FACTORS IN LIVE HOG MARKET VALUE DETERMINATION

by

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INTRODUCTION

There is a growing interest among producers, marketing agencies, educational folks, and processors to establish a more accurate means of pricing live hogs on the market. There is a great need for a method of marketing which through the pricing mechanism will reflect the actual cutout value to the producer. Slaughter hog prices based largely on averages is one of the main problems in marketing hogs in the United States. Basically, the packers interest seems to be that the total amount paid for all hogs is in line with the total value of all hogs purchased. This has been evidenced by healthy hogs within the same weight groups tending to sell for approximately the same price per hundred weight. Thus the higher quality hogs or those cutting out more of the valuable cuts receive too small a price differential for their above average value. Appropriate price differentials would provide powerful incentives for farmers to produce and market hogs that conform to consumer preferences.

A few important changes which are now being realized in the pork industry include a virtual loss of the lard market. This was due largely to the increased use of competing products. Consumer preferences are changing to where now they are protesting against the over fat cuts of pork shown in the meat cases. Presently, American men and women are more conscious of their weight and figure than ever before. Also, processors and consumers particularly are recognizing the economic waste which is inherent in producing this extra fat which is discarded.

All these changes are in effect lowering the demand and thus the price of the extra fatty cuts of pork. This change is one of the main reasons for the emphasis on the merit selling of hogs according to their cutout value.

The other reason being to give an incentive to producers through a means of price differentiation to produce the consumer preferred leaner pork cuts. Dressing percent had been used, and rightly so, as a basis of value determination for some time. However, due to the changes particularly in the value of lard and consumer demands, dressing percent is no longer a true indicator of value. At the present time, it is the ratio of lean to live weight which makes up the lean yield on a live basis and not the carcass yield itself which determines value.

Therefore, the emphasis should now be placed on the percent of lean yield or essentially the four lean cuts, the ham, loin, Boston butt and picnic to determine the real value of the individual hog. The four lean cuts, according to studies conducted in Ohio by Henning and Evans (1953) and in Minnesota by Engelman, et al. (1953), on 1949 prices, comprise 65 to 75 percent of the carcass cutout value. The percent of total value derived from the lean cuts was 74.5 percent using 1959 prices and the data obtained from this study.

The success of merit selling on an individual hog or small one owner group basis is generally dependent upon the ability of the buyer and seller to accurately evaluate, by estimation, the actual cutout value of the hogs. It is known that even though hogs appear quite similar on foot there is wide variation in cutout value even on hogs of the same weight. Therefore, it seems the responsibility of the buyer to become proficient to the extent that he is able to visually estimate quite accurately the actual value of the hogs he purchases. Physical characteristics have been found such as fatback thickness and body length which can be used to help estimate the cutout values. Also, studies have found that such physical characteristics can be estimated at a high level of accuracy through training and experience. The ability of buyers to associate these characteristics with the type of hog that will cutout a large portion of lean cuts is the ultimate goal of those interested in pork production.

The principle purpose of this study was to find those physical characteristics by use of actual measurements which are significantly correlated with the percent yield of the four lean cuts and these with the cutout values. The ultimate goal in mind being to find those factors which could be used to increase the accuracy of pricing hogs on the market and to reflect the true value differences back to the producer.

THE PROBLEM

Changes in consumer demand for pork products has caused a grave problem to the swine industry in general, but particularly in the field of marketing. Changes which are now taking place include a virtual loss of the lard market coupled with consumer protests against over-fat cuts of pork. Also, there is a growing recognition of the economic waste inherent in producing fat which has a relatively low use value.

The lower demand for lard and fat cuts of pork has emphasized the need for increased production of hogs yielding a higher proportion of lean cuts. The basic problem seems to be one of getting producers to change production to that type of pork which the consumers now desire. However, as long as all hogs, within the same weight class sell for approximately the same price per hundred weight, producers will not change the type of hog produced.

The question has been asked many times whether hog producers as a whole would gain financially through the use of a marketing system based on merit selling. The total receipts may not be increased under a system using the lean yield as a basis for the pricing mechanism, but this is not the important basic issue. The basic problem is one of producing an incentive for the farmer to improve the type of hog marketed. In other words, a system must be devised which will prove financially to the farmer that higher returns or net profits can be obtained by producing a meatier-type, higher yielding hog.

Today, many obstacles lie in the path leading to the ultimate objective of true returns to the producer and an increase in quality of hogs marketed. One important problem arises from the fact that very little sorting of like hogs together for selling purposes is carried on in the market place. Once again, the incentive for such a practice is lacking on most markets. Commission firms, which are responsible for selling the greater proportion of the hogs in a market place, receive their pay at the rate of so much per head. This gives no incentive to sort or even gain the highest returns possible except for their own continued relationship with the producer.

In a true competitive economy it is generally assumed that the demand for a commodity will determine the price and the price in turn will direct the producer in planning what products will be produced. When this theory was applied to the pork industry it was found that this has not been carried completely through especially back to the producer. In the pork industry many so-called middlemen are found between the producer and the consumer. It seems to be somewhere within this chain of intermediate producers that the real consumer preferences, which are relayed through the pricing mechanism, are altered or reduced in scope and magnitude. It is believed that the true force of the consumer demand is not being relayed properly to the producer or else the present problem would correct itself and would cease to exist.

An incentive of some nature must be given to the producer if a type change is to be accomplished. The packer buyer seems to be the one who can give this essential incentive to the producer through the media of a price differential. It does seem to be true that the primary concern of the packer is that the total amount paid for all hogs is in line with the total value of all hogs purchased. In other words, hogs of less than average value may be carried along by those above average in value with the same price being paid for the whole group. This method which is quite unfair, does not show the producer of the below average type hog that one should receive less returns for this type hog and that greater prices would be valid for higher yielding, meat-type hogs. However, excess fat is also a problem of the packer and in order to obtain the type of leaner hog desired, a price differential must be paid. This would appear to necessitate a payment to the producer more nearly in line with the actual value of the hogs marketed. This method would reward the farmer for producing the preferred meat-type hog and penalize one for the less desired over-fat types.

The actual cutout value is that value upon which the price differential must be based. The cutout value is that total value received from a hog after it has been slaughtered and each cut has been evaluated or sold. Another question which appears at this time is how can this cutout value be derived from a live animal. With the increased emphasis on the lean cuts, the ham, loin, picnic and Boston butt, it has been found that the percent of lean cuts are very highly associated with the cutout values. It was found using the data of this study that a correlation coefficient of .98324 exists between the percent yield of lean cuts and the total cutout value per one hundred pounds live weight. With the percent of lean cuts as the basis of value, then in order to derive at this value from the standpoint of a live hog one must find those live physical factors which are highly correlated with the percent of lean cuts. This was the problem involved in this study, to find those physical factors of a live hog which are significantly correlated with the percent of lean cuts which in turn would also be significantly correlated with the actual cutout values.

It is believed that with the live physical factors known which are associated by way of lean yield with the actual cutout value, one can estimate the value of the live animal before it is slaughtered. Through proper training and experience, it is believed that one can associate these live measurements with the true value of an animal to a high level of accuracy.

The long-range goal of the swine industry is that of producing the type of pork the consumers demand and to actually increase the total demand for pork. The part this study strives to accomplish is to find those physical factors which may be used to help accurately estimate the true value of the live animal in the market place. This accurate estimation would provide the basis for a price differential which would give the incentive necessary for the producer to produce the type of pork desired by the consumer.

THE HYPOTHESES AND OBJECTIVES

The following four hypotheses were selected as the basis for this study.

1. There are measurable physical factors of a live hog which are highly associated with the percent yield of the four lean cuts.

2. The percent of lean cuts is highly correlated with the total cutout value.

3. As the market value of lard and fat decreases, the yield of lean

cuts increases in value as a determiner of true cutout value.

4. There are significant differences in total cutout values derived from hogs of approximately the same live weight to warrant a large price differential among a market run of hogs.

The objectives which were set up to determine the validity of the hypotheses previously mentioned are as follows:

1. To find those live hog physical factors which may be used as a guide to visually estimate, on a market basis, the true value of market hogs.

2. To determine the degree of relationship existing between the percent yield of lean cuts and the total cutout value.

3. To compare the percent of lean yield as a basis of value determination with other previously used methods.

4. To find those live physical factors which are highly correlated with the percent yield of the four lean cuts.

5. To study the variation in lean yield of similar weight hogs and determine the price differential which was feasible had the true cutout value been paid.

6. To consider an improved method of evaluating live hogs on the market to give more accurate returns of the true value to the producer.

DEFINITIONS

A group of terms are defined in this section to aid in the comprehension of certain phrases as they appear in this study.

Meat-type hog - one possessing a fully developed ham, heavily muscled from ham to hock, long and uniform depth of side, trim jowl, and a large proportion of lean to fat in all cuts.

Lean yield - the yield of the combined four lean cuts which include the ham, loin, picnic, and Boston butt. The yield is calculated after the cuts have been trimmed to meet certain specifications.

Lean cuts - consists of the ham, loin, picnic, and Boston butt which are sometimes referred to as the four lean cuts or the high value cuts.

Primal cuts - consists of five cuts including the ham, loin, picnic, Boston butt, and bacon which may also be termed the preferred cuts.

Percent lean cuts - the relationship found by dividing the weight of the four lean cuts by the live or carcass weight. Live weight shall be the basis used in this study.

Percent primal cuts - the percent of the live or carcass weight obtained in the primal cuts. For purposes of this study, live weight shall be used.

Chilled carcass weight - the weight of the dressed carcass after allowing 24 to 48 hours of cooler shrink.

Dressing percent - the percentage of the weight of the live animal that will be represented by the chilled carcass after slaughter.

Cutout value - the combined value of all the component parts of an animal after slaughter.

Live-hog measurements - those physical measurements taken on a live hog.

Carcass measurements - those measurements taken from or on the carcass after slaughter.

Backfat thickness - the depth of adipose tissue deposited over the back of the hog.

Live fatback probe - a probe is a thin metal ruler gauged in inches used to measure the depth of backfat on live hogs.

Lean meter - an instrument for measuring the depth of muscling in an animal.

REVIEW OF LITERATURE

Consumer Preference and Trends

Self, et al. (1957), in their Wisconsin surveys discussed why consumers select high quality lean cuts in preference to those cuts which are excessively fat. The main reasons were a decreased demand for lard, consumer resistance to fatty foods, and more specialization in meat marketing methods. These consumer preferences have increased the need for improved evaluation techniques in hog marketing.

Working (1954), when observing the demand of pork relative to non-pork meats over a 40 year period, found the demand had declined quite strongly. Total demand for pork has increased due to the increased population but the per capita demand has declined. The drop was greatest for the fatter cuts and less marked for hams and was hardly noticeable for pork chops. Stevens, et al. (1956), have shown in their study the species of meat in the order of the consumer stated preference was beef, chicken, and pork.

As was stated by Working (1954), as the demand for pork declined, the demand for beef rose by approximately the same amount. Working also summarized the four factors influencing the per capita real demand for pork.

(1) Changes in real income of consumers.

(2) Downward trend in the demand for pork.

(3) Changes in supply of non-pork meats.

(4) Changes in pork prices.

A study by Trotter and Engelman (1957) indicated that consumers fail to recognize differences in grades when choosing pork products. Larzelere and

Gibb (1956) found that housewives are not consistent in selecting the coloring of meat and actually chose poor coloring over good. The housewife may pay a premium for the desirable fat covering but not for better color. Color has the least effect on purchase selection in any income group.

During the last several years, the influence of excessive weight as a factor affecting heart trouble has received considerable attention. Likewise, some evidence has been found that certain unsaturated fatty acids found in meat are necessary for the health of the skin. These statements are discussed more fully in the National Livestock and Meat Board's Annual Report (1953-54).

Factors Contributing to True Hog Value

As stated by Wiley, et al. (1951), the general decline in the price of lard in relation to pork prices has directed attention toward the percentage of lean cuts in the carcass as an indicator of market hog value. The average percentage of lean cuts among the live weight groups tended to decline as the live weight increased above the 220 pound level.

It is apparent in the study by Wiley, that yield differences are considerably more important than grade differences in contributing to the variation of values of hogs sold in lots.

Wiley, et al. (1951), noticed that among the weight groups there was no apparent relationship between the weight and the percent of lean cuts when the average fatback thickness was held constant. However, because the heavier weight groups averaged fatter carcasses than did the lighter ones, the average percentage of lean cuts appeared to decrease with increasing carcass weight. Actually, as the fatback thickness increased, the percent of lean cuts tended to decrease. Thus, the only way in which weight affected the percent of lean cuts was through backfat thickness.

Fox, et al. (1953), in a study of hog carcasses and an evaluation of trimmed cuts, proved conclusively that backfat thickness was a definite indicator of live-hog values. Hogs carrying a greater depth of backfat had an excess of fat on all cuts when their carcasses were broken down into their component parts. Excess fat lessened the value of all cuts and this study confirmed the principle that live-hog values should decline as backfat thickness increases.

Wiley, et al. (1951), found among the various live weight groups, the average per pound cutout value of hogs in the 180 to 199 and 200 to 219 pound groups were the highest of all the average group values. This was true no matter whether the lard was low, average, or high in value.

There seems to be a great variation between hogs of similar general appearance. Wiley, stated that although backfat thickness tended to increase with weight, the average backfat thickness of hogs of the same weight differed by two inches. Likewise for carcasses of the same weight, a range of 18 percentage points was found for the percent of lean cuts and a variation of 10 inches was cited in body length measurements. Large variations were also found in this study which shall be discussed in a later section.

According to Self, et al. (1957), the U.S.D.A. swine carcass grades are based largely on backfat thickness and provide a fairly accurate means of estimating the percent of lean cuts in a carcass. The live backfat probe technique developed by Hazel and Kline (1952), can be used to estimate the backfat thickness and consequently the carcass grade and percent lean cut yield with reasonable accuracy.

Zobrisky (1959), gave the correlations between the average of three live hog probes and five primal and four lean cuts as -.32 and -.43 respectively.

Pearson, et al. (1956), found little difference in the usefulness of the live probe or lean meter in regard to estimating backfat thickness and percent of either lean or primal cuts.

Holland and Hazel (1958) stated that the average of three backfat probes was more of an accurate indicator of percent lean cuts and percent fat cuts than length or backfat carcass measurements. This statement was in agreement with the data obtained from this study.

Pearson, et al. (1958), computed the correlations between a few physical measurements and lean or primal cuts as shown in Table 1. Here it was found that the live backfat probe received more significant coefficients with the lean and primal cuts than did the carcass backfat measure.

Table 1. Correlations of lean and primal cuts with body measurements.

	Carcass length	Backfat	Live probe
Lean cuts, live basis	.42	-.38	-.55
Lean cuts, carcass basis	.33	-.47	-.61
Primal cuts, live basis	.33	-.25	-.38
Primal cuts, carcass basis	.36	-.39	-.38
Fat trim	-.32	.52	.64

Source: J. Ani. Sci. 17:27-33. Feb. 1958.

According to Zobrisky, et al. (1959), carcass width increased as backfat increased with a correlation coefficient of .23. The carcass width and backfat both decreased however as length increased with correlation coefficients of -.31 and -.12 respectively.

Pearson, et al. (1958), studied the relationship of various individual lean cuts and the percent of lean and primal cuts on a live basis. They found correlations of the percent of loin with lean and primal cuts were .75 and .71 respectively. Likewise, for the percent of ham with the lean and primal cuts, the correlations were .75 and .64 in order.

In another study by Pearson, et al. (1958), dealing with lean cuts, sex of animal and other factors, the simple correlations as shown in Table 2 were found.

Table 2. Correlations with measures of leanness.

Other Factors	Percent trimmed loin		Percent skinned ham	
	Barrows	Gilts	Barrows	Gilts
Carcass length	.56**	.16	.16	.14
Backfat thickness	-.29**	-.39**	-.33**	-.12
Live Probe	-.33**	-.53**	-.61**	-.40**
Ratio fat/lean area	-.61**	-.65**	-.12	-.29*

*Significant at 5% level.
**Significant at 1% level.

Studies by Hetzer, et al. (1950), involved finding the relationships between live-hog measurements with each other and with the yield of primal cuts. Hetzer fouhd the trimness of middle to be a very important factor. The factors in order of their significance to the yield of primal cuts for barrows were: (1) depth of middle, (2) width of middle, (3) height of shoulder, (4) circumference of chest, (5) depth at chest, (6) width at hams,

(7) width at shoulders, and (8) length of body. These correlations by Hetzer and associates are shown in Table 3.

According to Pearson, et al. (1956), specific gravity of the carcass was a more precise measure of leanness than the backfat thickness. The correlations of Brown (1951) indicate that the fat or lean content of the carcass may be accurately estimated by specific gravity as well as by the percent of lean cuts or percent of fat cuts.

Relative Importance of Lard Prices

Lard prices in relation to live hog or lean cut prices have decreased considerably during the first half of the twentieth century according to Fox, et al. (1953). During the period, 1905-1909, the value of lard was 143.0 percent of that of a live hog and 83.3 percent of the value of fresh loins. Since this early time, lard has decreased in value until it was only worth 67.5 percent of the live hog value and 29.4 percent of the value of fresh loins in the period, 1951-1955. Prices of fresh bellies, however, have not varied as much as lard prices as is shown in Table 4. Fresh bellies have decreased in value as compared to live hog or lean cut prices during the past half century but not near as great as that shown for lard. This is illustrated best when compared to the value of a lean cut such as fresh loins. Bellies during the interval of 1905-1909, were actually of 4.3 percent greater value than fresh loins. However, during the more recent period of 1951-1955, bacon has decreased to 73.0 percent of the fresh loin value. Bacon has been of greater value than the live hog cost during the entire period. The percents used in Table 4 were based on the average values of the live hogs and fresh loins during the periods indicated.

Table 3. Simple correlation coefficients between live-hog measurements with each other and with yield of five cuts and yield of lean in hams for 71 barrows and 70 gilts.

Items	Sex	Height at shoulders	Width at shoulders	Width of middle	Width at hams	Depth at Chest	Depth of middle	Circum-ference	Yield: of 5 cuts[a]	Yield of lean in ham[a]
Length ear to tail	Barrows	+.50**	-.39**	-.50**	-.26*	+.03	-.16	-.33**	+.20	+.08
	Gilts	+.36**	-.35**	-.41**	-.26*	-.05	-.28*	-.40**	+.35**	+.39**
Height at shoulders	Barrows		-.51**	-.41**	-.35**	+.32**	-.23*	-.18	+.41**	+.25*
	Gilts		-.51**	-.39**	-.30*	+.27*	-.34**	-.21	+.50**	+.44**
Width at shoulders	Barrows			+.58**	+.41**	+.04	+.26*	+.43**	-.23*	-.15
	Gilts			+.44**	+.38**	+.18	+.38**	+.56**	-.23*	-.29*
Width of middle	Barrows				+.47**	-.18	+.37**	+.27*	-.40**	-.33**
	Gilts				+.60**	+.11	+.58**	+.55**	-.47**	-.39**
Width at hams	Barrows					+.04	+.25*	+.15	-.08	+.12
	Gilts					+.11	+.49**	+.34**	-.22	+.02
Depth at chest	Barrows						+.13	+.44**	+.37**	+.29*
	Gilts						+.30**	+.57**	+.02	+.16
Depth of middle	Barrows							+.14	-.43**	-.37**
	Gilts							-.51**	-.49**	-.29*
Circumference at chest	Barrows								+.16	-.02
	Gilts								-.34**	-.30*
Yield of five cuts	Barrows									+.72**
	Gilts									+.73**

[a]As percentage of live weight at slaughter.

*Significant at .05 level.

**Highly significant at .01 level.
Source: J. Ani. Sci. 9:37-47. Feb. 1950.

Table 4. Relative values of lard and bellies to live hog and lean cut prices.

	Live medium weight hogs (200-220 lbs.)	Fresh loins
	(percent)	
Lard, Prime Steam Tierces		
1905-1909	143.0	83.3
1921-1925	131.2	58.8
1951-1955	67.5	29.4
Bellies, Fresh		
1905-1909	179.1	104.3
1921-1925	185.5	83.1
1951-1955	167.8	73.0

Source: Prices of hogs and hog products, Ag. Mktg. Service, U.S.D.A., Stat. Bull. No. 205, March, 1957.

According to Wiley, et al. (1951), there was at one time, a delicate balance sensitive to the relative levels of lard value—between the advantage of a high percent of lean cuts and the offsetting disadvantages of frequent downgrading of extremely lean pork cuts and the accompanying low belly yield of the lean hogs. This may still be true to a certain extent, but nevertheless, this is a very important factor which must be kept in mind while increasing the lean yield of hogs. It is important that an opposite extreme not be reached where the quality standards cannot be met by the very lean type hogs. It may be more appropriate to think of a meat-type rather than a lean-type hog. Examples of a desired meat-type hog and an old style lard-type hog are shown in Plate I.

Wiley, et al. (1951), stated that when lard was low priced, dressing percent was less important as affecting carcass cutout value than when lard was higher. Also, the percent of lean cuts was closely associated with carcass cutout value when lard prices were low. Therefore, it seems that as the value

EXPLANATION OF PLATE I

Fig. 1. Example of a meat-type hog.

Fig. 2. Example of a lard-type hog.

PLATE I

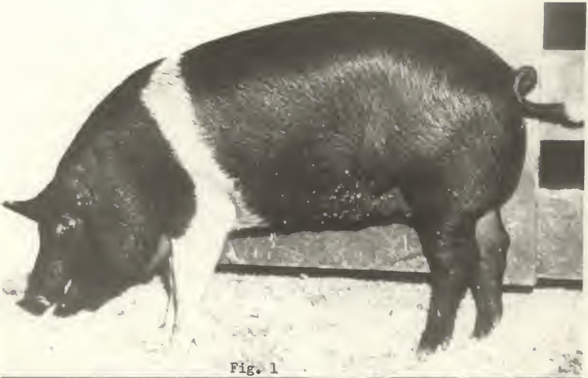

Fig. 1

Fig. 2

of lard continues to decrease, the percent of lean cuts will continue to grow in its relationship with the total cutout value.

Relationship of Live Estimates and Actual Measurements

In a study by Wiley, et al. (1951), the percent of lean cuts for each hog's carcass was estimated before slaughter by a Purdue representative. As was true for the dressing percentage estimates, the over-all average of the estimates was close to the average of the actual percentages of lean cuts for the carcasses of all the hogs. But when the individual estimates were related to the corresponding actual percentages of lean cuts, the estimates accounted for only 12 percent of the variation from one hog to another. Much greater accuracy would be necessary to make estimates of this factor of value in pricing live hogs.

Wiley stated the accuracy of estimating a finish grade on-foot was much higher than were those for dressing percentage and percentage of lean cuts. Since degree of finish is related with carcass cutout value, the ability to estimate finish on-foot could be used as an aid to price hogs more accurately. This group found that over 90 percent of the on-foot estimates of finish grade were the same as or within one grade of that which was assigned later to the carcass on the rail using nine different possible grades.

Fox, et al. (1953), proved conclusively that backfat thickness was a definite indicator of live hog values. Also, Fox stated that live hog values should decline as backfat thickness increases. Henning and Evans (1953) found that backfat measures can be estimated within a plus or minus 0.2 inches of the actual measurement.

In a study conducted by Fox, et al. (1953), the appraisers overestimated percent of five cuts in hogs low in yield and underestimated the yield of higher yielding hogs. This points out the fact that there may be a tendency of being conservative or that average estimates may deprive the producer of adequate returns for high-yielding hogs. With added experience appraisal errors would unquestionably be reduced. It would appear that men handling hogs at packing plants, stockyards, and buying stations could be trained to grade and select hogs so they could either buy or sell on a merit basis.

Bratzler and Margerum (1953) conducted a study to check how close persons could estimate body length, backfat thickness, and percent yield of preferred cuts. The 434 hogs used in the study were divided into three weight groups; 180-200, 200-220, and 220-240, and three judges were selected to estimate the the measures individually. They found the estimates were highly significant at the one percent level for length and fatback even though the heavier weight group did seem more difficult to estimate. The correlations for the percent of cutouts were much lower and harder to estimate even though the results did show they were significant at all weights. Even though the correlations for the lighter group were the most uniform, one judge's estimates were highly significant in all weight groups. Therefore, it appears hopeful that through considerable training and experience one can accurately live grade or estimate the true value of an individual live hog.

In a study conducted by Tuma (1958), similar results were obtained. Three experienced staff members, two commercial producers and a graduate student were selected to estimate the fatback thickness, carcass length and percent lean cuts of a group of barrows entered at a local spring barrow show. They witnessed highly significant correlations with the fatback and length measures. However, the estimate of percent lean cuts were not significant at the five percent level but were close. Bratzler and Margerum (1953) have also shown this factor the most difficult to appraise.

In the study by Tuma (1958), none of the scorers had actually estimated percent lean cuts previously, even though they were familiar with the cuts. It was felt by Tuma, "that evidently scorers do not associate percent lean cuts with fatback thickness and grade even though they are highly correlated with percent lean cuts." However, it would seem logical that the percent of lean cuts could be accurately estimated if through training one could associate all the known significant live characteristics with the percent yield of lean cuts in the appropriate manner.

Other Methods of Sale

Hogs are sold on three different bases; so much per head, so much per 100 pounds, and so much per 100 pounds carcass weight. A fourth method of sale could be listed as on the basis of lean yield.

The first method - sale by the head - is the oldest, the simplest, and the most inaccurate of the three. Sale by the head necessitates estimating not only the grade of the carcass but also the live weight and dressing percentage or carcass yield of the hogs. This system was used almost universally in England until recent times and is still the prevailing method in France.

The second method - selling by the 100 pounds live weight - is the prevalent method in the United States. It is a more accurate method than sale by the head. The weight of the hogs are determined by scales when the final settlement is concluded. But at many markets hogs are not weighed until after sale - so weight must be estimated as part of the pricing process. However, when the actual price bargaining is taking place, an estimate of the weight must be used as the actual live weight has not yet been obtained from the scales. There may be a few exceptions to this but for the great majority of the markets this does hold true. Therefore, the buyer and seller must still estimate the weight for price settlements along with the dressing percent or yield and grade of the carcass.

The third method - sale by carcass weight and grade - is in some respects, the most accurate of the first three. It is the basis on which all Danish hogs have been sold for many years. Strictly speaking, the Danes do not sell hogs, they sell hog carcasses. The carcass system takes most of the guesswork out of hog selling, because after the hog is slaughtered the carcass can be weighed and graded more accurately than a live hog. However, with the carcass grade and weight given, this still does not in itself give the total cutout value which is the final objective. Cutout would not be known precisely in straight carcass selling.

The fourth method - based on lean yield - is a new method which places great emphasis on the yield of lean cuts. This method is now being tried in the experimental stage on a few markets and in a few meat packing plants. In many cases where this method is being used, the hogs are slaughtered and cut up to find the actual yield of the four lean cuts. In the instances where live hogs are purchased on an estimated lean yield basis, the greatest problem arises from the difficulty of actually estimating, to a high degree of accuracy, the percent of lean cuts. These methods involve advantages as well as disadvantages which shall be discussed more fully later.

Two disadvantages of the live weight system as stated by Shepherd, et al. (1940), were: (1) the differences in yield are considerable but difficult to detect and (2) it provides only a small and uncertain incentive for producers to produce high-grade hogs. If a more accurate basis of sale could be worked out, each hog producer would get more nearly what his particular hogs were worth.

Shepherd, et al. (1940), stated the differences between the values of different lots of butcher hogs are greater than the differences between the prices paid for them. The correlations between values and prices, lot by lot within each weight class, was rather low as shown by the correlation coefficients of .34 to .56 received in the cases studied.

Carcass Grade and Yield. The advantages of the carcass grade and yield method as stated by Engelman, et al. (1953), include the following points:

1. Aid producers in satisfying consumer demand.
2. Payments are distributed according to value.
3. Bargaining, competition, and price determination.
4. Sale by description.
5. Reducing unnecessary fill before selling.
6. Aid in reducing losses from bruising and disease.
7. Make the work in swine genetics more effective.
8. Sharpen the objectives in swine nutrition.
9. Aid in the solution of the lard problem.

There are some who would argue with Engelman and his associates on their third point which includes bargaining and competition as an advantage of this method. Many feel that the producer loses a large degree of the bargaining and competitive power found in the live weight system when the hog is actually slaughtered before the settlement is completed. Once the hogs are delivered at the packing house, the producer has lot control over his product and little bargaining or competitive power is actually left to the farmer.

A passage from Shepherd, et al. (1940), was inserted here in answer to the question, could hogs be sold by carcass weight and grade in the United States? As far as can be determined, packers would pay out about the same amount of money for a given year's supply of hogs under the carcass system of sale as they would under the present live weight system. If the carcass system were adopted, the benefits to hog producers would come not from any increase in the total of money for a given run of hogs but from three other sources:

> 1. The money paid for the hogs would be distributed more equitably among the different hog producers than at present. Each producer would get more nearly what his particular hogs were worth. The producer of high-yielding and high-grade hogs would get more than under the present live weight system, and the producers of low-yielding and low-grade hogs would get less.
>
> 2. Under the stimulus of this incentive for raising high-yielding and high-grade hogs, with the passage of time, hog producers would bring in hogs of higher average grade and yield than would be under the present system. A year's run of these higher grade hogs would be worth more to packers, and would enable them to pay more money to hog producers.
>
> 3. The carcass basis of sale would remove any incentive for filling hogs, and hog producers would save the cost of the feed now wasted on this practice.

A group of possible problems associated with the carcass grade and yield method were discussed by Engelman, et al. (1953). These include the following points:

1. Maintaining the identity of the hogs until the carcasses were weighed and graded and the information recorded.

2. Obtaining an impartial weighmaster to record the correct weight in the absence of the owner.

3. That the carcasses be graded by impartial graders who have uniform standards of grading.

4. Returns from by-products not included in the carcass weight.

5. Settlement may be delayed for a longer period than is customary on a live weight basis.

6. Additional costs would be incurred in this method.

7. Risks to the producer may be increased due to the time and location elements of slaughter.

8. Maintaining grade identity to the retail counter.

9. Acceptability to producers especially producers of lower quality hogs.

Shepherd, et al. (1940), said many of the short-comings of the live weight system of sale would disappear if hogs were sold by carcass weight and grade. The Canadian farmers were selling 40 percent of their commercial hogs on the carcass value basis by 1938. Some of the problems as stated by Engelman, et al. (1953), have been solved under Canadian commercial conditions. Positive identification is obtained by tattooing the live hogs on the shoulder with a high speed rotary head tattooing iron with indelible ink. An accurate carcass weight is registered by automatic electric recording scales on the carcass rail built in the plant. An accurate and impartial grading is performed by a government carcass grader who is stationed by the carcass rail. The government grader or his assistant fills out the settlement sheets which gives an impartial and speedy settlement as the payment checks are mailed the same day the hogs are slaughtered. The extra cost of selling hogs on this basis was estimated to be about one cent per 100 pounds live weight in 1940. This cost figure may be more now in the United States.

As stated by Wiley, et al. (1951), the George A. Hormel and Company, Austin, Minnesota, has tried different systems of buying hogs upon the basis of carcass weight and grade since 1934. The Shen-Valley Meat Packing Co-op, which opened in November, 1949, at Timberville, Virginia, has been buying hogs on a carcass weight and grade basis.

According to the North-Central Livestock Marketing Research Committee (1952), a southern Minnesota meat-packing company in 1933, made payment to farmers for hogs on the basis of the value of the wholesale cuts. Since this process reduced the speed of cutting operations and increased processing costs, the plan was considered to be impractical and was discontinued during the same year. The following year this company began to buy hogs experimentally by carcass weight and grade.

As stated by the Central Livestock Marketing Research Committee (1952), few attempts have been made to improve on the usual live weight method of marketing hogs in this country. One such attempt was sale on the basis of guaranteed yield. In 1923, this was initiated by a federation of county livestock marketing cooperatives in Ohio and Indiana. These cooperatives assembled and sorted different owners hogs into uniform lots and shipped direct to eastern slaughterers on a basis of guaranteed yields. This method started and proved popular for a time and appeared to be an improvement in some respects over the usual live weight method of sale. It was ultimately discontinued in the 1930's due to two main reasons: (1) local managers were unable to estimate dressing yields accurately in order to send uniform loads to market, and (2) a representative of the seller was not present at the time of weighing the carcasses at the slaughtering plant which created suspicion in producers who expected greater yields than were received.

Dressing Percent. Hankins (1940) and Warner (1934) indicated that an increase in fatness was accompanied by an increase in weight and yield of the dressed carcass. Dressing percent and the yield of wholesale cuts are closely associated in hogs of similar finish and weight. Dressing percent was an important measure of the hog's value. According to Hammond and Murray

(1937), dressing percent was influenced more by the weight of the hogs than by breed or type.

Pearson, et al. (1958), stated that the percent of belly, live basis, was positively correlated with dressing percent, backfat thickness, live fatback probe, and fat trim. This would indicate that dressing percent tends to go up as percent of belly increases. Therefore, dressing percent does increase with fatness. This was also proven by Cummings and Winters (1951).

Holland and Hazel (1958) stated that correlations of body length, backfat probes, and circumferences of flank, middle, chest and jowl with the percent of fat cuts are higher than for the percent lean cuts.

As stated by Wiley, et al. (1951), only 28 percent of the variation in dressing percent of individual hogs was accounted for by differences in average backfat thickness. Fill was a very important factor in this case.

In a study by Zobrisky, et al. (1959), the correlation coefficient between the dressing percent and the percent of lean cuts was found to be .36. Pearson, et al. (1956), stated there was a small very nonsignificant degree of association between live probe and dressing percent. However, in this study there was a high degree of association found between live probe and the percent of lean cuts. Since the percent of lean cuts is highly correlated with the cutout value, the live probe is an important measure of cutout value.

Hankins, et al. (1953), suggested that the percent of preferred cuts, ham, loin, Boston butt, picnic, and belly, have a greater effect on dressing percent than the yield of fat which includes backfat, leaf fat, clear plate, and fat trimmings. They reported a multiple correlation of .91 for yield of fat and a -.72 for yield of lean cuts.

Zobrisky, et al. (1959), stated that the percent of lean cuts contribute more to dressing percent than the percent of fat. He proved this statement by saying muscle, fat and bone influence dressing percent. The component present in the largest quantity has the greatest influence. The yield of lean contributed more to dressing percent than either the miscellaneous cuts or fat by virtue of a greater percent yield per carcass.

Wiley, et al. (1951), announced that when lard was low priced, in relation to lean cuts, dressing percent was less important as effecting carcass cutout value than when lard was higher priced.

Fox, et al. (1953), stated that dressing percent is not always a true indicator of hog value. This measure provides very little allowance for the differences in cutout value among different type market hogs. It is the percent of fat to lean which makes up the yield and not the yield itself which determines value.

Fox, et al. (1953), also proved conclusively that backfat thickness was a definite indicator of live hog values. If the statements are true that live hog values should decline as backfat thickness increases and that dressing percent increases as fat back thickness increases, then there is no firm basis to state that dressing percent is any longer a good measure of value.

Yield of Fat. Hazel and Kline (1952) and Zobrisky (1954) have said the yield of fat can be more easily and accurately determined than the yield of lean in the live hog. Furthermore, Zobrisky, et al. (1959), stated the yield of fat is as accurate as the yield of lean for estimating carcass value. However, it has been found that the yield of fat is mainly associated with thickness of backfat as is shown by the correlation coefficient of .61. Holland and Hazel (1958), have also stated that the measurements of length, loin area, and backfat thickness are more highly correlated with the percent of fat cuts than for the percent of lean cuts.

It may be true that the yield of fat can be more easily and accurately estimated than the lean yield, but this does not prove that the yield of fat is more closely correlated to the cutout value than the lean yield. In fact, if the yield of fat and dressing percent are highly correlated and the dressing percent as stated by Fox (1953), was not always a true indicator of value, then the yield of fat likewise may not be a true indicator of value.

History of Swine Grades and Marketing Procedures

The methods of marketing swine and the standards for grading swine have witnessed a continual progressive evolution from the earliest times of recorded hog marketing. Down through the ages, the methods and procedures of marketing and grading swine have undergone continuous changes for the improvement of the industry. This is very true at the present time as new methods are being investigated to find an acceptable means of marketing whereby the true value of the hogs marketed will be focused back to the producer. The following section depicting the history of swine grades and marketing procedures was obtained mainly from the material of Reynolds and Kiehl (1952) and Fowler (1957). This section has been added to gain a better knowledge of the background from which the various methods of swine marketing have evolved.

From early colonial times through the first part of the nineteenth century, reference to livestock handled at the markets was generally made on the basis of species rather than by certain classes or grades. This was especially true for hogs and sheep.

During the early stages of the development of the livestock industry in the United States, trading in swine was conducted largely on the theory that "pigs is pigs" and "a hog's a hog." As a rule they were sold within a relatively narrow price range.

Lacking specific classes and grades during this time, the sale price was frequently determined by the head in most species of livestock. Very early references to marketing practices show that hogs were sold to packers graded according to weight, with a heavy animal selling for almost double the price per hundred pounds than for the lighter weights. With an increase in the volume of slaughter hog marketings around the turn of the nineteenth century, there appeared some voluntary recognition of quality differences by the establishment of price differentials. Premiums for quality were paid by pork packers of the Ohio Valley as early as 1817. However, there was little progress made in the method of sale of slaughter hogs by classes and grades during the first few decades. Each market developed classifications and adopted descriptive terms peculiar to its own trade area.

The first issue of "The Country Gentlemen" in January, 1853, reported the Brighton market classification of hogs as old hogs, fat distillery-fed hogs, and fat corn-fed hogs and shoats, the latter class being further divided into sows and barrows. These classifications were based principally upon differences in age, sex, and method of feeding. The "Prairie Farmer" in 1867, reported prices on choice, medium, and common bacon-type hogs. The price quotations apparently were based largely on weight with heavier hogs selling at considerably higher prices.

There are several kinds or classes of hogs and within each class there is a wide range in quality which usually accounts for a range in market value.

Some method of dividing the quality range of a given class or kind into groups of similar and uniform quality was considered necessary for promoting satisfactory marketing. Classifying market hogs is the process of sorting the animals on the basis of age, sex, weight, and use or purpose. The use of conformation, finish, and quality as factors in grading have been, even up to the present time, subjective measures and difficult for accurate interpretation.

In 1904, Illinois Agricultural Experiment Station made the first approach toward formulation of standard market classes and grades for hogs.

The U.S.D.A. issued several grade standards for slaughter livestock within a few years after initiation of their studies in 1915. The first system of tentative standards for market classes and grades of swine for use in market reporting work was completed in Chicago in 1918. The use of tentative and official standards was optional in so far as market agencies were concerned.

The first tentative standards for pork carcasses, cuts and miscellaneous meats were issued by the department in 1924. These standards were revised and expanded, and published as standards for pork carcasses and fresh pork cuts in 1933. They were: Fat-type (butcher), meat-type (bacon), sow (packing), shipper, roasting, and stag-pork carcasses. The designated grades within each of the classifications were: No. 1, No. 2, No. 3, and Cull grades.

Tentative standards for classes and grades of slaughter hogs were issued in 1931 and revised and published as U.S.D.A. Circular 569 in 1940. These standards were based on the grade factors of conformation, quality, and finish, and the grades selected were Choice (Fat-type), Choice (Meat-type), Good, Medium, and Cull.

In view of a diminishing market for lard and increased consumer demand for leaner cuts of pork, the U.S.D.A. proposed new standards for slaughter barrows and gilts in 1949. These were slightly revised and set up as official U.S. standards by the Secretary of Agriculture on September 12, 1952. These grades were based mainly on two aspects: (1) apparent differences in yield of lean cuts and fat cuts, and (2) differences in indications of quality. The main physical characteristic used to separate the grades was fatback thickness, which was aided in borderline cases with consideration of length in relation to weight and other body proportions. The five grades were called Choice No. 1, Choice No. 2, Choice No. 3, Medium, and Cull.

The three basic grades Choice, Medium, and Cull are further explained by Fowler (1957) as follows:

> 1. Hogs of Choice grade produce comparable quality lean cuts, but may differ widely in the degree of fatness. Hence, this grade is further divided into three segments--No. 1, No. 2, No. 3, -- to reflect the decreased yields of lean cuts and increased yields of fat cuts as finish exceeds the minimum required for the choice grade. 2. Medium grade barrows and gilts are slightly to moderately underfinished and have higher ratios of lean to fat than choice grade hogs, but they produce medium grade pork cuts in which the lean is slightly soft and has little or no marbling. 3. Cull grade hogs are decidedly underfinished resulting in higher lean to fat ratios than in any other grade, but they produce cull grade pork cuts which are soft and watery and have no visible marbling in the lean.

Those hogs on the border lines of grades are determined by consideration of length in relation to weight.

The official standards were revised in July, 1955, to read as follows: US No. 1, US No. 2, US No. 3, Medium, and Cull. In addition, the backfat thickness requirements were reduced for each grade in keeping with the growing consumer preference for leaner cuts of pork. In September, 1956, these grades were accepted for slaughter sows.

The present weight and measurement guides for barrow and gilt carcasses are shown in Table 5.

Efficiency of Feeding Type No. 1 Hogs

There has been some controversy about the efficiency of feeding the leaner, consumer preferred, meat-type hog. Many swine producers have said that the so-called meat-type hog was slower maturing and more costly to produce than the fatter type animal. However, the results of Fox, et al. (1953), indicated that hogs which fell in the meat-type category have been among the most efficient utilizers of grain and pasture, while producing more lean meat on fewer pounds of feed. According to U.S.D.A. Leaflet No. 429, November, 1957, it was found that No. 1 quality hogs required 24 pounds less feed to put on 100 pounds of gain than did No. 2 and No. 3 hogs. In relation to 1957 prices this would be 69 cents less feeding cost per 100 pounds gain. It was also found that one could produce 200 pound hogs in five to six months receiving one pound of gain for each 3.4 pounds of feed input.

Review of Literature Summary

This short section has the objective of summarizing briefly the previous sections of the review of literature. Included here are the main points brought out by the various references cited.

The housewife of today prefers the high quality leaner type cuts found in the show case. There is a greater concern toward the body weight and figure now so that there is more resistance to fatty-type foods. Pork has decreased in per capita consumption mainly due to the high content of fat

Table 5. Weight and measurement guides to grades for barrow and gilt carcasses.[1]

Carcass weight or carcass length[2]	Average back fat thickness (inches)[3] by grade				
	U.S. No. 1	U.S. No. 2	U.S. No. 3	Medium	Cull
Under 120 pounds or under 27 inches	1.2 to 1.5	1.5 to 1.8	1.8 or more	0.9 to 1.2	Less than 0.9
120 to 164 pounds or 27 to 29.9 inches	1.3 to 1.6	1.6 to 1.9	1.9 or more	1.0 to 1.3	Less than 1.0
165 to 209 pounds or 30 to 32.9 inches	1.4 to 1.7	1.7 to 2.0	2.0 or more	1.1 to 1.4	Less than 1.1
210 or more pounds or 33 or more inches	1.5 to 1.8	1.8 to 2.1	2.1 or more	1.2 to 1.5	Less than 1.2

[1]September 1, 1956, these grades were accepted for slaughter sows.

[2]Either carcass weight or length may be used with backfat thickness as a reliable guide to grade. The table shows the normal length range for given weights. In extreme cases where the use of length with backfat thickness indicates a different grade than by using weight, final grade is determined subjectively as provided in the standards. Carcass weight is based on a chilled, packer style carcass. Carcass length is measured from the forward point of the aitch bone to the forward edge of the first rib.

[3]Average of measurements made opposite the first and last ribs and last lumbar vertebra.

Source: Official United States standards for grades of pork carcasses (barrow and gilt), 1955, U. S. Department of Agriculture, Agricultural Marketing Service.

found on many pork cuts. Leaner pork cuts such as ham and pork chops have shown little decrease in demand. In general, the demand seems to be rising for beef and poultry and decreasing for pork. It has been found that as beef consumption increases, pork consumption will decrease by a similar amount.

The methods of marketing and pricing hogs have witnessed a continual progressive evolution from the earliest times of recorded swine marketing. The standards of grading have been developed and improved with time according to the consumer's demand. The sale of hogs has changed from a so much per head basis to a price for 100 pounds live weight. Many other short time methods have been tried but were unsuccessful. At the present time some attention has been given to a carcass grade and yield basis. Many of the problems found in this method have been eliminated in Canada. However, it is not certain that the problems could be solved in the United States in the same manner as they were in Canada. Another new method being investigated at this time is one in which the percent of lean yield is used as a basis for value determination. The objective of this method is to find an acceptable method whereby the true value of the hogs marketed will be focused back to the producer with the ultimate goal of improved consumer desired meat-type hogs being marketed.

Dressing percent was another method used as a basis for price determination. This method was of more importance when the value of lard was greater because dressing percent was influenced more by the fatness than the type of hog. Now when lard values are lower and less significant compared to lean cuts, it was found that the percent of lean yield was more significant with the total cutout value than the dressing percent. Some have said the yield of fat was just as important and more easily and accurately determined than the yield of lean. However, some rebute this because this does not prove that the yield of fat was more closely associated with the cutout value than the lean yield. In fact, if the yield of fat and dressing percent are highly correlated, then the yield of fat, as was likewise true for dressing percent, may not be a true indicator of value.

It has been found that experienced personnel can estimate certain physical factors of a live hog with a high degree of accuracy. These factors include such measures as fatback thickness, body length, and a finish grade. However, greater difficulty arises when estimating the percent of lean yield. Most estimations were conservative in that they overestimated the yield of low yielding hogs and underestimated the higher yielding hogs. However, the personnel participating in these studies had not had numerous experiences in estimating the percent of lean yield. With added experience and factor knowledge, appraisal errors would unquestionably be reduced.

Lean yield has gained the spotlight as being the measure most highly associated with the true cutout value. Therefore, it was important to find those factors highly correlated with the percent of lean yield. Fatback thickness has been proven a most definite indicator of live-hog value. Other important factors include carcass length, trimness of middle, height of shoulder, circumference of chest, depth at chest, width at hams, width at shoulders, and body length. The live backfat probe has been proven as accurate a measure of the adipose tissue covering the back as a carcass measure. Some have found a higher correlation between percent lean yield and the backfact probe measure than was received for the carcass fatback measure.

Some producers doubt the efficiency of feeding the leaner, consumer preferred, meat-type hogs. However, it has been found that the meat-type hog has been among the most efficient utilizers of grain and pasture while producing more lean meat on fewer pounds of feed. Others have reported that No. 1 quality hogs required 24 pounds less feed to gain 100 pounds live weight than did No. 2 and No. 3 quality hogs. Some meat-type hogs have added one pound of gain for each 3.4 pounds of feed input and have been finished in five to six months.

METHODOLOGY

This study was originally designed (1) to test the ability of terminal market personnel in visually estimating lean yield of live hogs and (2) evaluating the relationship of certain live hog measurements to lean yield of the market run of hogs at a terminal market. However, conflicts necessitated abandonment of original plans. A substitute plan was adopted whereby live hog measurements were obtained during the summer of 1959, on 31 barrows from the Kansas Swine Testing Station at Manhattan, Kansas. Since it was routine practice in carcass evaluation of these barrows to determine yield of lean cuts little extra work was required. These barrows, representing seven breeds, were voluntarily submitted to the station from 30 Kansas purebred breeders. As each barrow came into the range of 205 to 210 pounds it was weighed at the testing station and delivered to the meat laboratory at Kansas State University for slaughter and carcass evaluation. An effort was made to have the barrows weigh as near 200 pounds as possible at slaughter by delivering them to the laboratory at the weight of 205 to 210 pounds. The usual twelve hour shrink without feed or water was from five to ten pounds. The barrows were again weighed at the laboratory immediately before slaughter.

Live Animal Measurements

Prior to slaughter a number of measurements were made. Live probe measurements of backfat thickness were made with a metal ruler, as described by Hazel and Kline (1952), by an experienced staff member of the Animal Husbandry Department. These backfat probes were taken the day preceding the slaughter of an animal. All measures were taken to the closest .05 inch. The probing sites were over the fifth rib, last rib, and last lumbar vertebra on each side 1.5 inches from the midline. The average of these six probe measurements was used in the further analysis of this study.

All other live measurements were taken the evening preceding the early morning slaughter, by the author and an assistant. The pigs were not restrained in any manner except by a small holding pen in order to obtain as near normal measurements as possible. These measurements were taken to the closest tenth of an inch. Body length was measured with a steel tape along the top line from a point between the ears to the base of the tail. As the position of the head would tend to make the results vary, these measurements were taken with the head straight to the front and the snout two to three inches off the floor. Chest circumference was taken by passing the tape around the body immediately behind the shoulder. Front cannon circumference was found by running the tape around the small of the cannon bone directly below the knee joint. The circumference of the rear cannon was taken at the small of the cannon just below the hock joint. The forearm length was taken from the back of the knee joint to the point of the elbow.

The distance between the left and right edge of the base of the skull bones was measured with the use of a pair of large calipers. The width or thickness measurements of the shoulder, loin and ham, and the depth of the chest and twist were also taken with the aid of calipers. By coming down over the top, the widest point of the shoulder was measured. The loin thickness was measured across the loin edges at the center of the loin. Likewise, the ham was measured at the bulge of the ham as seen when looking downward from the top of the animal. Again using the calipers, the depth of chest was taken from a point immediately behind the top of the shoulder to the lowest point immediately behind the forelegs. The depth of twist measure was from the base of the tail downward to the twist or the point between the legs where the hams join. Plate II shows the location from which the measurements were obtained.

Carcass Measurement

The carcasses were cut approximately 24 hours after slaughter. Before cutting, the carcass was weighed and cooler shrink was calculated. Before removing the carcass from the rail the backfat thickness and carcass length was measured on each side. Length of carcass was measured from the anterior edge of the aitch bone to the anterior edge of the first rib adjacent to the vertebra. The three measurements that were taken of backfat thickness were opposite the first rib, 10th rib, and last lumbar vertebra. The skin thickness was included in the backfat measurement. All linear measurements were taken to the nearest tenth of an inch.

Cutting Procedure

All carcasses were cut and trimmed according to a prescribed procedure set up by the Kansas Swine Improvement Association to insure uniformity in cut and trim among carcasses. Weights of each trimmed cut of meat, fat trim,

EXPLANATION OF PLATE II

Fig. 3. The following numbers show the location of each measurement.
1. Depth of twist.

Fib. 4. The following numbers show the location of each measurement.
2. Rear cannon circumference.
3. Depth of chest.
4. Forearm length.
5. Forearm circumference.

Fig. 5. The following numbers show the location of each measurement.
6. Ham thickness.
7. Loin thickness.
8. Backfat probe sites.
9. Body length.
10. Heartgirth circumference.
11. Shoulder thickness.
12. Base of skull width.

PLATE II

Fig. 3

Fig. 4

Fig. 5

lean trim and waste were recorded.

Statistical Methods

The methods of statistical analysis applied to this data were simple and multiple correlations. Simple correlations were run using linear regression analysis as described by Snedecor (1956). The multiple correlation analysis for 11 variables were computed on the International Business Machines Corporation 650 electronic computer at Kansas State University.

ANALYSIS OF DATA

The data used in this study were obtained from 31 market barrows from the Kansas Swine Testing Station. These hogs were slaughtered in the meat's laboratory at Kansas State University where the live as well as the carcass measurements were taken. The objective was to find the relationship between certain live characteristics and the yield of the four lean cuts and/or five primal cuts. To analyze the data the analysis was divided into four sections which include simple correlations and multiple correlations a section of ratios using simple correlations and finally an analysis of values.

Simple Correlation Analysis

Simple correlations were run using linear regression analysis as described by Snedecor (1956). Relationships were run on a large number of variables which shall be referred to as X's. A listing of the variables studied is as follows:

1) Fatback thickness
2) Shoulder thickness
3) Heartgirth circumference
4) Loin thickness
5) Body length
6) Ham thickness
7) Base of skull width
8) Forearm length
9) Forearm circumference
10) Depth of twist
11) Percent yield of four lean cuts
12) Fatback probe depth
13) Pound yield of four lean cuts
14) Skinned ham weight
15) Trimmed loin weight
16) Trimmed picnic weight
17) Trimmed Boston butt weight
18) Bacon weight
19) Percent live weight of hams
20) Percent live weight of loins
21) Percent live weight of picnics
22) Percent live weight of Boston butt
23) Percent live weight of bacon
24) Percent of five primal cuts
25) Value of four lean cuts
26) Value of five primal cuts

27) Cutout value

28) Live hog cost

29) Carcass grade

30) Dressing percent

31) Carcass length

The relationships for 24 of these 31 variables are shown in Table 6.

In order to sell and/or buy swine on a live basis, live physical factors must be used in determining the price or value of the livestock. However, the factors used must be highly associated with the yield of the more valuable cuts if the true value is to be found by visual estimation means. When looking at the percent yield of four lean cuts and five primal cuts, X11 and X20 respectively, many high correlations are found. Wiley, et al. (1951), have stated that the percent yield of the four lean cuts was the best measure of value because these are the more important high priced cuts. It would seem logical that perhaps a fifth cut (bacon) should be added to this group at least for study purposes. Bacon is approximately equal in demand to the Boston butt or picnic, as evidenced by price per hundred weight, and is greater in weight than these two cuts combined thus yielding a higher value product than the Boston butt and/or the picnic.

As is evidenced in Table 6, a large number of these correlations were found to be highly significant. Those live-hog measurements giving the most significant correlations with the percent of the major four or five cuts were: (1) carcass fatback thickness, (2) the shoulder thickness, (3) heart-girth circumference, (4) ham thickness, and (5) the live fatback probe. In comparing these variables with both the percent of lean yield and percent of primal cuts, the backfat measurements were found to be the most significantly

Table 6. Summary of simple correlation coefficients computed in this study.

Measurement	X_1 Fatback thickness	X_2 Shoulder thickness	X_3 Heartgirth circumference	X_4 Loin thickness	X_5 Body length	X_6 Ham thickness
X_2 Shoulder thickness	.37366*					
X_3 Heartgirth circ.	.43624*	.54940**				
X_4 Loin thickness	.25437	.49510**	.50340**			
X_5 Body length	-.27462	-.58001**	-.29269	-.63311**		
X_6 Ham thickness	.08357	-.07416	.01466	-.04069	-.03530	
X_7 Base of skull width	.16519	.18087	.15146	.25898	-.28972	.09941
X_8 Forearm length	-.13763	-.27334	-.20322	-.61305**	.23546	.05473
X_9 Forearm circ.	.07840	.10019	.00219	-.08491	-.34273	.28142
X_{10} Depth of twist	-.23678	-.35596*	-.38576*	-.21353	.20252	.10459
X_{11} Percent lean yield	-.67071**	-.46828**	-.38099*	-.27903	.22609	.17724
X_{12} Fatback probe depth	.74181**	.45609**	.47565**	.33521	-.31015	.08839
X_{13} Pounds lean cuts	-.54342**	-.34199	-.17855	-.18938	.14440	.16881
X_{14} Percent hams (live wt.)	-.46895**	-.47507**	-.30655	-.25962	.17089	.45275*
X_{15} Percent loin (live wt.)	-.65692**	-.53238**	-.34961	-.27894	.36213*	-.30237
X_{16} Percent picnic (live wt.)	-.00456	.18314	-.06684	.05974	-.18136	.35911*
X_{17} Percent butts (live wt.)	-.37957*	.01217	-.14915	-.08647	-.03357	-.00273
X_{18} Percent bacons (live wt.)	.13702	.14651	.21392	.15887	.08288	.19613
X_{19} Percent primal cuts	-.59264**	-.37912*	-.24407	-.17740	.28519	.31324
X_{20} Value of lean cuts	.07379	.06410	.18911	.01736	-.21327	-.17181
X_{21} Value of primal cuts	-.48245**	-.31478	-.07153	-.12883	.19927	.20668
X_{22} Total cutout value/cwt.	-.68301**	-.53026**	-.39913*	-.30170	.26625	.11995
X_{23} Carcass grade	-.86914**	-.31526	-.32639	-.31193	.29166	-.17694
X_{24} Dressing percent	-.25802	-.05321	.11589	.11612	.01777	.21984

*Significant at 5 percent level (.355).

**Significant at 1 percent level (.456).

Table 6. (cont.).

Measurement	X_7 Base of skull width	X_8 Forearm length	X_9 Forearm circumference	X_{10} Depth of twist	X_{11} Percent lean yield	X_{12} Fatback prove depth
X_8 Forearm length	-.31374					
X_9 Forearm circ.	-.04937	.43768*				
X_{10} Depth of twist	.05884	.14726	-.16105			
X_{11} Percent lean yield	-.14249	.14555	.10879	.10366		
X_{12} Fatback probe depth	.26176	-.23859	.05255	-.15636	-.60715**	
X_{13} Pounds lean cuts	-.09444	.20762	.27356	.00450	.92891**	-.55692**
X_{14} Percent hams (live wt.)	-.06609	.26177	.30330	.18069	.87500**	-.45726**
X_{15} Percent loin (live wt.)	-.16049	.09799	-.14906	.32121	.70796**	-.53749**
X_{16} Percent picnic (live wt.)	.14748	-.16605	.13605	-.33553	.35801*	.05956
X_{17} Percent butts (live wt.)	-.30699	.02579	-.06126	-.28655	.37958*	-.49508**
X_{18} Percent bacons (live wt.)	-.13984	-.05967	.06584	-.08947	-.36026*	-.07739
X_{19} Percent primal cuts	-.23847	.10769	.15602	-.04521	.77602**	-.66849**
X_{20} Value of lean cuts	.20411	.19239	.28277	-.10919	.27957	.10701
X_{21} Value of primal cuts	-.14968	.21962	.31763	.02048	.76692**	-.58922**
X_{22} Total cutout value/cwt.	-.14590	.17068	.08688	.18888	.98324**	-.61017**
X_{23} Carcass grade	-.16203	.16876	-.19939	.14851	.54971**	.68829**
X_{24} Dressing percent	-.05091	-.16085	-.06219	-.17817	.43660*	-.21220

*Significant at 5 percent level (.355).

**Significant at 1 percent level (.456).

Table 6. (cont.).

Measurement	X_{13} Pounds: lean cuts	X_{14} Percent: ham	X_{15} Percent: loin	X_{16} Percent: picnic	X_{17} Percent: Boston butt	X_{18} Percent bacon
X_{14} Percent hams (live wt.)	.84048**					
X_{15} Percent loin (live wt.)	.63185**	.46503**				
X_{16} Percent picnic (live wt.)	.34278	.30628	-.24334			
X_{17} Percent butts (live wt.)	.32504	.10127	.12069	.23340		
X_{18} Percent bacons (live wt.)	-.23840	-.22307	-.50560**	-.00018	-.03781	
X_{19} Percent primal cuts	.78523**	.74223**	.37972*	.36598*	.35672*	.30868
X_{20} Value of lean cuts	.45571**	.21641	.37226*	-.00240	-.02717	-.68024**
X_{21} Value of primal cuts	.91360**	.74273**	.49726**	.22805	.23650	.14685
X_{22} Total cutout value/cwt.	.91032**	.85974**	.80658**	.21378	.29912	-.42113*
X_{23} Carcass grade	.42546*	.28860	.58927**	.01572	.42709*	-.11892
X_{24} Dressing percent	.39097*	.38159*	.14022	.33292	.25500	.09809

*Significant at 5 percent level (.355).

**Significant at 1 percent level (.456).

Table 6. (concl.).

Measurement	X_{19} Percent primal cuts	X_{20} Value of lean cuts	X_{21} Value of primal cuts	X_{22} Total cut-out value	X_{23} Carcass grade
X_{20} Value of lean cuts	-.17645				
X_{21} Value of primal cuts	.88036**	.25053			
X_{22} Total cutout value/cwt.	.71840**	.42111*	.89701**		
X_{23} Carcass grade	.48000**	-.09435	.36402*	-.55487**	
X_{24} Dressing percent	.51203**	-.13982	.37252*	.36770*	-.40936*

*Significant at 5 percent level (.355).

**Significant at 1 percent level (.456).

correlated. Carcass fatback thickness shows a higher association with the percent of lean cuts than with the percent of five primal cuts by a correlation coefficient of -.67071 to -.59264 respectively. On the other hand, the live fatback probe displays a correlation coefficient of -.60715 with the percent of four lean cuts as compared with a higher correlation of -.66849 with the percent yield of primal cuts. Any correlation over .456 was highly significant at the one percent level of rejection and coefficients between this and .355 were significant at the five percent level. A highly significant correlation of .74181 was found between the carcass fatback thickness and live probe. Either of these two measures can be used as a basis for fatback estimation as they both are measures of the backfat or the adipose tissue covering the back. However, if an actual measure of the fatback thickness of a live hog was desired, then the probing method would be the means of obtaining the data.

According to Henning and Evans (1953), backfat measures can be estimated within a plus or minus 0.2 inches of the actual measurement. Bratzler and Margerum (1953), as well as Tuma (1958), also found that the live fatback estimates were highly significant at the one percent level with the carcass measurement. It was assumed, even though no statistical proof was found, that the live estimation of backfat would be approximately equal in correlation to the live probe measure as with the carcass fatback measure.

If consideration is given to the value of the primal cuts factor, a higher correlation was found with the live probe than with the carcass fatback measure. These correlations were -.58922 and -.48245 respectively. However, both fatback measures are highly significant at the one percent rejection level. When running correlations using carcass backfat thickness and the backfat probe measure with the total cutout value per 100 pounds liveweight, similar significant correlations were found. The coefficients were: -.68301 and -.61017 for the carcass backfat and live backfat probe measures respectively. In conclusion, fatback thickness was a significant factor which should be used in estimating true value. As these correlations were negative, one may conclude that as fatback thickness increases, the percent of the valuable cuts decrease and the live value of the hog per hundred weight also will decrease.

Fatback thickness, shoulder thickness, and heartgirth circumference had a strong relationship in a negative fashion with two of the more important lean cuts. The percent yield of ham and loin were highly significant with fatback thickness and shoulder thickness and a significant correlation was found for the heartgirth circumference variable. Fatback was also significantly correlated with the percent yield of Boston butt, but the remaining primal cuts were found to be non-significant with these three variable factors.

The shoulder thickness and heartgirth circumference measures were also significantly correlated with the percent of lean and primal cuts. These two factors are again measures which rely largely upon the amount of adipose tissue present. This relationship was further shown by their correlation coefficients of .37366 and .43624 respectively which are significant at the 5 percent level of rejection with the carcass fatback thickness. The association with the live probe measure was even higher as portrayed by their respective .45609 and .47565 coefficients. Shoulder thickness showed a higher correlation with the percent of lean cuts than the heartgirth measure by the figure of -.46828 to -.38099 respectively. This was also significantly true with the percent of five primal cuts as -.37912 and -.24407 respective coefficients were found. This order of significance was reversed when reviewing their relationship with the backfat variables. Here the heartgirth measure showed a higher correlation than shoulder thickness. It was believed that these measures are valuable in estimating the amount of backfat but their significance with the four or five cut yield was indirect through the fatback thickness. This will be discussed further in the next section dealing with multiple analysis.

A fifth variable having a significant correlation with the percent of five primal cuts was ham thickness. Ham thickness was not significantly correlated with percent of lean cuts and was near the five percent rejection level with a coefficient of .31324 relating to primal cuts. The main reason for this association seems to be through the relationship with the percentage yield of the ham, loin, and picnic cuts. These lean cuts are in turn highly associated with the percentage yield of the five primal cuts. It was not apparent why the ham thickness should have a higher correlation with the primal cuts than with the lean cuts unless it was due to the very low correlation with the percent yield of Boston butt and a higher correlation with bacon yield.

All the other live factors measured portrayed no significant relationship with the percent of lean or primal cuts nor with the value of lean or primal cuts. Body length was a valuable factor in two indirect aspects. First, body length was significantly correlated with the percent of loin yield by a coefficient of .36213. As the body length increased, the percent of loin also became greater. The percent yield of loin in turn showed a highly significant correlation of.70796 with the percent yield of four lean cuts or a significant correlation of .37972 with the percent of primal cuts. Secondly, body length was negatively correlated (-.31015) with the live backfat probe. This indicates that as body length increases the thickness of backfat diminishes on hogs of the same weight. This correlation coefficient was near even though below the five percent level of rejection.

Loin thickness was also somewhat significant through indirect means. A highly significant correlation of -.63311 was found with body length. This would seem to indicate that even though the percent of loin increases with greater body length, the thickness of the loin becomes less. This may be explained by the fact that the thickness of fat, which is included in the measurement over the loin, also decreases with increased body length. A correlation coefficient of .33521 was found between loin thickness and the live backfat probe. Loin thickness and forearm length presented a highly significant negative correlation of -.61305. Forearm length, even though at a low level of significance, shows a correlation with body length, yield of ham, value of the primal cuts, and inversely with the backfat thickness.

The depth of twist factor seems in itself to have little value. It shows a low degree of correlation with the four lean cuts individually but with the yield of ham, of which it is actually a part, a very low correlation was found. If such a measure could project the meatiness of the ham in relation to its depth down toward the hock joint, then a value of greater importance may be derived. The measure of the width of the base of skull was found to be of no significance in estimating lean yield or yield of primal cuts.

Forearm circumference was measured at the small of the cannon bone to test the influence of the size of bone on the yield of lean cuts, totally and individually, as well as on the value of the lean and primal cuts. Some value does seem to exist in this variable particularly in relation to the yield of hams. A correlation coefficient of .30330 was found for the percent yield of ham and .41177 for the quantity or pound yield of ham. These significant correlations with the ham yield seem to be portrayed also in the values of the lean and primal cuts. The coefficients received were .28277 and .31763 respectively which were not significant at the five percent level but were within the 10 percent rejection limit. The full importance of this factor cannot be derived from this study. However, the size of bone does show an effect on the yield of ham which is the most important single cut of a hog from the standpoint of percent of total value.

Carcass grades based on the standards set up by the U.S.D.A. in 1955, and shown in Table 5 were used to compute correlations with all the variable X's. These accepted standards were based on three main factors: (1) fat-back thickness, (2) weight, and (3) length, as they affect the yield of lean and fat cuts. In this study, the weight element was held as constant and as near 200 pounds live shrunk weight as possible. Carcass fatback thickness had the highest correlation coefficient with carcass grade at -.86914 and the live backfat probe was second with -.68829. Here the negative coefficients signify that as fatback thickness increased the carcass grade was lowered. These computations found that almost all of the factors significantly correlated with backfat thickness were significantly correlated with the carcass grade.

In the 31 selected barrows used in this study, 14 graded U.S. No. 1., 13 U.S. No. 2, and 4 U.S. No. 3's. Carcass grade received a highly significant correlation of .54971 with the percent yield of lean cuts. The correlation for the percent yield of primal cuts was close behind with a .48007 coefficient. When considering the value of the lean or primal cuts, and carcass grade but only a -.36402 was found between the value of the five primal cuts and carcass grade but only a -.09435 was indicated for the value of the four lean cuts. However, a highly significant correlation coefficient of -.55487 was found between the carcass grade and the total cutout value of the hog.

When computing the correlation for length and carcass grade, a coefficient of only .29166 was found. This may be considerably lower than some would expect. Another correlation was run using the carcass length with the body length in which a .67689 correlation coefficient was calculated. Of the five primal cuts, the percent yield of loin had the highest correlation of .58927 with the carcass grade which was highly significant at the one percent rejection level.

A few simple correlations were run with dressing percent as a variable because there is much discussion as to the validity of dressing percent as a determinant of true hog value under present day conditions. One factor which must be kept in mind when reviewing these correlations is that these measures were taken from barrows of approximately the same weight. If there were greater fluctuation between weights then these dressing percent correlations may have been lower. The percent yield of primal cuts was the only highly significant correlation with dressing percent with a coefficient of .51203. The correlation for the percent of lean cuts was .43660 which was above the five percent level. The carcass grade correlation of .40936 was also above the five percent rejection level. One surprising result was that the backfat correlation coefficients were -.25802 and -.21220 respectively for carcass fatback and the live probe measurement when correlated with dressing percent. It would seem that as the amount of fatback increased, the dressing percent would also increase rather than this negative result. The percent of bacon and loin were the only two of the primal cuts which were not significantly correlated with dressing percent. The value of the five primal cuts was significantly correlated at the five percent rejection level with .37252 as its correlation coefficient. Here again a very low negative coefficient of -.13982 was found for the value of the four lean cuts.

In general, it may be stated that upon the basis of this study and of other studies, there are live physical factors which are significantly correlated with the percent yield of lean and primal cuts. Correlations computed in this study show that a certain few of these measurable factors are directly associated while others are indirectly related to the yield of valuable cuts. The main live factors which are closely associated with the lean or primal cut yield include thickness of backfat, shoulder thickness, and body length. The greatest significance seems to be the fatback measure which received its highest correlation coefficients by using the live fatback probe method.

The percent yield of lean and primal cuts were very highly significant with the cutout value of the five primal cuts which makes up 86.6 percent of the total cutout value as stated by Engelman, et al. (1953).

The value of the five primal cuts was 93.7 percent of the total cutout value for the barrows of this study using summer prices of 1959. The percent of lean cuts had a higher correlation coefficient with the present carcass grade than did the percent of primal cuts by coefficients of .54971 and .48000 respectively. A very high correlation coefficient of .98324 was found between the percent lean yield and the total cutout value. The close association found between the percent of lean cuts and the total cutout value is illustrated by means of a scatter diagram in Fig. 6. It was thought that the closeness of this relationship will depend upon two price ratios: (1) price ratio of lean cuts to lard, and (2) price ratio of lean cuts to bacon. A highly significant coefficient of .71840 was also determined for the correlation of percent primal cuts with the cutout value but was considerably less than that found for the percent of lean cuts. Lean cuts showed a higher degree of correlation with the carcass grade than with dressing percent whereas the percent of primal cuts portrayed a higher association with dressing percent.

Multiple Correlation Analysis

With the aid of the International Business Machines 650 electronic computer on the Kansas State University campus it was possible to run multiple correlations with the same live variables as used in the simple correlation analysis. These computations were desired to find those variables which explained the greatest portion of the variation in the percent yield of lean cuts. By this means it was possible to rank the variables in order of their value in explaining the variation of percentage yield of lean cuts among hogs of very similar live weights. The variables analyzed are hereby stated with their algebraic symbols which were used for convenience in setting up the multiple correlation equations.

$X1$ = Backfat thickness.

$X2$ = Shoulder thickness.

$X3$ = Heartgirth circumference.

$X4$ = Loin thickness.

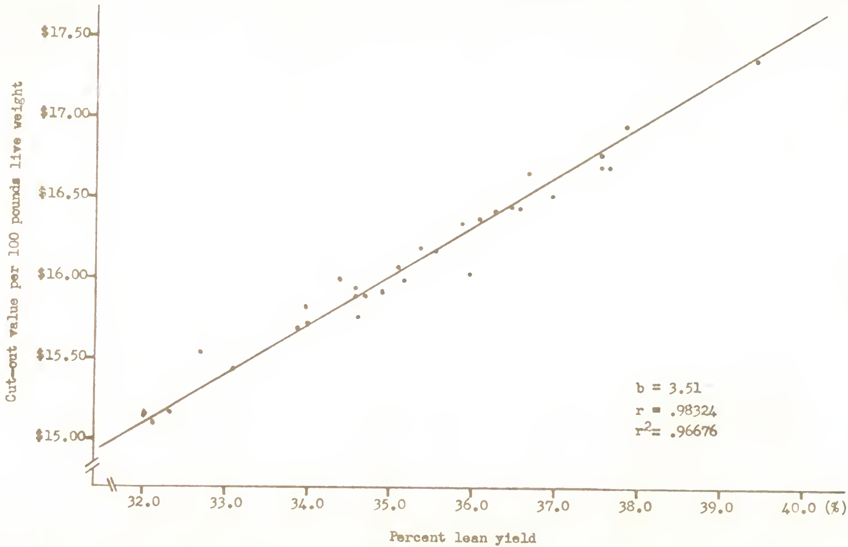

Fig. 6. Relationship between the percent lean yield of live weight and the cut-out value per 100 pounds live weight based on the average Chicago wholesale price quotations, July 1 to August 15, 1959.

$X5$ = Body length.

$X6$ = Ham thickness.

$X7$ = Width at base of skull.

$X8$ = Forearm length.

$X9$ = Forearm circumference at the small of the cannon bone.

$X10$ = Depth of twist.

Y = Percent of lean cuts.

The ten live measurable factors stated above, X1 to X10, were used in various combinations to test their individual significance in explaining the lean yield variations. A range of 32.0 percent to 39.5 percent was found in the percent yield of lean cuts on a live basis among the 31 hogs of similar weight. The multiple correlation equations analyzed in this study are stated below. The percent of lean cuts was denoted by the symbol Y.

1. $Y = a + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + b6X6 + b7X7 + b8X8 + b9X9 + b10X10$
2. $Y = a + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + b6X6 + b7X7 + b8X8 + b9X9$
3. $Y = a + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + b6X6 + b7X7 + b8X8$
4. $Y = a + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + b6X6 + b7X7$
5. $Y = a + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + b6X6$
6. $Y = a + b1X1 + b2X2 + b3X3 + b4X4 + b5X5$
7. $Y = a + b1X1 + b2X2 + b3X3 + b4X4$
8. $Y = a + b1X1 + b2X2 + b3X3$
9. $Y = a + b1X1 + b2X2$
10. $Y = a + b1X1 + b2X2 + b4X4 + b5X5 + b6X6$
11. $Y = a + b1X1 + b2X2 + b5X5 + b6X6$

12. $Y = a + b1X1 + b2X2 + b5X5$

13. $Y = a + b1X1 + b2X2 + b4X4 + b5X5$

14. $Y = a + b1X1 + b4X4 + b5X5$

15. $Y = a + b1X1 + b5X5 + b6X6$

16. $Y = a + b1X1 + b5X5 + b6X6 + b10X10$

17. $Y = a + b5X5 + b6X6 + b10X10$

18. $Y = a + b1X1 + b3X3 + b5X5$

19. $Y = a + b3X3 + b5X5$

20. $Y = a + b1X1 + b5X5 + b8X8$

21. $Y = a + b1X1 + b5X5 + b9X9$

22. $Y = a + b2X2 + b5X5 + b8X8$

23. $Y = a + b1X1 + b5X5$

24. $Y = a + b2X2 + b4X4 + b5X5 + b6X6$

25. $Y = a + b2X2 + b3X3 + b4X4 + b5X5 + b6X6$

The results obtained from these equations by multiple regression methods are shown in Table 7.

The first nine of these equations were used to find the added value for each variable to the coefficient of determination. The coefficient of determination is the percent of total variation explained by the variable or variables studied. In this study the ten combined variables explained 59.177 percent of the variation found in the percent yield of lean cuts. This coefficient leaves 40.823 percent of the variation still unexplained which was higher than that anticipated when the problem was set up. When the fatback thickness was discussed in a preceding section, it was found that this one factor alone explained 45 percent of the variation. Thus the nine other variables combined explained only 15 percent of the total variation.

Table 7. Results obtained from a selection of multiple correlation equations.

Equation no.	(R^2) Degree of variation explained	($1-R^2$) Degree of variation not explained
1	.59177	.40823
2	.57861	.42140
3	.56372	.43628
4	.55965	.44035
5	.55831	.44169
6	.52051	.47949
7	.50521	.49479
8	.50505	.49495
9	.50491	.49509
10	.55724	.44276
11	.55472	.44528
12	.51434	.48566
13	.51836	.48163
14	.46335	.53665
15	.50683	.49317
16	.51598	.48402
17	.08693	.91307
18	.46009	.53991
19	.15951	.84049
20	.45383	.54616
21	.48683	.51317
22	.22297	.77703
23	.45175	.54825
24	.24880	.75120
25	.26657	.73343

It can be safely said, based on these results, that fatback thickness is the most important single factor in determining the percentage yield of lean cuts.

Shoulder thickness explained an additional 5 percent of the variation when added to backfat thickness. These two variables combined explained half of the variation in the percent of lean yield. Ham thickness was next in importance as it added 3 percent to the coefficient of determination. Following this in order of importance were body length, 1.5 percent; forearm circumference or size of bone, 1.5 percent; depth of twist, 1.3 percent; and forearm length added 0.5 percent. The measures for heartgirth circumference, loin thickness, and width at base of skull added no further value to the total amount of variation explained by the preceding factors.

From equations 10 through 25 some additional information was obtained that was not apparent in the previous equation results. Here various combinations of the variables were studied. Any combination which omitted fatback thickness received a low coefficient of determination. The results of these equations were shown in Table 7.

Table 8 shows another breakdown of these equations in such a way as to determine the additional value added to the coefficient of determination by each individual factor. This table was set up with the variables ranked in the order of their importance in relation to the effect on the percent of lean cuts. Here again fatback thickness was found to be the most important factor followed by shoulder thickness, ham thickness, forearm circumference, and body length. Depth of twist added 0.9 percent when comparing equations 15 and 16 and 1.3 percent when comparing equations 1 and 2. The remaining variables added less than 1 percent each to the coefficient of determination.

When reviewing all the variables used in this multiple correlation analysis, one finds a few which have sufficient merit to be used in estimation of the percentage yield of lean cuts. The four factors combined in equation 11, which included the backfat thickness, shoulder thickness, body length, and ham thickness, seem to be the main important measures found in this study. These four factors alone presented a .55472 coefficient of determination as compared to a .59177 for all ten variables. Body length as shown by the data derived from this study was the lesser important of these four factors. However, it still has sufficient merit to be included on the list of important variables studied. Two other variables, size of bone and

Table 8. Equation comparison of different factor combinations to give values of individual variables in order of their importance in determining the percent yield of lean cuts.

Equation numbers: compared, pages 59 and 60		Value determined for factor	Coefficient of determination value of X in percent	Remarks
	and			
16	17	X1 Fatback thickness	43.0	As near as
10	24	X1 Fatback thickness	31.0	possible,
12	23	X2 Shoulder thickness	6.3	if a factor
11	12	X6 Ham thickness	4.0	of higher
21	23	X9 Forearm circumference	3.5	rank was
9	12	X5 Body length	1.0	available,
15	16	X10 Depth of twist	0.9	it was in-
18	23	X3 Heartgirth circumference	0.9	cluded in
12	13	X4 Loin thickness	0.4	the equation
10	11	X4 Loin thickness	0.25	to determine
20	23	X8 Forearm length	0.2	the next
4	5	X7 Width base of skull	0.1	ranking factor

depth of ham, have shown importance in this study. It is believed that with further study in the methods of determining accurate measures for these two factors, they should be included in the list of variables used in determination of the percent yield of lean cuts and/or live hog value.

Simple Correlation with Ratios

In this section a selection of logical ratios are analyzed. These ratios are logical in the sense that they could be feasibly estimated on a live hog with a basis of sound reasoning to support them. The various forms of mathematical equations were devised to be used in simple correlation with the percent of lean yield. The purpose of this section was to find the significant ratios which may be used to aid in the estimation of live hog value through their close association with the percent yield of four lean cuts.

The equations for the factor ratios which were used in simple regression analysis with the percent of lean yield are stated below. Again, the same algebraic symbols are used to denote the variables in these equations as in previous sections.

26. $Y = X2 + X4 + X6 / 3 \div X1$

27. $Y = X2 + X4 + X6 / 3, \cdot X5 \div X1$

28. $Y = X2 + X5 + X6 \div X1$

29. $Y = X2 + X5 + X6 \div X3$

30. $Y = X5 + X6 \div X1$

31. $Y = X5 + X6 \div X3$

32. $Y = X5 \div X1$

33. $Y = X5 \cdot X6 \cdot X10 \div X1$

34. $Y = X5 \cdot X6 \cdot X10 \div X3$

35. $Y = X4 \cdot X5 \div X1$

36. $Y = X2 \cdot X5 \div X1$

37. $Y = X5 \cdot X6 \div X1$

38. $Y = X5 \cdot X6 \div X3$

39. $Y = X3 \cdot X5$

40. $Y = X2 \cdot X5 \cdot X6$

41. $Y = X2 \cdot X5 \cdot X6 \div X1$

42. $Y = X2 \cdot X5 \cdot X6 \div X3$

The results from these equations are shown in Table 9. This table gives the coefficients of correlation (r) and determination (r^2), the Y axis intercept value (A), the slope of the regression line (B), and the value from a T-test (t).

The most significant correlations in this section were found by using the ratios derived from equations 37 and 30. In both equations the same three

Table 9. Results obtained by use of factor ratios in simple correlation with the percent yield of the four lean cuts.

Equation	r	r²	A	B	t
26) Y = X2 + X4 + X6 /3 ÷ X1	.63227**	.39977	24.925	1.4841	4.3948**
27) Y = X2 + X4 + X6 /3 · X5 ÷ X1	.65311**	.42655	24.853	0.0334	4.6445**
28) Y = X2 + X5 + X6 ÷ X1	.67744**	.45893	24.868	0.2439	4.9596**
29) Y = X2 + X5 + X6 ÷ X3	.36303*	.13179	14.106	13.2202	2.0981*
30) Y = X5 + X6 ÷ X1	.69537**	.48354	25.012	0.2933	5.2107**
31) Y = X5 + X6 ÷ X3	.43074*	.18554	15.381	15.1548	2.5703*
32) Y = X5 ÷ X1	.67812**	.45985	25.426	0.3508	4.9687**
33) Y = X5 · X6 · X10 ÷ X1	.62548**	.39123	28.156	0.0022	4.3170**
34) Y = X5 · X6 · X10 ÷ X3	.31076	.09657	29.542	0.0471	1.7607
35) Y = X4 · X5 ÷ X1	.61423**	.37728	25.803	0.0334	4.1916**
36) Y = X2 · X5 ÷ X1	.52940**	.28026	26.709	0.0249	3.3604**
37) Y = X5 · X6 ÷ X1	.71462**	.51068	25.279	0.0323	5.5014**
38) Y = X5 · X6 ÷ X3	.39242*	.15399	23.836	0.9860	2.2975*
39) Y = X3 · X5	-.20436	.04176	47.183	-0.0062	-1.1242
40) Y = X2 · X5 · X6	-.18870	.03561	40.764	-0.0009	-1.0348
41) Y = X2 · X5 · X6 ÷ X1	.57982**	.33619	26.294	0.0024	3.8323**
42) Y = X2 · X5 · X6 ÷ X3	-.01066	.00011	35.641	-0.0023	-0.0574

1 percent level of rejection (r) .456 **

5 percent level of rejection (r) .355 *

1 percent level of rejection (t) 2.750 **

5 percent level of rejection (t) 2.042 *

factors of body length, ham thickness, and fatback thickness were used. In equation 37, the body length measure was multiplied by ham thickness and then divided by backfat thickness for a simple correlation coefficient of .71462 when correlated with the percent of lean yield. A coefficient of .69537 was observed for the ratio obtained by adding the body length to the ham thickness measure and then dividing the sum by the amount of fatback. Both of these ratios are highly significant at the one percent rejection level, with the equation using multiplication of factors having a two percent greater value. As was shown by the r^2 value of equation 37, 51.1 percent of the total variation found in the percent of lean cuts was explained by these three factors combined in such a fashion as to give this highly significant ratio. A very small difference however, was found in favor of equation 37 when comparing it to equation 15 of the preceding multiple correlation section. Equation 15 received a .50683 coefficient of determination when using the same three variables in a multiple correlation equation. An r^2 value of .48354 was found for equation 30 which was lower by a small percentage than either of the other coefficients.

It was observed in this study that if any other factor were used in place of fatback as the divisor in these equations, the coefficients were reduced greatly. In all cases where heartgirth circumference was substituted for fatback, the coefficient of determination was reduced by at least 30 percentage points.

In the case of equation 32, the body length measure was divided by fatback thickness to give an r^2 which explained 46 percent of the percent of lean yield variation. This value was quite similar to the 45.2 percent found in the multiple correlation section for equation 23 which used only the fatback thickness and body length factors. The comparison of equations 32 and 37 show an addition of 5 percent to the amount of variation explained due to the ham thickness factor. In equation 28, a summation of shoulder thickness, body length, and ham thickness divided by fatback thickness produced an r^2 of .4589. This coefficient is approximately of equal value to the r^2 of .4598 of number 32 in which only length and backfat were considered.

In equation number 27 an average of the three body thickness measures, shoulder, loin, and ham was multiplied by body length and divided by fatback thickness. The resulting r^2 value of .42655 shows that ham thickness, as in equation 37, was a more important single factor than the average of the three body thickness measures. When the average of the three body thickness factors was divided by fatback thickness as in number 26, a .39977 coefficient of determination was received. The omittance of the body length factor reduced the coefficient by 2.7 percentage points. In the other stated equations where additional factors were combined into the previously discussed equations, only decreasing coefficients were received.

The relative importance of ham thickness in these equations combined with body length and fatback thickness, can be pointed out by a comparison of equations 27, 35, and 36 with equation number 37, which includes the ham thickness factor. When the average of the body thickness measure was substituted for ham thickness as in number 27, a decrease of 8.4 percent in the r^2 value was observed. Likewise when loin thickness of equation 35 was included instead of ham thickness, the coefficient was decreased by 13.34 percentage points. The lowest rate of substitution for ham was found for shoulder thickness as in number 36 where a decrease of 23.04 percentage points was witnessed. Part of this decrease may be explained by these two facts:

(1) as one moves from the hams forward on a hog a lower correlation was found with the percent yield of ham which makes up the largest portion of the percent yield of lean cuts, (2) as one moves forward on a hog a greater degree of fat is encountered in the body measurements. An attempt to remove this fat measure has been included in the equations by the use of fatback thickness as a divisor.

In conclusion to this section it may be stated that no new important factors were discovered. However, the importance of ham thickness as a determiner of percent lean yield was made eminent through the use of ratios. The three most important variables as witnessed by the use of ratios were by order of rank, fatback thickness, ham thickness, and body length.

Little significant difference was observed in the coefficients of determination whether the same variables were expressed as a ratio in simple correlation analysis or as a group in multiple regression analysis. As these two methods are approximately equal in value for these few factors, the best method to be used would depend, to a great extent, on the one which could be associated with the highest degree of accuracy by estimation means with the percent yield of lean cuts or actual live hog value.

Comparative Cutout Values

This section has the objective of depicting the importance of the value of the four lean cuts in relation to the total cutout value. If a marketing system were developed which used the percent yield of lean cuts as the basis for price determination then the relationship of lean yield value to total cutout value would be very important. In other words, if the true total value was to be determined for an animal then the value of the four lean cuts must be combined with the value of the rest of the carcass. If a constant ratio was found for the value of the non-lean portion in relation to the lean yield a definite aid would be rendered to the determination of true hog value. The percent of total live hog value found in the four lean cuts shall be computed in this section.

A combination of data derived from the Livestock Division, A.M.S., U.S.D.A. (1957), was shown in Table 10. In this table, all percentages for major and minor cuts plus the by-products of a hog were computed on a live weight basis. These percentages were obtained from an average of medium weight good to choice butcher hogs over the period 1905 to 1944. Combined with these percentage figures are values for 1956 average prices obtained from the same U.S.D.A. source. By multiplying these two columns, the value for each cut was given as would be derived from 100 pounds live weight. The value of the four lean cuts per live hundred weight was found to be $11.56 using these figures. When comparing the total cutout value of $19.02 per live hundred weight with the four lean cut value, it was found that 60.8 percent of the total value came from the four lean cuts. This leaves 39.2 percent or $7.46 to be explained by the non-lean portions of the hog. When figuring the percent of four lean cuts by weight it was found that 31.8 percent of the live hog accounts for 60.8 percent of the total value and the rest which is 68.2 percent contributes 39.2 percent of the total cutout value. To be broken down farther this means that 1.91 percent of total value was explained by each one percent yield of lean cuts.

If a consideration of the value of the primal cuts were made, then 75.2 percent of the total value would be derived from 44.3 percent of the live weight. This states that 1.70 percent of the total value was explained by

Table 10. Prices of hogs and hog products, Chicago.

Item	(1905-1944): percent live wt.	(1956) Wholesale price per cwt.	Value per 100 lbs. live wt.	Total hog value 200 lbs.
Carcass	70.00	$17.50	$12.25	$24.50
Hams	13.38	41.48	5.55	11.10
Loin	8.92	41.12	3.67	7.34
Picnic	5.50	21.43	1.18	2.36
Butt	4.00	28.95	1.16	2.32
Bacon	12.50	21.94	2.74	5.48
Spare ribs	1.25	31.07	0.39	0.78
Plate	2.50	13.68	0.34	0.68
Jowl	2.25	8.76	0.20	0.40
Lean trimming	2.00	12.74	0.25	0.50
Feet	1.55	4.99	0.08	0.16
Neck	0.54	6.72	0.04	0.08
Tail	0.11	7.50	0.01	0.02
Fatback	8.50	12.00	1.02	2.04
Fat trimmings	6.90	12.00	0.83	1.66
Shrinkage-cutting	1.00	12.00	0.12	0.24
Head	4.50	7.70	0.35	0.70
Leaf fat	2.25	12.00	0.27	0.54
Edible offal	5.36	10.00	0.54	1.08
Edible fat	2.33	12.00	0.28	0.56
Inedible material	15.31	-	-	-
Total	100.00		19.02	38.04

Source: Prices quoted for 200-220 lbs. hogs of grade 1 to 3. U.S.D.A., A.M.S., March, 1957.

each one percent in yield of primal cuts. Prices of bacon have decreased more over the last ten years than the 4 lean cuts, therefore to remove this variation it was preferred to use the percent yield of four lean cuts for the following study.

By using the figures from Table 10, a form has been devised which may be followed in determining the price which could be paid per live hundred weight. This form was set up on the basis of a pre-determined value for each one percent yield of lean and non-lean cuts. The method used to determine this value will be explained later. The percent of lean yield is the only factor which need be estimated as the real weight may be obtained by scale weighing and the value for each one percent yield per 100 pounds live weight may be computed by actual cutting, weighing, and evaluating the individual cuts. This form as previously mentioned is shown in Table 11.

Column I. Obtain the live weight by either estimation or actual scale weight.

Column II. Combine the individual weights of the four lean cuts and divide by the live weight.

Column III. The value for each one percent of lean yield per 100 pounds is determined by taking the combined four lean cut value per 100 pounds and dividing by the percent of lean yield.

Column IV. The lean cut value per 100 pounds is derived by multiplying column 2 by column 3.

Column V. The percent non-lean is simply 100 percent minus the percent lean yield of column 2.

Table 11. A form to follow in deriving the price which may be paid per 100 pounds live weight based on value of percent lean yield.

I	II	III	IV	V	VI	VII	VIII	IX
			(2.3)	(100-2)	Value 1%	(5.6)	(4+7)	(1.8)
Live weight	Percent lean yield	Value per 1% lean yield per 100 lbs.	Lean value per 100 lbs.	Percent non-lean	yield per 100 lbs.	Non-lean value per 100 lbs.	Total value per 100 lbs.	Total value per live hog
200	30	36.0¢	$10.80	70	11¢	$7.70	$18.50	$37.00
200	31	36.0	11.16	69	11	7.59	18.75	37.50
200	32*	36.0	11.52	68	11	7.48	19.00	38.00
200	33	36.0	11.88	67	11	7.37	19.25	38.50
200	34	36.0	12.24	66	11	7.26	19.50	39.00
200	35	36.0	12.60	65	11	7.15	19.75	39.50
200	36	36.0	12.96	64	11	7.04	20.00	40.00
200	37	36.0	13.32	63	11	6.93	20.25	40.50
200	38	36.0	13.68	62	11	6.82	20.50	41.00
200	39	36.0	14.04	61	11	6.71	20.75	41.50
200	40	36.0	14.40	60	11	6.60	21.00	42.00

*Thirty-two percent lean yield was the average yield upon which the rest of this table was derived.

Column VI. The value for each one percent of non-lean per 100 pounds is computed in two steps.

(a) Subtract the four lean cut value from total cutout value to obtain the value of the non-lean cuts.

(b) Divide the non-lean cut value by the percent of non-lean cuts.

Column VII. The value of the non-lean portion is found by multiplying column 5 by column 6.

Column VIII. The value or price which may be paid per 100 pounds live weight, assuming no handling or overhead cost, is the total of column 4 and 7.

Column IX. The total value of a live hog is determined by multiplying column 1 by column 8 and dividing by 100.

The form found in Table 11 will hold true as long as the wholesale prices for the individual cuts remain unchanged. As the prices change then the values to be used in columns III and VI must be recomputed. Actually the live weight of column I is only needed to complete the total live hog value found in column 9. Column VIII shows that a price differential of \$2.50 per hundred weight could be paid for hogs ranging from 30 to 40 percent in lean yield.

A value analysis on the prices of hogs and hog products was also run on the 31 barrows used in this study. The values used for the price of live hogs and the five primal cuts was obtained from an average of the weekly Chicago quotations for the period July 1 to August 12, 1959. This period was selected because it was the actual period in which the hogs of this study were slaughtered. The averages as derived from the National Provisioner are shown in Table 12.

Table 12. Weekly cash price quotations per weight on the Chicago Market for the period July 1 to August 12, 1959.

Week	Live hogs (No. 1-3s) (180-200 lb.)	Skinned hams (12-14 lb.)	Picnics (6-8 lb.)	Loins (12 lb.)	Boston butts (4-8 lb.)	Fresh Bellies 12-14 lb.)
July 1	$16.00	$36.00	$23.00	$41.00	$29.00	$25.00
July 8	15.85	35.50	24.00	43.00	30.00	25.50
July 15	14.75	34.00	23.00	42.50	29.00	24.00
July 22	14.50	33.00	21.50	38.50	28.50	23.00
July 29	14.25	35.50	21.50	41.50	29.00	22.00
Aug. 5	15.10	35.00	23.00	39.00	27.00	22.00
Aug. 12	14.65	37.50	23.00	42.00	29.00	22.00
7 week avg.	15.00	35.20	22.70	41.00	28.80	23.35

Source: The National Provisioner, July 4 to August 15, 1959.

The data for the cutout weights of the individual primal cuts as determined by this study are shown for each hog in Table 13. The average values of Table 12 were used in computing the values for the five main cuts as shown in Table 14.

The method used in determining the value for 100 pounds live weight of non-lean cuts as shown in column 9 of Table 13 is shown below. The price used was taken from a table presented by M. B. Kirtley and E. E. Broadbent of the University of Illinois (1960). This material was used because it was the most recent data available for non-lean cut values. It must be recognized that there was a possible decrease in prices from the summer of 1959, when this study was conducted, until the week of January 22, 1960, which

Table 13. Yield in pounds of primal cuts from 31 market barrows, July 1 to August 12, 1959.

Hog no.	(1) Live wt.	(2) Cold carcass wt.	(3) Trimmed ham wt.	(4) Loin wt.	(5) Picnic wt.	(6) Boston butt wt.	(7) Bacon wt.	(8) Lean cuts wt.	(9) Non-lean cuts live wt.	(10) Percent lean cuts	(11) Percent non-lean cuts
134	195	139	24.90	21.20	14.20	7.00	21.20	66.30	128.70	34.0	66.0
135	193	143	24.45	21.25	13.00	6.65	25.65	65.35	127.65	33.9	66.1
136	198	147	27.15	19.60	16.30	8.25	26.35	71.30	126.70	36.0	64.0
138	198	141	23.60	19.10	12.70	8.10	31.20	63.50	134.50	32.1	67.9
139	196	147	24.40	22.10	13.70	7.90	28.80	68.10	127.90	34.7	63.3
140	198	147	21.70	20.40	13.30	8.60	29.70	64.00	134.00	32.3	67.7
141	199	151	24.50	21.40	14.50	8.40	26.70	68.80	130.20	34.6	65.4
142	200	147	26.20	24.40	14.00	8.50	29.80	73.10	126.90	36.6	63.4
143	201	153	27.70	22.70	13.30	6.80	30.30	70.50	130.50	35.1	64.9
144	195	148	26.70	23.70	14.30	8.60	27.10	73.30	121.70	37.6	62.4
145	192	145	25.50	22.90	13.80	8.90	23.70	71.10	120.90	37.0	63.0
146	190	142	20.80	20.50	12.20	7.30	25.60	60.80	129.20	32.0	68.0
147	195	145	24.20	21.70	13.50	8.70	24.80	68.10	126.90	34.9	65.1
148	200	152	23.70	22.60	13.10	8.60	26.00	68.00	132.00	34.0	66.0
150	200	147	24.15	25.15	12.20	7.30	25.00	68.80	131.20	34.4	65.6
151	200	148	27.00	26.20	12.25	7.90	22.55	73.35	126.65	36.7	63.3
152	188	140	23.20	21.60	12.70	7.60	23.95	65.10	122.90	34.6	65.4
153	190	143	26.70	22.05	12.70	7.60	23.10	69.05	120.95	36.3	63.7
154	195	147	27.10	24.60	13.60	7.95	24.95	73.25	121.75	37.6	62.4
155	195	147	29.00	26.05	13.05	8.90	22.90	77.00	118.00	39.5	60.5
156	193	144	23.35	23.05	12.75	9.55	23.00	68.70	124.30	35.6	64.4
157	193	146	26.10	22.55	12.40	7.30	24.70	68.35	124.65	35.4	64.6
159	200	142	23.70	23.40	10.60	7.60	24.65	65.30	134.70	32.7	67.3
160	195	146	27.20	25.65	12.80	8.25	25.70	73.90	121.10	37.9	62.1
161	194	146	24.15	19.60	12.00	8.50	28.55	64.25	129.75	33.1	66.9
162	200	148	27.80	23.30	13.00	8.90	27.00	73.00	127.00	36.5	63.5
163	198	148	26.00	22.20	12.40	7.90	29.00	68.50	129.50	34.6	65.4
164	204	152	27.20	21.90	14.10	8.50	29.55	71.70	132.30	35.2	64.8
165	190	137	25.10	23.25	12.20	8.00	23.15	68.55	121.45	36.1	63.9
166	190	143	26.00	22.30	12.10	7.90	27.05	68.30	121.70	35.9	64.1
167	199	153	29.45	22.40	14.65	8.55	24.75	75.05	123.95	37.7	62.3
Total	6074	4524	788.70	698.80	407.40	250.50	806.45	2144.40	3929.60	1094.6	2005.4
Ave.	196	146	25.44	22.54	13.14	8.08	26.01	69.20	126.80	35.3	64.7

Table 14. Value of hogs and hog products based on average weekly Chicago prices, July 1 to August 12, 1959, associated with 31 barrows slaughtered at Kansas State University during same period.

Hog no.	(1) Live cost: $15.00 cwt.	(2) Skinned ham values $35.20 cwt.	(3) Trimmed loin values $41.00 cwt.	(4) Boston butt values: $28.80: cwt.	(5) Picnic: values: $22.70: cwt.	(6) Bacon values: $23.35: cwt.	(7) Primal cut values per hog	(8) Lean cut values per hog	(9) Non-lean cut values $6.35 cwt.	(10) Total cutout values	(11) Cutout value per 100 lbs. lv. wt.
134	$29.25	$8.76	$ 8.69	$2.02	$3.22	$4.95	$27.64	$22.69	$8.17	$30.86	$15.83
135	28.95	8.61	8.71	1.92	2.95	5.99	28.18	22.19	8.11	30.30	15.70
136	29.70	9.56	8.04	2.38	3.70	6.15	29.83	23.68	8.05	31.73	16.03
138	29.70	8.31	7.83	2.33	2.88	7.29	28.64	21.35	8.54	29.89	15.10
139	29.40	8.59	9.06	2.28	3.11	6.72	29.76	23.04	8.12	31.16	15.90
140	29.70	7.64	8.36	2.48	3.02	6.93	28.43	21.50	8.51	30.01	15.16
141	29.85	8.62	8.77	2.42	3.29	6.23	29.33	23.10	8.27	31.37	15.76
142	30.00	9.22	10.00	2.45	3.18	6.96	31.81	24.85	8.06	32.91	16.46
143	30.15	9.75	9.31	1.96	3.02	7.08	31.12	24.04	8.29	32.33	16.08
144	29.25	9.40	9.72	2.48	3.25	6.33	31.18	24.85	7.73	32.58	16.71
145	28.80	8.98	9.39	2.56	3.13	5.53	29.59	24.06	7.68	31.74	16.53
146	28.50	7.32	8.41	2.10	2.77	5.98	26.58	20.60	8.20	28.80	15.16
147	29.25	8.52	8.90	2.51	3.06	5.79	28.78	22.99	8.06	31.05	15.92
148	30.00	8.34	9.27	2.48	2.97	6.07	29.13	23.06	8.38	31.44	15.72
150	30.00	8.50	10.31	2.10	2.77	5.84	29.52	23.68	8.33	32.01	16.01
151	30.00	9.50	10.74	2.28	2.78	5.27	30.57	25.30	8.04	33.34	16.67
152	28.20	8.17	8.86	2.19	2.88	5.59	27.69	22.10	7.80	29.90	15.90
153	28.50	9.40	9.04	2.19	2.88	5.39	28.90	23.51	7.68	31.19	16.42
154	29.25	9.54	10.09	2.29	3.09	5.83	30.84	25.01	7.73	32.74	16.79
155	29.25	10.21	10.68	2.56	2.96	5.35	31.76	26.41	7.49	33.90	17.38
156	28.95	8.22	9.45	2.75	2.89	5.37	28.68	23.31	7.89	31.20	16.17
157	28.95	9.19	9.25	2.10	2.81	5.77	29.12	23.35	7.92	31.27	16.20
159	30.00	8.34	9.59	2.19	2.41	5.76	28.29	22.53	8.55	31.08	15.54
160	29.25	9.57	10.52	2.38	2.91	6.00	31.38	25.38	7.69	33.07	16.96
161	29.10	8.50	8.04	2.45	2.72	6.67	28.38	21.71	8.24	29.95	15.44
162	30.00	9.79	9.55	2.56	2.95	6.30	31.15	24.85	8.06	32.91	16.46

Table 14. (concl.).

Hog no.	(1) Live cost: $15.00 cwt.	(2) Skinned: ham values $35.20 cwt.	(3) Trimmed: loin values $41.00 cwt.	(4) Boston: butt values: $28.80 cwt.	(5) Picnic: values: $22.70 cwt.	(6) Bacon values: $23.35 cwt.	(7) Primal cut values per hog	(8) Lean cut values per hog	(9) Non-lean cut values $6.35 cwt.	(10) Total cutout values	(11) Cutout value per 100 lbs. lv. wt.
163	$29.70	$9.15	$9.10	$2.28	$2.81	$6.77	$30.11	$23.34	$8.22	$31.56	$15.94
164	30.60	9.57	8.98	2.45	3.20	6.90	31.10	24.20	8.40	32.60	15.98
165	28.50	8.84	9.53	2.30	2.77	5.41	28.85	23.44	7.71	31.15	16.39
166	28.50	9.15	9.14	2.28	2.75	6.32	29.64	23.32	7.73	31.05	16.34
167	29.85	10.37	9.18	2.46	3.33	5.78	31.12	25.34	7.87	33.21	16.69
Tot.	911.10	277.63	286.51	72.18	92.46	188.32	917.10	728.78	249.52	978.30	499.34
Ave.	29.39	8.96	9.24	2.33	2.98	6.07	29.58	23.51	8.05	31.56	16.11

Source: The National Provisioner, July 4 to August 15, 1959.

was the period the prices were obtained by Kirtley and Broadbent. If there was a decrease in prices during this period, then the value used for non-lean cuts will be low. However, the objective of these value comparisons, which was to show the range of cutout values obtained from a group of similar weight hogs, will still be quite apparent. The values used by Kirtley and Broadbent, based on 100 pounds of carcass weight, were set up as follows:

	Percent of Carcass	Value per 100 lbs. carcass weight
Four lean cuts	47.1	$10.45
Non-lean cuts	52.9	4.92

To change this $4.92 value to the value of 100 pounds of non-lean cuts on a live basis, the following method was used:

52.9 percent of the total carcass was worth $4.92 per 100 pounds.

52.9 pounds of non-lean cuts would be worth $4.92.

100.0 pounds of non-lean cuts would be worth $9.30.

However, if the weight of non-lean cuts equals the live weight minus the weight of the four lean cuts, then the value must be computed on a live-weight basis. The value of 100 pounds of live weight for non-lean cuts was $9.30 times 68.5 percent. The carcass yield or dressing percent used by Kirtley was 68.5 percent. The value of non-lean cuts on a live basis as used in this study was $6.35.

A short summary of the averages and values found in Tables 13 and 14 are regrouped in Table 15. An average carcass weight of 146 pounds was found for this group of barrows which had a live-weight average of 196 pounds. These figures give a group carcass yield of 74.5 percent.

The data as compiled in Table 13 contains many significant facts as shall be noted here. As was explained in an earlier section, an attempt was

Table 15. Summary of results for the five main cuts as obtained from Tables 13 and 14.

Item	Percent of live wt.	Wholesale price per 100 lbs.	Value per 100 lbs. live wt.	Percent of total value
Skinned hams	12.98	$35.20	$ 4.57	28.39
Loins	11.50	41.00	4.72	29.28
Boston butts	4.12	28.80	1.19	7.38
Picnics	6.70	22.70	1.52	9.44
Bacon	13.27	23.35	3.10	19.23
4 lean cuts	35.30	-	12.00	74.49
5 primal cuts	48.57	-	15.10	93.73
Total cuts and products	100.0	-	16.11	100.00

made to remove the variable weight factor by slaughtering as near the same weight as possible. The live shrunk weight range for this group of barrows was from 188 pounds to 204 pounds. This small range of 16 pounds was very minor as compared to the large weight ranges which may be found on a central hog market. The weight of carcasses ranged from 137 pounds to 153 pounds which was also a very narrow spread as compared to actual market conditions.

The variation among each of the five primal cuts was computed as a percent of the average yield of these cuts. The greatest variance percentage wise was 43.4 percent for the yield of picnics. Bacon, Boston butts, and hams came next in that order with variation percentages of 38.4, 35.9, and 34.0 respectively. The yield of loins showed the least percent variation, 29.1, of the primal cuts. The combined four lean cut yield had a lower variation of 23.4 percent and a 21.2 percent for the percent of lean cuts. This may, to a certain extent, mean that a lower than average cut may be somewhat offset by a higher than average yield of another cut of the same carcass. A small degree of variation was expected even though one person did all the cutting and weighing. However, a variation of 21.2 percent in the lean yield was quite significant. The actual range in percent of lean cuts was from 32.0 to 39.5 percent. This means that a large variation can be expected from a group of similar weight hogs. If a large variation can be expected in the percent of lean yield or high value cuts, then a large variation can be expected in the actual value of the live hogs. This point was expressed with even greater emphasis in Table 14, when the actual money values were included. It was found that the variation in the value of lean cuts was somewhat reduced when bacon value was added to give the primal cut value. A variation of $5.81 per hog was found for lean cuts as compared to $5.23 for the primal cuts. The lean yield variation was quite significant for only 35 percent of the live weight as compared to $1.06 variation in the value of the non-lean cut portion which makes up 65 percent of the live hog. Therefore, it can be seen that the variation in hog values was largely due to variation in the yield of four lean cuts.

When considering the total cutout value per 100 pounds live weight as shown in column 11 of Table 14, a large value differential was found among this small group of barrows. A $2.28 value range from $15.10 to $17.38 per 100 pounds live weight was shown for this group of similar weight hogs. In other words, a price differential of $2.25 per 100 weight could have been paid in the market place between the high and low yielding hogs. Again, this was only a small variation as compared to the actual market run where a greater price differential could be paid. Fox, et al. (1953), also found in their study a range in actual cutout value of $2.00 to $3.00 per 100 pounds live weight. It was noted by Wiley, et al. (1951), that variations as great as 18 percentage points were found in the percent yield of lean cuts among carcasses of equal weights. A method available in which to show the desire for this higher yielding lean-type hog is through an adequate price differential.

The data of this study was injected as an average into the form presented in Table 11 to read as shown in Table 16. The table was then completed for the 30-40 percent range in percent of lean yield. Column (8) shows the amount which actually could have been paid for the hogs had the percent of lean yield been known. It is shown here that hogs ranging from 30 to 40 percent in lean yield could have a price differential of $2.75 per live hundred weight. By taking the material of Wiley, et al. (1951), and applying it to this table, the 18 percent variation would be approximately equal to 14 percent variation on a live basis. With a 14 percent variation in lean yield it was found by following the prices and method found in Table 16, that a price range of $3.85 per live hundred weight could have been followed on this group of hogs studied by Wiley. It can be concluded, that the producer is justified in demanding a large price differential in the market place for hogs with such a large degree of variation in the percent yield of four lean cuts.

SUMMARY AND CONCLUSIONS

The main objective of this study was to find those physical factors of a live hog which would aid in the determination of real cutout value. In this

Table 16. Prices which could be paid for hogs ranging from 30 to 40 percent in lean yield as based on the data obtained in this study.

(1) Live weight (lbs.)	(2) Percent lean yield	(3) Value per one percent lean yield per cwt.	(4) Lean value per cwt.	(5) Percent non-lean	(6) Value one percent non-lean per cwt.	(7) Non-lean value per cwt.	(8) Total value per 100 lbs. live wt.	(9) Total value per hog
196	30	$ .34	$10.20	70	6.5¢	$4.55	$14.75	$28.91
196	31	.34	10.54	69	6.5	4.49	15.03	29.46
196	32	.34	10.88	68	6.5	4.42	15.30	29.99
196	33	.34	11.22	67	6.5	4.36	15.58	30.54
196	34	.34	11.56	66	6.5	4.29	15.85	31.07
196	35	.34	11.90	65	6.5	4.23	16.13	31.60
196	36	.34	12.24	64	6.5	4.16	16.40	32.14
196	37	.34	12.58	63	6.5	4.10	16.68	32.69
196	38	.34	12.92	62	6.5	4.03	16.95	33.22
196	39	.34	13.26	61	6.5	3.97	17.23	33.77
196	40	.34	13.60	60	6.5	3.90	17.50	34.30

study, 31 barrows were measured and slaughtered to find the factors of a live hog which were significantly correlated with the percent yield of the four lean and five primal cuts. The percent of lean cuts when compared with the percent yield of primal cuts was found to have the higher degree of correlation, .98324 to .71840, with the true cutout value. Therefore, with such a high relationship between the cutout value and percent lean yield, those factors highly correlated with the percent lean yield will also be highly correlated with the real value.

The data of this study was analyzed by means of simple and multiple correlation techniques. Inter-correlations were computed for 24 of the variables studied. Also, a group of equations were designed to gain additional information concerning the relative and absolute quantity of variation in lean yield explained by each of the live physical measurements taken. The last section on comparative cutout values, was included to illustrate the actual large fluctuation in true values existing among hogs of similar weights.

The significant physical factors found to be correlated with the percent of lean yield by use of simple correlation analysis include: (1) carcass fatback thickness, (2) live backfat probe depth, (3) shoulder thickness, and (4) heartgirth circumference. Correlation coefficients of .456 were significant at the one percent level and .355 at the five percent level of rejection. The backfat measures were by far the most significant factors with the percent lean yield as the carcass fatback and backfat probe measures had correlation coefficients of .67071 and .60715 respectively. The relationship between carcass backfat thickness and backfat probe depth was .74181. Coefficients of .68301 and .61017 were obtained for the backfat thickness and backfat probe respectively with the cutout value. Measures of shoulder thickness and heartgirth circumference had correlations of .46828 and .38099 respectively with the percent yield of lean cuts. These two measures are also partial measures of fatness as they were highly correlated with the backfat probe depth and were significant with carcass fatback thickness. Ham thickness and body length were only indirectly associated with percent lean yield by way of their relationship to the yield of ham and yield of loin respectively. The remaining factors which were loin thickness, base of skull width, forearm length, forearm circumference, and depth of twist, apparently have little association with the percent of lean yield. However, it should be mentioned that the forearm circumference, which is a measure of the size of bone, does show some relation with the yield of ham and inversely with the body length. Possibly a more accurate measure of the size of bone could be obtained which may be of more importance than that shown here.

A few possible measures which have been used or considered for the basis of price determination were correlated with the true cutout values. The percent of lean yield which had a correlation coefficient of .98324 was by far the most significant factor correlated with the cutout value. The other measures which were all significant at the five percent level with the cutout value were: (1) percent yield of primal cuts, .71840; (2) carcass grade, .55487; and (3) dressing percent, .36770.

The ten physical factors were combined in a multiple correlation analysis to determine the actual amount of variation in the lean yield explained by each of the factors. All ten variables combined explained 59.2 percent of the total variation found in the lean yield. This percent was lower than that desired and expected by the author. Once again, fatback thickness was the most significant in relation to the percent of lean yield. The factors and the amount of variation explained in the order of their significance were: (1) fatback thickness, 43.0 percent; (2) shoulder thickness, 6.3 percent; (3) ham thickness, 4.0 percent; (4) forearm circumference, 3.5 percent; (5) body length, 1.0 percent; (6) depth of twist, 0.9 percent; and (7) heartgirth circumference, 0.9 percent. The remaining factors of loin thickness, forearm length, and base of skull width, were non-significant. The importance of ham thickness and forearm circumference, which was a measure of the size of bone, were improved under the multiple correlation analysis. With 40.8 percent of the variation in the lean yield still unexplained by these ten factors, it is likely that there are some important factors still to be found.

By devising certain ratios using the same factors, it was found that essentially the same correlation coefficients were obtained irregardless of whether ratios were used or multiple correlation analysis. The three factors which were found to be the most significant by the use of ratios were: (1) fatback thickness, (2) ham thickness, and (3) body length. These three factors alone explained 51.1 percent of the total lean yield variation when assembled in this equation form (percent lean yield = body length·ham thickness ÷ fatback thickness). When any other fatness factor was substituted for fatback thickness a great decrease in the coefficient occurred. The importance of ham thickness was again brought out here by an addition of five percent to the coefficient of determination.

In concluding these sections which were seeking those factors highly associated with the percent of lean yield which may be used as an aid in estimating the true live value, it may be said that a few such factors were found. A measure of the fatback thickness was the most significant of all the important factors. Shoulder thickness, ham thickness, forearm circumference, and body length were found through multiple correlation analysis to be the other important factors as they are stated in the order of their significance.

The data of this study was combined with the average Chicago wholesale price quotations, July 1 to August 15, 1959, and the value of non-lean cuts derived from Kirtley and Broadbent (1960), to determine the amount of variation in cutout values among hogs of similar weights. A form was devised which may be used in determining the price which could be paid per 100 pounds live weight based on the value of each percent yield of lean and the value of each percent of non-lean yield. This form was shown in Table 11 and the instruction to aid in completion was included on page 71. The yield of the four lean cuts averaged 35.3 percent of live weight and 74.5 percent of total value. The five primal cuts averaged 48.6 percent of live weight and 93.7 percent of total value. The percent of lean cuts ranged from 32.0 percent to 39.5 percent among hogs which varied only 16 pounds in live weight. A variation of $5.81 was found for the lean cut values and $5.23 for the primal cut values. This shows that the greater portion of value variation was due to the variation in the yield of lean cuts. A total value variation per 100 pounds live weight was shown to be $2.28. This was the price differential which could have been paid on the market for hogs of similar weight. For hogs with an average weight of 196 pounds, a total hog value differential of $4.00 could have been paid between the high and low of this range. Therefore, it was seen that a large value differential does exist among hogs of similar weights and this was mainly due to the variation in the percent of lean yield. It can be concluded, that the producer is justified in demanding a large price differential in the market place for hogs with such a large degree of variation in the percent yield of the four lean cuts.

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APPENDIX

Table 17. Summary of live hog measurements.

Hog no.	Fat-back probe (in.)	Shoulder thickness (in.)	Heartgirth circumference (in.)	Loin thickness (in.)	Body length (in.)	Ham thickness (in.)	Base of skull width (in.)	Forearm length (in.)	Forearm circumference (in.)	Depth of twist (in.)
134	1.99	12.40	41.9	10.2	43.5	11.9	3.55	8.3	6.5	10.8
135	1.87	12.35	42.7	10.1	44.0	10.9	3.40	8.3	6.4	10.5
136	1.61	13.30	41.5	9.9	44.3	11.1	3.50	8.2	6.8	9.6
138	1.56	12.9	43.5	10.8	44.6	11.3	3.40	7.5	6.0	10.5
139	1.65	13.5	44.5	10.4	44.9	10.9	3.30	7.5	6.2	10.0
140	1.62	13.2	43.2	10.7	44.0	11.1	3.30	6.8	5.9	10.2
141	1.88	12.9	45.7	11.1	43.3	10.8	3.30	8.0	6.2	10.2
142	1.10	10.8	41.2	9.6	46.3	10.5	3.10	8.5	6.3	10.6
143	1.52	11.5	42.5	10.5	45.7	11.8	3.60	8.3	6.3	11.5
144	1.48	11.4	42.4	9.8	45.9	11.2	3.20	8.0	5.7	10.1
145	1.48	11.9	40.8	9.6	45.3	11.7	3.60	7.6	5.9	10.6
146	1.62	13.0	42.3	10.6	43.2	10.0	3.50	7.2	5.9	10.5
147	1.42	12.6	43.7	10.4	44.3	11.0	3.70	8.3	6.3	9.8
148	1.62	13.4	43.8	10.8	44.9	10.6	3.20	7.9	5.9	9.8
150	1.48	12.5	42.1	9.8	45.2	9.6	3.60	8.7	5.9	11.0
151	1.44	11.7	43.2	10.0	45.0	10.6	3.60	7.8	6.5	10.0
152	1.48	11.5	41.4	9.6	46.9	10.8	3.00	8.4	5.7	9.5
153	1.62	11.7	41.3	11.2	43.8	11.1	3.40	7.2	6.0	10.9
154	1.18	12.1	41.2	10.2	44.0	11.1	3.20	7.7	6.3	11.0
155	1.13	11.8	41.5	10.1	44.6	10.7	2.90	8.4	6.4	10.2
156	1.42	12.4	41.4	10.0	44.4	10.5	3.10	8.5	6.3	10.8
157	1.72	12.0	43.7	9.4	47.1	11.4	3.20	8.0	5.9	11.1
159	1.72	12.3	44.2	10.1	44.7	10.5	3.20	8.6	6.2	10.8
160	1.32	12.3	42.3	10.7	44.7	11.2	3.50	7.6	6.1	11.0
161	1.45	12.0	42.6	9.8	44.3	11.4	3.30	8.8	6.3	10.1
162	1.26	11.9	42.0	9.9	44.8	10.8	3.30	8.9	6.4	10.1
163	1.65	11.8	41.6	9.7	45.0	11.4	3.10	8.8	7.3	10.4
164	1.53	13.5	43.6	10.2	43.6	11.7	3.10	9.2	6.9	10.1
165	1.36	11.7	39.8	9.0	46.1	10.8	3.20	9.1	6.0	12.1
166	1.12	11.8	41.4	9.7	45.4	11.6	3.20	8.8	6.1	11.5
167	1.38	12.3	43.8	9.9	43.9	11.9	3.50	8.4	6.4	10.4
Total	46.68	380.45	1316.8	313.8	1387.7	341.9	103.05	253.3	193.0	325.7
Ave.	1.51	12.27	42.5	10.1	44.8	11.0	3.32	8.2	6.2	10.5

Table 18. Summary of carcass measurements and weights.

Hog no.	Fatback thick- ness (in.)	Live shrunk weight (lbs.)	Trimmed ham weight (lbs.)	Loin weight (lbs.)	Picnic weight (lbs.)	Boston butt weight (lbs.)	Bacon weight (lbs.)	Carcass grade	Percent lean yield (live wt.)	Dressing percent
134	2.00	195	24.90	21.20	14.20	7.00	21.20	3	34.0	71.3
135	1.62	193	24.45	21.25	13.00	6.65	25.65	2	33.9	74.1
136	1.90	198	27.15	19.60	16.30	8.25	26.35	3	36.0	74.2
138	1.73	198	23.60	19.10	12.70	8.10	31.20	3	32.1	71.2
139	1.55	196	24.40	22.10	13.70	7.90	28.80	1	34.7	75.0
140	1.82	198	21.70	20.40	13.30	8.60	29.70	2	32.3	74.2
141	1.82	199	24.50	21.40	14.50	8.40	26.70	2	34.6	75.9
142	1.47	200	26.20	24.40	14.00	8.50	29.80	1	36.6	73.5
143	1.65	201	27.70	22.70	13.30	6.80	30.30	2	35.1	76.1
144	1.68	195	26.70	23.70	14.30	8.60	27.10	2	37.6	75.9
145	1.47	192	25.50	22.90	13.80	8.90	23.70	1	37.0	75.5
146	1.75	190	20.80	20.50	12.20	7.30	25.60	2	32.0	74.7
147	1.41	195	24.20	21.70	13.50	8.70	24.80	1	34.9	74.4
148	1.75	200	23.70	22.60	13.10	8.60	26.00	2	34.0	76.0
150	1.60	200	24.15	25.15	12.20	7.30	25.00	1	34.4	73.5
151	1.63	200	27.00	26.20	12.25	7.90	22.55	2	36.7	74.0
152	1.50	188	23.20	21.60	12.70	7.60	23.95	1	34.6	74.5
153	1.62	190	26.70	22.05	12.70	7.60	23.10	2	36.3	75.3
154	1.32	195	27.10	24.60	13.60	7.95	24.95	1	37.6	75.4
155	1.32	195	29.00	26.05	13.05	8.90	22.90	1	39.5	75.4
156	1.49	193	23.35	23.05	12.75	9.55	23.00	1	35.6	74.6
157	1.73	193	26.10	22.55	12.40	7.30	24.70	2	35.4	75.6
159	1.94	200	23.70	23.40	10.60	7.60	24.65	3	32.7	71.0
160	1.28	195	27.20	25.65	12.80	8.25	25.70	1	37.9	74.9
161	1.82	194	24.15	19.60	12.00	8.50	28.55	2	33.1	75.3
162	1.47	200	27.80	23.30	13.00	8.90	27.00	1	36.5	74.0
163	1.65	198	26.00	22.20	12.40	7.90	29.00	2	34.6	74.7
164	1.63	204	27.20	21.90	14.10	8.50	29.55	2	35.2	74.5
165	1.30	190	25.10	23.25	12.20	8.00	23.15	1	36.1	72.1
166	1.55	190	26.00	22.30	12.10	7.90	27.05	1	35.9	75.3
167	1.50	199	29.45	22.40	14.65	8.55	24.75	1	37.7	76.9
Total	49.97	6074	788.70	698.80	407.40	250.50	806.45	52	1094.6	2309.0
Ave.	1.61	196	25.44	22.54	13.14	8.08	26.01	1.68	35.3	74.5

Table 19. Summary of values and percentages.

Hog no.	Percent ham (lv.wt.)	Percent loin (lv.wt.)	Percent picnic (lv.wt.)	Percent Boston butt (lv.wt.)	Percent bacon (lv.wt.)	Percent primal cuts (lv.wt.)	Value 4 lean cuts (cwt.)	Value 5 primal cuts (cwt.)	Cutout value per (cwt.)	Total cutout value
134	12.77	10.87	7.28	3.59	10.87	44.87	12.46	14.17	15.83	30.86
135	12.67	11.01	6.67	3.41	13.15	47.15	11.90	14.60	15.70	30.30
136	13.71	9.90	8.23	4.17	13.31	49.32	11.89	15.07	16.03	31.73
138	11.92	9.65	6.41	4.09	15.76	47.83	11.32	14.46	15.10	29.89
139	12.45	11.28	6.99	4.03	14.69	49.44	11.57	15.18	15.90	31.16
140	10.96	10.30	6.72	4.34	15.00	47.32	11.50	14.36	15.16	30.01
141	12.31	10.75	7.29	4.22	13.42	47.99	11.87	14.74	15.76	31.37
142	13.10	12.20	7.00	4.25	14.90	51.45	11.52	15.91	16.46	32.91
143	13.78	11.29	6.62	3.38	15.07	50.15	11.48	15.48	16.08	32.33
144	13.69	12.15	7.33	4.41	13.90	51.49	11.75	15.99	16.71	32.58
145	13.28	11.93	7.19	4.64	12.34	49.38	12.12	15.41	16.53	31.74
146	10.95	10.79	6.42	3.84	13.47	45.47	11.85	13.99	15.16	28.80
147	12.41	11.13	6.92	4.46	12.72	47.64	12.03	14.76	15.92	31.05
148	11.85	11.30	6.55	4.30	13.00	47.00	11.97	14.57	15.72	31.44
150	12.08	12.58	6.10	3.65	12.50	46.90	12.08	14.76	16.01	32.01
151	13.50	13.10	6.13	3.95	11.27	47.95	12.37	15.29	16.67	33.34
152	12.34	11.49	6.76	4.04	12.74	47.37	12.03	14.73	15.90	29.90
153	14.05	11.61	6.68	4.00	12.16	48.50	12.16	15.21	16.42	31.19
154	13.90	12.62	6.97	4.08	12.79	50.36	12.01	15.82	16.79	32.74
155	14.87	13.36	6.69	4.56	11.74	51.23	12.26	16.29	17.38	33.90
156	12.10	11.94	6.61	4.95	11.92	47.51	12.22	14.86	16.17	31.20
157	13.52	11.68	6.42	3.78	12.80	48.21	12.01	15.09	16.20	31.27
159	11.85	11.70	5.30	3.80	12.33	44.98	12.12	14.15	15.54	31.08
160	13.95	13.15	6.56	4.23	13.18	51.08	11.92	16.09	16.96	33.07
161	12.45	10.10	6.19	4.38	14.72	47.84	11.56	14.63	15.44	29.95
162	13.90	11.65	6.50	4.45	13.50	50.00	11.85	15.58	16.46	32.91
163	13.13	11.21	6.26	3.99	14.65	49.24	11.58	15.21	15.94	31.56
164	13.33	10.74	6.91	4.17	14.49	49.63	11.62	15.25	15.98	32.60
165	13.21	12.24	6.42	4.21	12.18	48.26	12.15	15.18	16.39	31.15
166	13.68	11.74	6.37	4.16	14.24	50.18	11.67	15.60	16.34	31.05
167	14.80	11.26	7.36	4.30	12.44	50.15	12.10	15.64	16.69	33.21
Total	402.51	356.72	207.85	127.83	411.25	1505.89	368.94	468.07	499.34	978.30
Ave.	12.98	11.51	6.70	4.12	13.27	48.58	11.90	15.10	16.11	31.56

FACTORS IN LIVE HOG MARKET VALUE DETERMINATION

by

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AN ABSTRACT OF A THESIS

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There is a growing interest among producers, marketing agencies, educational folk, and processors to establish a more accurate means of pricing live hogs in the market. The need is great for a method marketing which through the pricing mechanism will reflect the actual cutout value to the producer.

Due to changes in the pork industry which include a virtual loss of the lard market coupled with consumer protests against over-fat cuts of pork, demand and thus prices have been lowered for fatty cuts of pork. Appropriate price differentials would provide powerful incentives for farmers to produce and market the leaner, consumer preferred, meat-type hog. At the present time, it is the ratio of lean to live weight which makes up the lean yield and not the carcass yield which determines value.

The principle objective of this study was to find those physical characteristics by use of actual measurements which were significantly correlated with the percent yield of the four lean cuts and with the cutout values.

In this study, 31 barrows were weighed and measured for ten characteristics to determine the degree of correlation existing between the factors and the percent of lean yield. The hogs were slaughtered in the meat's laboratory, Kansas State University, where all weights and measures were obtained.

The percent of lean yield which had a correlation coefficient of .98324 was by far the most significant factor correlated with the cutout value. The other measures considered as the base for price determination were the percent yield of primal cuts (.71840), carcass grade (.55487), and dressing percent (.36770). Correlation coefficients of .355 were significant at the five percent level and .456 at the one percent level of rejection.

The significant physical factors found to be correlated with the percent of lean yield by use of simple correlation analysis include: (1) carcass fatback thickness, -.67071; (2) live backfat probe depth, -.60715; (3) shoulder thickness, -.46828; and (4) heartgirth circumference, -.38099. The measures of shoulder thickness and heartgirth circumference were significantly related to the backfat measures.

The ten physical factors were combined in a multiple correlation analysis to determine the actual amount of variation in the lean yield explained by each of these factors. The ten variables combined explained 59.2 percent of the total variation found in the lean yield. The factors and the amount of variation explained in the order of their importance were: (1) fatback thickness, 43.0 percent; (2) shoulder thickness, 6.3 percent; (3) ham thickness, 4.0 percent; (4) forearm circumference, 3.5 percent; (5) body length, 1.0 percent; (6) depth of twist, 0.9 percent; and (7) heartgirth circumference, 0.9 percent. The remaining factors of loin thickness, forearm length, and base of skull width, were non-significant. The importance of ham thickness and forearm circumference were improved under the multiple correlation analysis.

By devising certain ratios using the same factors, it was found that essentially the same correlation coefficients were obtained irregardless of whether ratios were used or multiple correlation analysis. The three factors in the equation (percent lean yield = body length X ham thickness ÷ fatback thickness), explained 51.1 percent of the total lean yield variation.

A section on comparative cutout values, was included to illustrate the actual large fluctuation in true values found among hogs of similar weights. A range of 32.0 to 39.5 percent in lean yield was observed. A total value variation per 100 pounds live weight was shown to be $2.28. This was the price differential which could have been paid for this group in the market.