significant (P<.01)

TABLE XI

ANALYSIS OF VARIANCE OF CARCASS LENGTH

Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	237	213.5405		
Between Stations	1	2.4713		
Within Stations	236	211.0692		
Line	5	67.4652	13.4930	21.36**
Season	2	1.1396	0.5698	0.90
Line X Season	5	0.9447	0.1889	0.30
Error	224	141.5197	0.6318	

** Highly Significant (P<.01)

The committee scored each pig for length after the animal had been probed for backfat thickness and each committee member was familiar with the probe measurement. The most significant obersvation, from examining Table VI with respect to length score, is that the probed backfat thickness did not seem to influence the committee's scoring of carcass length as much as it might have. The correlation between probed backfat and carcass length (-.44) and the correlation between carcass backfat and carcass length (-.45) were both higher than the -.20 correlation between probed backfat thickness and length score. Whether this criticism of the scoring system or committee is warranted is questionable, as the value of carcass length is still undetermined. However, carcass length is thought to have some value in producing longer bellies and loins.

The negative correlation between carcass length and backfat thickness is in good agreement with similar results presented by Lush (1936) and DePape and Whatley (1956). The most plausible explanation is that given by Lush, namely, that slaughtering at a constant live weight would require that the pigs longer than average be smaller in some other dimension, for instance, backfat.

The correlation between length score and carcass length was positive and highly significant (.67). This indicates that the committee could detect differences in body length of live hogs that were highly associated with actual carcass length. This observation is in agreement with those of Bratzler and Margerum (1953).

The correlations in Table VI indicate that the relationship between length score, carcass length, probed backfat thickness or carcass backfat with loin lean area are essentially of the same magnitude.

Carcass Leanness:

Meatiness as scored in this study was intended to be an estimate of the loin lean area at the tenth rib.

An easy and readily available measurement on the carcass which will predict the lean content of the carcass with a high degree of accuracy has not been developed. The loin lean area meets the above requirements and is the best method which has been developed for determining total lean in the carcass. This is in accordance with the findings of Whiteman et al (1953) when they reported the correlation of .68 between planimeter readings of the loin lean area and total lean of the carcass.

The analyses of variance for meatiness score and loin lean area are presented in Tables XII and XIII. Line and season had a highly significant effect upon both meatiness score of the live animal and loin lean area of the carcass. The highly significant line effect could be readily expected from examining the line means presented in Table IV. There are two possible explanations for the highly significant seasonal effect. The first is that an entirely different group of sires was used to sire the spring pigs than was used to sire the fall pigs and the second explanation is the faster rate of gain of the fall pigs. The latter is in agreement with the findings of Brunstad and Fowler (1959) while studying different levels of feeding and their effect upon carcasses of gilts. They concluded that better selection for meat type hogs, as based on muscular development, can be accomplished under optimum feeding conditions where the muscling is allowed to express itself to the fullest extent by selection time, 180 to 200 pounds. However, it must not be forgotten that real differences between spring and fall farrowed pigs might exist.

TABLE XII

ANALYSIS OF VARIANCE OF MEATINESS SCORE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	237	63.7311		
Between Stations	1	3.7256		
Within Stations	236	60.0055		
Line	5	27.0070	5.4014	39.25**
Season	2	1.5634	0.7817	5.68**
Line X Season	5	0.6239	0.1248	0.91
Error	224	30.8112	0.1376	

** Highly Significant ($P < .01$)

TABLE XIII

ANALYSIS OF VARIANCE OF LOIN LEAN AREA

Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	237	74.5908		
Between Stations	1	7.8947		
Within Stations	236	66.6961		
Line	5	14.5283	2.9057	16.75**
Season	2	12.0270	6.0135	34.68**
Line X Season	5	1.2937	0.2587	1.49
Error	224	38.8471	0.1734	

** Highly Significant ($P < .01$)

Meatiness score and loin lean area were found to be highly correlated (.46). However, when the computations were made on an intraline basis to eliminate line differences the degree of association was considerably reduced (.24). After examining the simple correlations of Table VI with respect to meatiness score and loin lean area, it should be noted that the probed backfat thickness is highly associated with meatiness score (-.73) while the correlation of probed backfat thickness to loin lean area is only -.31. The probed backfat thickness, which was known at the time the committee scored each pig for meatiness, influenced the committee's evaluation of meatiness. This influence on meatiness score may have caused the relationship between meatiness score and loin lean area to be reduced. The correlation between meatiness score and loin lean area might have been increased if the hogs had been scored for meatiness before being probed for backfat thickness.

Due to the relatively low correlation between loin lean area and meatiness score little can be gained from scoring prospective breeding animals for meatiness. Also, the loin lean area is not a highly accurate measure of muscling in the carcass.

The Repeatability of Scores

Three live animal scores (length, meatiness and soundness of feet and legs) were made on 1958 Stillwater fall pigs. In order to check the amount of error in repeated scores of these items on the same pig, three men made two scores for each item on three groups of 16 pigs each. The scores were made according to the live animal score card presented in Table V.

Each man scored each pig for each item on two different days. No particular order was used in scoring nor was there any known tendency for an individual to remember previous scores on the same pig. The average probed backfat thickness of each pig was known by the committee on both days.

Length Score:

An analysis of variance of the length scores is shown in Table XIV. The mean square between scores by different men was significant and the mean square between scores on different days was highly significant. However, the mean square between scores on different pigs was considerably larger than either of the former and was also highly significant. The interactions Men x Days and Men x Pigs were highly significant while the interaction Pigs x Days was significant.

In the column of Table XIV labeled "Interpretation" the amount of variance contributed to the different sources is shown. In this Table the variance between pigs (P) was the largest item of variance in the Table. P represents the extra variance between pairs of pigs as compared to that between pairs of scores on the same pig.

The Men x Days x Pigs interaction was the second largest contribution to the variance. This triple interaction represents the differences in scores which are not explained by day to day differences, or man to man differences, or by pig to pig differences, or by interactions between any two of these. This triple interaction was used as the error term in testing for significance.

The variances contributed by the different interactions, in general, represent differences in scores not explained by general differences in the specific factors concerned.

The repeatability between single scores of body length was 0.756, or 75.6 percent. This figure is to be compared with the residual variance (24.4 percent) which is due to errors of scores, including differences in the scores of the three men. Although this latter value is only about one-third as large as the former, it is large enough to

TABLE XIV

ANALYSIS OF VARIANCE OF LENGTH SCORE

Source of Variation	D/f	Sum of Squares	Mean Square	Interpretation 1/	
Total	287	555	1.9338		
Between groups	2	3	1.5000		
Within groups	285	552	1.9368		
Pigs	45	449	9.9778**	E + 48A + 2B + 3C + 6P ;	P = +1.3907
Men	6	6	1.0000*	E + 48A + 2B + 3C + 96M ;	M = -0.0066
Days	3	2	0.6667**	E + 48A + 2B + 3C + 144D ;	D = -0.0067
Men x days	6	7	1.1667**	E + 48A ;	A = +0.0194
Men x pigs	90	50	0.5556**	E + 2B ;	B = +0.1612
Pigs x days	45	17	0.3778*	E + 3C ;	C = +0.0482
Men x pigs x days	90	21	0.2333	E ;	E = +0.2333

*Significant ($P < .05$)
**Highly significant ($P < .01$)

1/
P = the variance due to differences between pigs
M = the variance due to the scores assigned by the three men
D = the variance due to the scores assigned on different days
A = the variance due to the interaction between men and days
B = the variance due to the interaction between men and pigs
C = the variance due to the interaction between pigs and days
E = the variance due to the triple interaction of men, pigs, and days

Repeatability between single scores on the same pig = $\frac{P}{E+C+B+A+D+M+P} = .756.$

suggest that a substantial gain in precision might be obtained by averaging several scores by different men.

The repeatability of scores for body length is in agreement with measurements of body length reported by Hetzer et al (1950) and is considerably higher than the results reported by Whatley (1941) using calipers to measure body length.

Meatiness Score:

Table XV shows the analysis of variance of the meatiness score of the forty-eight pigs. The mean square between scores by different men was highly significant. However, the mean square between scores on different pigs was larger than the former and was also highly significant. The only significant interaction was that between men and days.

The Interpretation column of Table XV shows that the extra variance between pairs of pigs (P) was by far the largest item of the variance (.9018). The second largest item of variance was E (Men x Days x Pigs interaction) which had a value of .2444. Differences between men (M = .0079) and days (D = -.0052) were very much smaller than pig to pig differences. The value of .0389 for B is the variance due to differences in scores by different men on the same pig which did not correspond to differences in their scores on other pigs.

The repeatability between single scores for meatiness was 0.753, or 75.3 percent. The residual variance (24.7 percent) is of sufficient size to suggest that a higher degree of accuracy could be expected from averaging several scores. However, due to the low correlation between meatiness score and loin lean area this method of evaluating

TABLE XV

ANALYSIS OF VARIANCE OF MEATINESS SCORE

Source of Variation	D/f	Sum of Squares	Mean Square	Interpretation 1/	
Total	287	354	1.2334		
Between groups	2	2	1.0000		
Within groups	285	352	1.2351		
Pigs	45	277	6.1556**	E + 48A + 2B + 3C + 6P ;	P = +0.9018
Men	6	9	1.5000**	E + 48A + 2B + 3C + 96M ;	M = +0.0079
Days	3	0	0.0000	E + 48A + 2B + 3C + 144D ;	D = -0.0052
Men x days	6	4	0.6667*	E + 48A ;	A = +0.0088
Men x pigs	90	29	0.3222	E + 2B ;	B = +0.0389
Pigs x days	45	11	0.2444	E + 3C ;	C = +0.0000
Men x pigs x days	90	22	0.2444	E ;	E = +0.2444

*Significant ($P < .05$)
**Highly Significant ($P < .01$)

1/
P = the variance due to differences between pigs
M = the variance due to the scores assigned by the three men
D = the variance due to the scores assigned on different days
A = the variance due to the interaction between men and days
B = the variance due to the interaction between men and pigs
C = the variance due to the interaction between pigs and days
E = the variance due to the triple interaction of men, pigs, and days

Repeatability between single scores on the same pig = $\frac{P}{E+C+B+A+D+M+P} = .753.$

the live animal for meatiness is of little value. Since loin lean area is only an estimate of the lean content of the carcass the true value of meatiness scores cannot be determined at this time.

Legs Score:

The soundness of feet and legs score appeared to be the least accurate of the three scores made. In Table XVI differences between pigs (5.3333) were the most important source of variance (P = .6796). The extra variance contributed by E (Men x Days x Pigs interaction) approached that contributed by differences between pigs. This triple interaction represents the differences in scores which are not explained by day to day differences, or man to man differences, or pig to pig differences, or by interactions between any two of them. It indicates the inability of the same man to score each pig the same on different days. This error could arise because of changes in the way the pig stood from one day to the next or from the inability of the man to score the same each time even if there were no changes in the pig's position.

There was no distinct man to man difference in the legs score. Man to man difference was slightly negative which very likely can be explained by sampling errors.

The mean square for the interaction pigs x days was highly significant. This indicates that there was a tendency for the committee to score the same pig differently on different days. This interaction also was an important source of variation (.1963).

The repeatability between single scores of soundness of feet and legs was .458, or 45.8 percent. This figure is to be compared with the

TABLE XVI

ANALYSIS OF VARIANCE OF LEGS SCORE

Source of Variation	D/f	Sum of Squares	Mean Square	Interpretation 1/	
Total	287	425	1.4808		
Between groups	2	12	6.0000		
Within groups	285	413	1.4491		
Pigs	45	240	5.3333**	E + 48A + 2B + 3C + 6P ;	P = +0.6796
Men	6	5	0.8333	E + 48A + 2B + 3C + 96M ;	M = -0.0044
Days	3	6	2.0000*	E + 48A + 2B + 3C + 144D ;	D = +0.0052
Men x days	6	3	0.5000	E + 48A ;	A = -0.0005
Men x pigs	90	62	0.6889*	E + 2B ;	B = +0.0834
Pigs x days	45	50	1.1111**	E + 3C ;	C = +0.1963
Men x pigs x days	90	47	0.5222	E ;	E = +0.5222

*Significant ($P < .05$)
**Highly significant ($P < .01$)

1/
P = the variance due to differences between pigs
M = the variance due to the scores assigned by the three men
D = the variance due to the scores assigned on different days
A = the variance due to the interaction between men and days
B = the variance due to the interaction between men and pigs
C = the variance due to the interaction between pigs and days
E = the variance due to the triple interaction of men, pigs, and days

Repeatability between single scores on the same pig $= \frac{P}{E+C+B+A+D+M+P} = .458.$

residual variance (54.2 percent) which is due to errors of scores, including differences in the scores of the three men. The latter value is larger than the former, this suggests that a considerable gain in precision can be expected by averaging several scores.

The lower the repeatability between single scores, the greater the increase in accuracy can be expected to result from averaging several scores. The amount of error which is removed by averaging several scores would be expected to decrease as the accuracy of individual scores increase. At any rate, the expected increases in accuracy resulting from several scores appear to be large enough to justify obtaining more than one score where such practice is feasible.

SUMMARY

The main purposes of this study were to determine the relationship of scores and measurements of certain live animal traits with similar traits on the carcass and to test the reliability of these scores as determined by the repeatability in the scores of different judges.

Two hundred thirty-eight hogs from the swine breeding project at the Oklahoma Experiment Station were used in the study. One hundred nine of these hogs were from the Stillwater station and 129 from the Ft. Reno station. Eighteen of these hogs were gilts and 220 were barrows. The data were collected during 1958 with two pig crops represented in the study from the two stations.

The correlation between the averages of eight backfat measurements taken on carcasses and four probed backfat measurements on the live hog was .72 and with breed effect removed it was .64. Probed backfat thickness and carcass backfat gave essentially the same highly significant negative relationships with carcass length and loin lean area.

The average of three judges' scores for carcass length gave a correlation of .67, and with breed effect removed .52, with the average length of the carcass. Both the length score and carcass length gave similar positive correlations with loin lean area.

The relationship between meatiness score and loin lean area leaves much to be desired. The correlation between the two was .46, but when breed effect was removed it was reduced to .24.

An analysis of the Stillwater fall data, with respect to the repeatability of single scores on the same hog, gave repeatability estimates ranging from .75 for length score and meatiness score to .45 for soundness of feet and legs score. The errors in scores is large enough in all instances to suggest that a gain in precision might be obtained by averaging several scores.

Although the predictive value of the scores and measurements studied was not as great as might be desired, it is concluded that the use of probed backfat thickness and length score offers possibilities of being a valuable tool in selecting breeding stock.

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A P P E N D I X

TABLE XVII

POST-WEANING RATIONS FOR STILLWATER AND FT. RENO SPRING PIGS

First Month (Entire Ration Mixed and Self-Fed)	
Ground Corn	75.000
Soybean Meal	12.500
Tankage	5.125
Alfalfa Meal	5.000
Bone Meal	1.000
Trace Mineralized Salt	0.500
Aurofac	0.500
Hygromix	0.250
Fortafeed	0.100
Quadrex	0.014
Zinc Sulfate	0.011
TOTAL	100.000
After First Month (Self-Fed Free Choice)	
Shelled Corn	
Protein and Mineral Supplement Mix	
Soybean Meal	50.00
60 percent Tankage	20.00
Alfalfa Meal	20.00
Bone Meal	4.00
Trace Mineralized Salt	2.00
Limestone	1.50
Aurofac	2.00
Fortafeed	0.40
Quadrex	0.06
Zinc Sulfate	0.04
TOTAL MIX	100.00

TABLE XVIII

POST-WEANING RATIONS FOR STILLWATER FALL PIGS

Growing Ration*
(Entire Ration Mixed, Pelleted (3/16") and Self-Fed)

Ground Corn	38.00
Ground Milo	38.00
Soybean Meal	13.00
Meat & Bone Scraps	5.00
Alfalfa Meal	4.00
Dikal	0.50
Trace Mineralized Salt	0.50
Vitamin-Antibiotic Pre-Mix (Hoffman-Taft No. 992)**	0.75
Hygromix	0.25
TOTAL	100.00

*Each Pig was fed the equivalent of 150 lbs. each.

Fattening Ration***
(Entire Ration Mixed, Pelleted (3/16") and Self-Fed)

Ground Corn	41.00
Ground Milo	41.00
Soybean Meal	10.00
Meat & Bone Scraps	3.00
Alfalfa Meal	3.00
Ground Limestone	0.50
Dikal	0.50
Trace Mineralized Salt	0.50
Vitamin-Antibiotic Pre-Mix (Hoffman-Taft No. 992)**	0.50
TOTAL	100.00

**Hoffman-Taft No. 992 (each 20 lbs. contains)

Vitamin A (Stabilized Palmitate)	4,000,000 USP Units
Vitamin D_2	2,000,000 USP Units
Riboflavin	6,000 mgs.
d-Calcium Pantothenate	17,392 mgs.
(As d-Pantothenic acid	16,000 mgs.)
Niacin	40,000 mgs.
Choline Chloride	400,000 mgs.
Vitamin B-12	20 mgs.
Procaine Penicillin	45 Gms.
Bacitrocin	15 Gms.
Zinc Sulfate	1 lb.

***Fed from approximately 100 lbs. to market weight.

TABLE XIX

POST-WEANING RATIONS FOR FT. RENO FALL PIGS

Growing Ration*
(Entire Ration Mixed and Self-Fed)

Ground Wheat	80.00
Protein and Mineral Supplement Mix**	20.00
TOTAL	100.00

*Fed from 56 days to 100 lbs. (40 days).

**Protein and Mineral Supplement Mix

Soybean Meal	50.00
Tankage	20.00
Alfalfa Meal	20.00
Dikal (or Bonemeal)	3.50
Ground Limestone	1.50
Trace Mineralized Salt	2.50
Aurofac	2.50
Fortafeed	0.40
Quadrex	0.06
Zinc Sulfate	0.04
TOTAL	100.50

Fattening Ration***
(Self-Fed Free Choice)

Ground Wheat

Protein and Mineral Supplement Mix

Soybean Meal	40.00
Tankage	20.00
Alfalfa Meal	20.00
Dikal (or Bonemeal)	2.50
Ground Limestone	10.00
Trace Mineralized Salt	5.00
Aurofac	2.50
Quadrex	0.25
TOTAL	100.25

***Fed from approximately 100 pounds to 200 pounds.

VITA

Carl Edwin Gardner

Candidate for the Degree of

Master of Science

Thesis: THE RELATION OF CERTAIN LIVE ANIMAL SCORES AND MEASUREMENTS TO CARCASS MEASUREMENTS IN SWINE

Major Field: Animal Breeding

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Date of Final Examination: July, 1959.