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Gerald Engelman,[2] Austin A. Dowell, Evan F. Ferrin, and Philip A. Anderson[3]

## INTRODUCTION

SLAUGHTER HOGS are ordinarily sold in the United States by liveweight with relatively little attention given to quality.[4] There is a rather general tendency for all hogs of the same class within the same weight range, except for gilts and sows advanced in pregnancy and hogs with obvious defects, to sell at about the same price per hundredweight.[5]

Under such conditions hogs producing high value carcasses do not command the appropriate premiums over less valuable animals. The producer of hogs is, therefore, not given adequate incentive to improve the quality of the product he brings to the market place.

### EFFORTS AT IMPROVEMENT

This does not mean that efforts have not been made to improve hog marketing methods. Many individuals and organizations have attempted to develop standards for live hogs, hog carcasses, and wholesale pork cuts that would have economic significance and at the same time be practical.

During the nineteenth century, the work toward improving hog marketing methods was carried on largely by private individuals and organizations who prepared current market reports and who endeavored to make their reports intelligible to others scattered over the

[1] Since this study was initiated, "Marketing Slaughter Livestock by Carcass Weight and Grade" was adopted as a regional project by the North Central Livestock Marketing Research Committee. Research and Marketing Administration funds were made available for the regional project in the fall of 1947.

[2] Gerald Engelman is now employed jointly by the Bureau of Agricultural Economics and the University of Minnesota.

[3] The data upon which this study is based were obtained at the Geo. A. Hormel & Co. meat packing plant at Austin, Minnesota. The authors wish to acknowledge the hearty cooperation received from officials and employees of the plant. The authors are also indebted to Mr. Fred J. Beard, Chief of the Standardization and Grading Division, Livestock Branch, Production and Marketing Administration, and Mr. Knute Bjorka, Bureau of Agricultural Economics, United States Department of Agriculture who contributed to the organization of the project. They are especially indebted to Mr. Charles E. Murphey of the Standardization and Grading Division who standardized the cutting procedures and suggested the correlation approach to the study of carcass merit which proved basic to the subsequent development of carcass standards.

[4] *The National Provisioner*. July 3, 1948, p. 57.

[5] Shepherd, Geoffrey, Beard, Fred J., and Erikson, Arval, *Could Hogs Be Sold by Carcass Weight and Grade in the United States?* Iowa Agricultural Experiment Station Research Bulletin 270. January, 1940, pp. 449, 465, 470, and 473.

market area.[6] During the present century, public agencies, including some of the state agricultural experiment stations and some of the bureaus of the United States Department of Agriculture, have entered the field.

Until shortly after the first World War, more emphasis was placed on the development of classifications for live hogs than for hog products, but since then an increasing amount of attention has been given to pork carcasses and wholesale pork cuts.

**Developing Standards.** The Illinois Agricultural Experiment Station published a bulletin on "Market Classes and Grades of Swine" in 1904.[7] Tentative United States standards for classes and grades of slaughter barrows and gilts were issued by the United States Department of Agriculture in 1931.[8] These standards, still tentative, were revised and explained in considerable detail in 1940.[9]

Tentative specifications for pork carcasses and cuts and miscellaneous meats were published by the United States Department of Agriculture in 1924.[10] Revised tentative United States standards for pork carcasses and fresh pork cuts were issued in 1933.[11]

In these tentative specifications it was assumed that a Choice (Fat Type) grade barrow or gilt would produce a No. 1 Fat Type (Butcher) pork carcass, and that this carcass would tend to yield No. 1 pork cuts; that a Choice (Meat Type) grade barrow or gilt would produce a No. 1 Meat Type (Bacon) pork carcass and this carcass would also tend to produce No. 1 pork cuts, or would produce No. 1 export Wiltshire or Cumberland sides if these items were desired.[12]

Similarly, it was assumed that a Good grade barrow or gilt would produce a No. 2 carcass, and this carcass would tend to yield No. 2 cuts; that a Medium grade barrow or gilt would produce a No. 3 carcass which would tend to yield No. 3 cuts; and that a Cull grade barrow or gilt would produce a Cull carcass which would tend to yield Cull cuts that are usually sold in the form of processed meat products.

Regardless of the relationships between the grades of live hogs, pork carcasses, and wholesale cuts, which are implied in these tentative specifications, they have not been promulgated as official United States standards as has been the case with beef, veal, lamb, and mutton carcasses.

One of the reasons pork carcass standards have not come into general use in the United States is that very little of the pork that is processed in this country leaves the packing plant and moves into the wholesale trade in the form of carcasses as do the other species of slaughter livestock. Most of the carcasses from slaughter hogs are disassembled into a number of wholesale cuts and trimmings in the same plant in which the animals have been killed. The products are merchandised in that form. Furthermore, only about 15 per cent of the wholesale cuts and other edible parts are sold as fresh pork to be consumed without further process-

[6] Dowell, Austin Allyn, and Bjorka, Knute, *Livestock Marketing.* McGraw-Hill Book Company, Inc., 1941. Chapters XIV and XV.

[7] Dietrich, William, *Market Classes and Grades of Swine.* Illinois Agricultural Experiment Station Bulletin 97. November, 1904.

[8] *Tentative U. S. Standards for Classes and Grades of Slaughter Barrows and Gilts.* Bureau of Agricultural Economics, United States Department of Agriculture. Mimeograph. July 31, 1931.

[9] Slater, Don J., *Market Classes and Grades of Swine.* United States Department of Agriculture, Circular No. 569. September, 1940.

[10] *Specifications for the Purchase of Pork Carcasses and Cuts and Miscellaneous Meats.* Bureau of Agricultural Economics, United States Department of Agriculture. Mimeograph. March, 1924.

[11] Davis, W. C., McCarthy, B. F., and Burgess, J. A., *Market Classes and Grades of Pork Carcasses and Fresh Pork Cuts.* United States Department of Agriculture. Circular No. 288. October, 1933.

ing. The other 85 per cent are cured, rendered into lard, or manufactured into various meat products.[13]

Processing procedures for pork in the United States differ considerably from those in Canada and some western European countries where a considerable proportion of the pork is sold in the form of carcasses or sides.[14]

The value of the live hog naturally depends upon the value of the carcass and other products it will yield, less marketing and processing costs. The value of the carcass, in turn, is the sum of the values of the various cuts and trimmings it will yield on the cutting floor. This suggests that one way to determine the true value of the product delivered would be to record the weights and calculate the values of the various wholesale cuts from each owner's lot of hogs separately. It has been found, however, that this is not practicable under conditions which prevail in a typical hog slaughtering plant in the United States. Under these conditions, the determination of value necessarily must be based upon the live hogs or the resulting carcasses.

Another reason for the lack of acceptance of these tentative standards issued in 1933 is the fact that some significant questions have been raised as to the accuracy with which they reflected cutout values based on the wholesale cuts and trimmings. For example, a Choice Fat Type grade hog was expected to yield a carcass which had a "relatively large percentage" of fat cuts and a "proportionately small percentage" of lean cuts.[15]

A Choice Meat Type grade hog was expected to yield a carcass which had a "moderately large percentage" of fat cuts and a "moderately small percentage" of lean cuts.[16] A Good grade hog was expected to yield a carcass which had a "slightly low percentage" of fat cuts and a "correspondingly high percentage" of lean cuts.[17] But how much is a "relatively large percentage" and how much is a "slightly low percentage" of fat cuts in the carcass? How much is a "proportionately small percentage" and how much is a "correspondingly high percentage" of lean cuts? The lean cuts normally are the high-value cuts of the carcass while the fat cuts, with the exception of the bellies, are normally the low-value cuts. Consequently, the most valuable hog or the most valuable carcass per pound is the one that will yield the highest proportion of high-value cuts, provided that satisfactory quality is maintained.[18] Nevertheless, these tentative standards placed the premiums on hogs and carcasses which produce a relatively low proportion of the lean or high-value cuts.

It is even more difficult to estimate the actual value of a live hog than of the carcass after the hog has been slaughtered. The live hog is one step further removed from the wholesale products which determine value than is the carcass. Differences in the relative proportions and qualities of the several wholesale cuts can be more easily detected by examining the carcasses than by looking at the live hog. Furthermore, dressing yields vary greatly among hogs that appear to be quite similar in conformation, finish, and quality. These differences in yield are also difficult to detect by looking

[12] Practically no carcasses are processed into Wiltshire or Cumberland sides in this country.
[13] Davis, W. C., McCarthy, B. F., and Burgess, J. A., *op. cit.*, p. 7.
[14] Shepherd, Geoffrey, *Livestock Marketing Methods in Denmark, Great Britain and Canada*. Iowa Agricultural Experiment Station Bulletin 353. January 1937; and Dowell, Austin Allyn and Bjorka, Knute, *op. cit.*, Chapter XX.
[15] Slater, Don J., *op. cit.*, p. 14.
[16] *Ibid.*, p. 16.
[17] *Ibid.*, p. 17.
[18] Although the United States tentative standards appear to place a premium on a high degree of finish, the Danish, British, and Canadian standards, based on objective measurements and geared to the Wiltshire side, all penalize carcasses with a high degree of finish.

at the live hog. The tentative standards for live hogs and hog carcasses apparently did not provide an entirely satisfactory criterion either of live hog merit or of carcass merit.

In the absence of satisfactory carcass standards, hogs continue to be sold by liveweight. And in the absence of satisfactory live hog standards, hogs continue to be sold with very little sorting other than for weight.

**Alternative Methods of Sale.** A few significant attempts have been made to improve upon the usual liveweight method of marketing hogs in this country. One such attempt was sale on the basis of guaranteed yield.

In 1923 a federation of county livestock marketing cooperatives in Ohio and Indiana initiated the sale of hogs to eastern slaughterers on the basis of guaranteed yields.[19] Different owners' hogs were assembled, sorted into fairly uniform lots, commingled, and shipped in full double-deck carloads direct to eastern slaughterers. Each sale was made on the basis of a specific price for a guaranteed yield for the entire load. Yields were guaranteed by the managers of the local associations while the carcasses were weighed by employees of the plants in which the animals were slaughtered. Final settlement was made on each shipment on the basis of a previously agreed upon adjustment for any divergence between the guaranteed yield and the actual yield.

This plan proved to be popular for a time; the number of hogs sold on this basis increased from 1924 to 1930, but thereafter declined. At one time, about 60 per cent of all hogs handled by these cooperatives were sold in this manner.

Although this method appeared to be an improvement, in some respects, over the usual liveweight method of sale, the plan ultimately was discontinued. One difficulty arose because of the inability of the local managers to estimate dressing yields accurately. Yields in excess of the guaranteed yields were accepted by farmers as desirable windfalls, but yields below the estimates of the managers were often resented.

Since the yield of the entire carload, which usually included several owners' lots of hogs, was generalized, some farmers who delivered, or at least thought they delivered, high-yielding hogs, felt that they did not receive all that was due them. Furthermore, since a representative of the seller was not present at the time the carcasses were weighed, some owners, especially those who expected higher than the reported yields, tended to question the accuracy of the carcass weights. For these and other reasons, this method of sale proved to be relatively short-lived.

Another experiment aimed at improving hog marketing methods was initiated in southern Minnesota in 1933 and was carried on for a period of about ten years. As early as 1928, Jay C. Hormel, then vice president and general manager of Geo. A. Hormel & Co., Austin, Minnesota, advocated trading in hogs on the basis of meat yield.[20]

In February, 1933, Geo. A. Hormel & Co. inaugurated a plan of buying hogs on the basis of the value of the wholesale cuts. This method required that the wholesale cuts from each lot of hogs be segregated, weighed, and recorded. This procedure greatly reduced the speed at which the carcasses could be handled in the cutting room. Furthermore, it increased the cost of settling for hogs by an estimated 50 cents per 100 pounds liveweight. Consequently, this method proved to be impracticable and was abandoned later during the year.

[19] Dowell and Bjorka, *op. cit.*, Chapter XIX.

[20] Thompson, Samuel Holliston, *Economic Trends in the Marketing of Iowa Livestock.* Doctoral Thesis, University of Minnesota, December, 1937, p. 102.

The following year, Geo. A. Hormel & Co. began to buy hogs on the basis of carcass weight and grade. The plan was regarded as being experimental and no effort was made to popularize it. Under this plan deductions were made for condemned and bruised parts, and a flat charge of 52 cents per 100 pounds liveweight was made for processing. This experiment was carried on for about two years and then was discontinued. It was felt that more investigation was needed to determine grade standards that would adequately reflect value differences between carcasses.

In June, 1940, this packing company again undertook the buying of hogs on a grade and yield basis. Four subjective carcass grades were established as follows:[21]

No. 1—Prime or top grade
No. 2—Overfinished
No. 3—Underfinished
No. 4—Scalawag or scrub

The No. 1 carcass had a medium thickness of backfat and a relatively high percentage of high-value cuts which could be sold as No. 1 cuts in the wholesale trade. The No. 2 carcasses were discounted because they carried a higher percentage of lard and a smaller percentage of high-value cuts. No. 3 carcasses yielded hams, loins, bellies, and other cuts so lacking in quality that they had to be merchandised under second grade brands. The cuts from the No. 4 carcasses lacked quality to the extent that they had to be utilized as trimmings or sold as inferior brands.

This subjective standard suggests a somewhat different criterion of carcass merit than the tentative United States carcass standards. It assumes a functional relationship between degree of finish and carcass value as determined by consumer preference. Underfinished carcasses, although they have a high proportion of lean, are discounted because they tend to yield cuts lacking in quality. Carcasses with a desirable degree of finish yield cuts of first grade quality, but do not yield an excessive amount of lard. Overfinished carcasses, on the other hand, are to be discounted not primarily because the cuts they yield lack quality but because the carcasses yield a high proportion of the relatively low-value lard in relation to the yield of high-value cuts.

Under this plan the carcasses were classified according to the corresponding sex and weight classification then in use for live buying. Standard dressing yields were established for each sex and weight class. The carcass price for the No. 1 or Prime grade of a given class was the live price converted to a carcass price on the basis of the standard dressing yield for the particular weight group. Discounts, which were applied on Nos. 2, 3, and 4 grades, varied from time to time as the wholesale prices of the different cuts and the relations of these prices to the price of lard changed. Processing charges, condemnations, and bruising losses were not deducted from the returns to farmers. A flat condemnation insurance fee of one-half of 1 per cent was assessed, however, to focus attention on this problem, and all condemnations were reported to the producers concerned.

As before, no particular effort was made to induce farmers to sell their hogs in this manner. It was offered as an optional plan. During the accounting year beginning November 1, 1940 a total of 4,088 hogs was purchased on this basis. During the next accounting year the number increased to 8,871, and during the next eleven months 11,804 hogs were purchased under this plan. Although the number purchased by carcass grade and yield was very small in relation to the total number

[21] Spahn, Harry, "Selling Hogs on Yield and Carcass Grade," an address given at Farm and Home Week, South Dakota State College, Brookings, South Dakota, November 18, 1940.

handled at this plant, the increase during the nearly three years it was in effect suggests that increasing numbers of farmers were attracted to the plan. The distribution of the carcasses among the different grades for one twelve-month period was as follows: Grade No. 1, 95.4 per cent; No. 2, 2.9 per cent; No. 3, 1.5 per cent; and No. 4, 0.2 per cent. These figures suggest either that Grade No. 1 covered a very wide range of desirability, or that the plan was selective in attracting top quality hogs.

Purchase on the carcass grade and yield basis was discontinued on October 2, 1943 as price ceilings on hogs, which were established by the Office of Price Administration, did not permit the payment of a premium price on No. 1 carcasses. The plan was not resumed for several years after price ceilings were lifted because it was believed that the subjective grade standards did not adequately reflect value differences in hog carcasses, and that additional work was needed to develop suitable standards. In 1948 this company resumed the purchase of hogs by carcass weight and grade on the basis of information supplied by this study.

## OBJECTIVES OF THE STUDY

It is apparent that attempts which have been made in the United States to establish satisfactory criteria of merit for slaughter hogs and hog carcasses have not been completely successful. The problem appears to be more difficult here than in some other countries, such as Canada, Denmark, Great Britain, and Sweden, where many, if not most, of the carcasses are sold in the form of sides rather than in the form of wholesale cuts and processed meats. In their search for an equitable method of pricing hogs, these countries have adopted rail grading or sale on the basis of carcass weights and grades. Under this system the carcasses are graded largely on the basis of objective or quantitative standards which include carcass weight, backfat thickness, and carcass length. The carcasses are graded on the rail after the viscera are removed and the backs split but before they are moved from the killing floor into the chill room. The grader in addition to using objective or quantitative measures, may make a subjective or qualitative evaluation of the conformation and other characteristics of each carcass so that off-grade carcasses can be detected.

One approach to the problem in the United States is to develop objective carcass standards that will serve to differentiate carcasses on the basis of the weight and grade of the wholesale cuts and trimmings they are expected to yield rather than on the basis of entire sides. This is the approach that has been made in this study.

To answer the question of whether or not slaughter hogs should be marketed by carcass weight and grade in the United States, it will be necessary to determine the desirability and the practicability of such a system. The desirability of marketing hogs by carcass weight and grade will depend upon the relative accuracy of the carcass method and the present liveweight method of marketing, and upon the attitude of farmers towards the two methods. Questions of practicability include, among others, the identification of the carcasses, weighing the carcasses, delay in making settlement to the owners of the animals, and the relative cost of the carcass and the liveweight methods.

Relatively little attention was given to several of these problems in this study which is limited largely to the following specific objectives:

1. To establish objective grade standards which will make it possible to distribute hog carcasses into relatively homogeneous groups with respect to physical composition.

2. To establish methods by which the values of the several weights and

grades of carcasses can be determined according to different schedules of prices for wholesale cuts and trimmings.

3. To determine relative accuracy of pricing butcher hogs under the present liveweight method and under an objective carcass weight and grade method.

## Source and Character of the Data

The basic data for the analysis leading toward the development of grade standards for hog carcasses were obtained at the Geo. A. Hormel & Co. packing plant at Austin, Minnesota. A total of 695 carcasses was selected during the period from August, 1946 through March, 1947. Several measurements were taken of the carcasses while they were hanging in the coolers. After being measured, the carcasses were moved to the cutting floor and subjected to a detailed cut-out test. The study centered on a search for possible functional relationships between the recorded carcass measures and the relative proportions of the various wholesale cuts.

### SELECTION OF CARCASSES

An attempt was made to obtain butcher hog carcasses that would be representative of a wide range of physical variation. It was intended that the carcass weights should vary from 115 pounds to 215 pounds. In a few cases these limits were exceeded slightly. This range in carcass weight approximates a liveweight range of 180 to 300 pounds and would include most of the butcher hogs marketed in Minnesota and other western corn belt states.

The entire range of 115 to 215 pounds was divided into 10 consecutive weight groups, each having a 10-pound weight range. One objective of the sampling procedure was to obtain approximately equal numbers of carcasses in each of the 10 weight groups.

Another objective was to obtain as wide a range as possible of finish or condition within each 10-pound weight group. To achieve this objective, carcasses were selected on the basis of the grade standards formerly used by the cooperating packer. These carcass grades included grade No. 2, which was believed to be overfinished; grade No. 1, which was presumed to have the desired finish; grade No. 3, which was considered to be somewhat underfinished; and grade No. 4, which appeared to be extremely underfinished.

As the selection of carcasses on the basis of these subjective standards progressed, it became apparent that grade No. 1 included within its limits a much wider physical range of finish than the other three grades.[22] Consequently, it was decided to divide the original grade No. 1 into three grades as follows: Grade No. 1a, which included carcasses in the original grade No. 1 with the most finished; grade No. 1b, which included carcasses in the original grade No. 1 with medium finish; and grade No. 1c, which included carcasses in original grade No. 1 with least finish.

By September 14, 1946, a total of 570 carcasses had been selected, measured, and processed. The reimposition by the OPA of price ceilings on hogs at that time resulted in a sharp reduction in market receipts so that the selection of carcasses was temporarily suspended.

Small numbers of carcasses were selected and processed from time to time during the next six months, and a special effort was made to round out the sample by obtaining lightweight overfinished carcasses and heavyweight underfinished carcasses.

[22] This was also suggested in the distribution of carcasses purchased by carcass weight and grade by the cooperating packing plant during 1941. See page 8.

The selection of carcasses was discontinued in March, 1947. By that time, a total of 695 carcasses had been measured, weighed, graded, and subjected to the detailed cutting procedures.

The difficulty encountered in obtaining overfinished lightweight carcasses, and underfinished heavyweight carcasses is indicated in table 1. The original objectives of approximately equal numbers of carcasses in each 10-pound weight group, and approximately equal numbers of carcasses in each grade within each weight group were not fully achieved. The sample, however, was considered fairly satisfactory for purposes of this study.

## Carcass Measurements

All carcass measurements were taken from the cold carcasses hanging in the coolers. Measurements included body length, ham length, backfat thickness at the first rib, last rib, and last lumbar vertebra, width through the shoulders, width through the hams, and thickness of belly pocket. A detailed description of the various measurements is given in Appendix A. All measurements were recorded in millimeters to facilitate subsequent computations.

## Cutting the Carcasses

In the cooperating packing plant, carcasses are moved through the cutting room at a rate varying from 1,100 to 1,400 carcasses an hour. Because of the speed with which the carcasses are disassembled, there is considerable variation in the points on the carcass at which the several cuts are separated. This results in considerable variation in the size of cuts from identical carcasses. Because the study was concerned with actual physical differences between carcasses rather than with variations in the accuracy with which hog carcasses are cut up by the regular cutting gang in a typical packing plant, it was considered advisable to standardize the cutting procedure and to apply it to each carcass individually.

The regular gang cutting operation was observed by representatives of the Standardization and Grading Division, Livestock Branch, Production and Marketing Administration, United States Department of Agriculture, and a standardized cutting procedure was prepared (Appendix B). The personnel who were required to cut the carcasses used in this study were carefully selected from the regular cutting gang and were supervised by representatives of the packing plant to insure adherence to the standardized cutting procedures.

## Grading Wholesale Cuts

To evaluate the effect of finish upon the probable frequency with which cuts

**Table 1. Distribution of Carcasses Selected for Cut-out Tests by Weight and Subjective Grade**

| Weight group | Carcass weight | Subjective carcass grades | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | | 2 | 1a | 1b | 1c | 3 | 4 | |
| I | 115-125 | 4 | 6 | 21 | 21 | 21 | 6 | 79 |
| II | 125-135 | 8 | 10 | 29 | 16 | 20 | 2 | 85 |
| III | 135-145 | 16 | 4 | 27 | 10 | 17 | 1 | 75 |
| IV | 145-155 | 9 | 6 | 42 | 5 | 11 | 2 | 75 |
| V | 155-165 | 14 | 18 | 37 | 8 | 16 | 2 | 95 |
| VI | 165-175 | 17 | 12 | 28 | 15 | 10 | ...... | 82 |
| VII | 175-185 | 17 | 14 | 25 | 7 | 9 | ...... | 72 |
| VIII | 185-195 | 11 | 5 | 21 | 8 | 5 | ...... | 50 |
| IX | 195-205 | 16 | 8 | 13 | 6 | 2 | ...... | 45 |
| X | Over 205 | 18 | 7 | 8 | 3 | 1 | ...... | 37 |
| Totals | | 130 | 90 | 251 | 99 | 112 | 13 | 695 |

NO. 210 SEX B WEIGHT 135 GRADE 2 DATE 14 Jan '47

| | | CUTS | WEIGHT | PER CENT | GRADE | PRICE | VALUE |
|---|---|---|---|---|---|---|---|
| LENGTH | | REG. HAM | $28^{1}$ | | | | |
| BODY | 663 | SKD. HAM | $24^{10}$ | 18.3 | | | |
| HAM | 354 | PICNIC | $13^{8}$ | 10.1 | | | |
| BKFAT THKNESS | | B. BUTT | $7^{13}$ | 5.8 | | | |
| 1ST RIB | 68 | LOIN | $21^{0}$ | 15.7 | | | |
| LAST RIB | 45 | REG. TRIM | $5^{3}$ | 3.8 | | | |
| LAST LUMB. | 35 | | $72^{1}$ | 53.7 | | | |
| AV— | 49 | SQ. BELLY | $19^{8}$ | 14.5 | | | |
| WIDTH HAM R. | 136 | | $91^{9}$ | 68.2 | | | |
| L. | 139 | FAT BACK | $13^{6}$ | 11.4 | | | |
| TOTAL | 275 | D.S. JOWLS | $4^{8}$ | 3.4 | | | |
| WIDTH SHLDR R. | 142 | FAT TRIM | $13^{4}$ | 9.9 | | | |
| L. | 147 | | $33^{1}$ | 24.7 | | | |
| TOTAL | 289 | SP. RIBS | $3^{2}$ | 2.3 | | | |
| BELL. POCKET | 24 | NECK BONES | $2^{8}$ | 1.8 | | | |
| | | FRNT. FEET | $1^{9}$ | 1.2 | | | |
| | | HIND FEET | $2^{0}$ | 1.5 | | | |
| | | TAIL | $^{6}$ | .3 | | | |
| | | | $9^{9}$ | 7.1 | | | |
| | | TOTAL | $134^{3}$ | 100.0 | | | |

FIG. 1. Individual hog carcass data card.

may be discounted for reasons of quality, the hams, loins, and bellies were graded by an employee of the packing plant as they were separated from the carcass. The data collected from this portion of the study, however, were not entirely satisfactory for the purposes for which they were intended as will be indicated later.

### Recording Primary Data

Information concerning each carcass was transcribed to a card such as is shown in figure 1. Weights of cuts were recorded in pounds and ounces. The weight of the regular (unskinned) ham was recorded on the card but was not included in the totals. Cuts and trimmings are grouped according to similarity of type and use. The four lean cuts, skinned hams, loins, picnics, and butts, all of which are usually high in value, are grouped together with the regular lean trimmings. The belly is a high-value cut, but since it is not a lean cut, it is placed by itself. The next group includes the fat cuts, other than the belly, and the fat trimmings. The final grouping includes the miscellaneous cuts consisting primarily of some of the skeletal parts of the carcass. The figures entered in undesignated spaces are subtotals for the various groupings. The entry below that for the belly is a subtotal for all cuts and trimmings entered above it. The total at the bottom of the weight column is the sum of the weights of the various cuts and trimmings, and this was presumed to be the total weight of the carcass.

## ANALYSIS OF DATA

The primary data for the development of quantitative standards for hog carcasses include, on the one hand, the individual carcass measurements, and

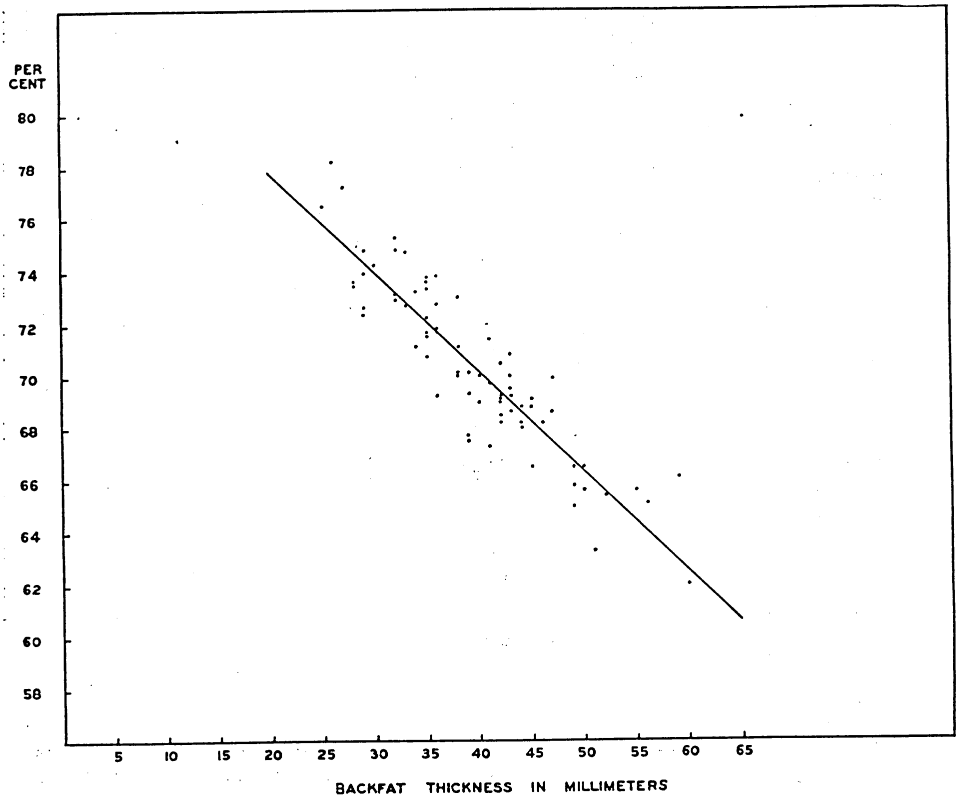


FIG. 2. Relationship between average backfat thickness and the percentage of the four lean cuts (hams, loins, Boston butts, and picnics), plus lean trimmings, and bellies. Weight group IV, 145-155 pounds.

on the other hand, the weights of the several wholesale cuts and trimmings obtained from each carcass. The problem is to determine relationships between carcass measurements and the weight and grade of the various wholesale cuts and trimmings the carcasses will yield on the cutting floor.

## Preliminary Analysis

Four different combinations of wholesale cuts appear to have merit as possible criteria of carcass desirability. These include: (1) the four principal lean cuts—hams, loins, Boston butts, and picnics; (2) the four lean cuts plus lean trimmings; (3) the four lean cuts plus lean trimmings and bellies; and (4) the four lean cuts plus bellies.

The hams, loins, Boston butts, and picnics are high-value lean cuts. The lean trimmings are usually quite high in value and are positively associated, quantitatively, with the four lean cuts. The bellies, although negatively associated with the various lean cuts, are nevertheless high-value cuts. The four combinations of high-value cuts were tested to determine the relative suit-

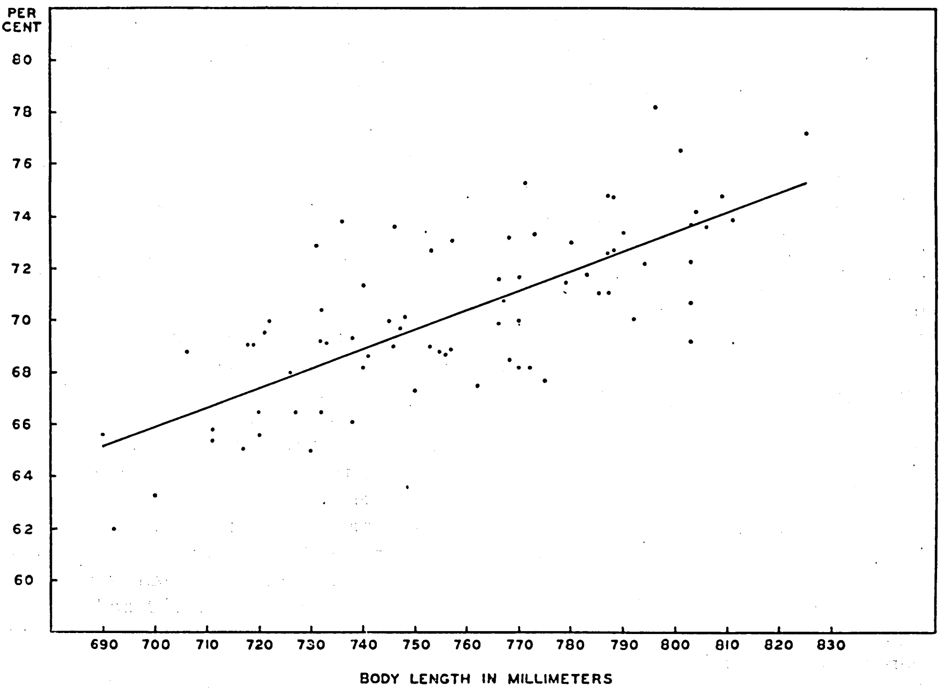


FIG. 3. Relationships between body length and the percentage of the four lean cuts (hams, loins, Boston butts, and picnics), plus lean trimmings and bellies. Weight group IV, 145-155 pounds.

ability of each for use as an index of carcass merit.

The 145- to 155-pound carcass weight group was selected for the preliminary analysis. Carcasses in this weight range are produced from hogs weighing in the neighborhood of 220 pounds liveweight. Scatter diagrams were plotted to show the relationship of each of the four criteria of carcass desirability to each of the six carcass measurements. This made a total of 24 scatter diagrams. From a visual examination of the scatter, the six carcass measurements appeared to rank in the following order with respect to their ability to predict the proportion of high-value cuts: (1) average backfat thickness; (2) length of body; (3) length of ham; (4) index of muscling in hams;[23] (5) index of muscling in shoulders;[23] and (6) thickness of belly pocket.

Average backfat thickness maintained a consistent superiority over the other measurements when plotted against each of the four criteria of carcass merit. Belly pocket thickness consistently proved to be the measure with least promise. Almost no relationship was shown by this measure. Al-

[23] The index of muscling in hams and the index of muscling in shoulders are calculated measures not shown on the carcass data card (figure 1). The index of muscling in hams was obtained by subtracting twice the thickness of backfat at the last lumbar vertebra from the total width of hams. The index of muscling in shoulders was calculated by subtracting twice the thickness of backfat at the first rib from the total width of shoulders. The objective was to approximate the thickness of the lean portions of the hams and shoulders respectively. See Appendix A for method followed to obtain width of hams and shoulders.

though length of body ranked second, it was far below backfat thickness. The differences between length of body, length of ham, index of muscling in hams, and index of muscling in shoulders were not clear-cut.

A scatter diagram showing the relationship between average backfat thickness and the percentage of four lean cuts plus lean trimmings and bellies is shown in figure 2. A distinct negative correlation is apparent. As backfat thickness increases the percentage of lean cuts plus lean trimmings and bellies decreases. The line drawn through the scatter is the line of average relationship of backfat thickness to the percentage of lean cuts plus lean trimmings and bellies.

A scatter diagram showing the relationship between length of body and the percentage of four lean cuts plus lean trimmings and bellies is shown in figure 3. Here, length of body and the percentage of four lean cuts plus lean trimmings and bellies are positively correlated. The percentage of four lean cuts, lean trimmings, and bellies increases with an increase in body length. The width of the scatter about the line of average relationship indicates that correlation between body length and this combination of high-value cuts and trimmings within this weight group is lower than correlation of backfact to the same cuts and trimmings (figure 2).

The scatter diagrams and simple correlations, showing the relationship between backfat and each of the four combinations of cuts, indicated that the combination of the four lean cuts and bellies was a less consistent and reliable criterion of carcass merit or desirability than were the other three combinations. There appeared to be no significant differences between the three remaining combinations of cuts.[24] When plotted against body length, however, the combination of four lean cuts, lean trimmings, and bellies appeared to give a slightly closer relationship than the other two combinations. Partly for this reason, but chiefly because the four lean cuts, lean trimmings, and bellies include most of the high-value components of the entire hog carcass, this combination was selected as the principal criterion for estimating the degree of carcass merit.

We have termed the percentage of the entire carcass which is made up of the four lean cuts, lean trimmings, and bellies the "index of lean." This is a quantitative objective measure of the degree of finish. Instead of being described as very fat, fat, moderately fat, moderately lean, lean, etc., carcasses may be classified by measurable indices of lean, such as 66.0, 68.0, 70.0, etc. An index of 70 means that the four lean cuts, lean trimmings, and bellies constitute 70 per cent of the weight of the carcass. The problem in establishing grade standards is to provide means for evaluating hog carcasses according to their expected indices of lean before they have been disassembled on the cutting floor.

The average correlation of backfat to the index of lean for the entire sam-

[24] The theoretical weighted averages of the simple correlation coefficients and the associated zetas of average backfat thickness to each of the four combinations of cuts for the 10 weight groups were as follows (table 19, Appendix G).

| Combination of cuts | Theoretical average correlation ($\rho$) | Zeta ($\zeta$) |
|---|---|---|
| (1) Four lean cuts | —.8639 | 1.3087 |
| (2) Four lean cuts plus lean trimmings | —.8581 | 1.2863 |
| (3) Four lean cuts plus lean trimmings and bellies | —.8589 | 1.2892 |
| (4) Four lean cuts plus bellies | —.7925 | 1.0784 |

The standard deviation of the difference between any two of the above zetas was 0.0538. This suggests that there is no significant difference between any of the first three combinations. However, since the difference between the zeta for the last combination and the zeta for any one of the first three would be approximately four standard deviations, the superiority of any of the first three combinations of cuts over the last must be regarded as highly significant.

ple was —.8589. The corresponding coefficient of determination (the correlation squared) was .7377. In other words, within comparable weights, the backfat measure alone explains about 74 per cent of the variability in the index of lean. For that reason it seemed doubtful that much improvement in correlation could be expected from the addition of other variables. Since, however, the scatter diagrams indicated that length was the second most promising measure, multiple correlation analyses, using backfat and body length as the two independent variables, were made separately within each of the 10 weight groups (table 20, Appendix G).

There was little improvement in the multiple correlation, relating backfat thickness and body length simultaneously to the index of lean, over the simple correlation of backfat alone to the index. This seems to indicate that, at least within fairly narrow weight limits, the addition of body length contributes little to the accuracy in predicting the index of lean over a prediction based entirely on backfat thickness and carcass weight. This does not mean that body length by itself has no value in predicting the index of lean, but if backfat thickness is known, length is of little further use for carcasses of approximately equal weight.

The relatively small improvement in the multiple correlation over the simple correlation is explained largely by the high degree of intercorrelation between backfat thickness and body length for carcasses of similar weight.[25] This means that among carcasses of the same weight, long carcasses will be likely to have a relatively thin backfat and a correspondingly high index of lean. Short carcasses of the same carcass weight will have a relatively thick backfat, and are likely to have a low index of lean. In other words, backfat thickness has a great deal of influence on the index of lean. The influence of length on the index of lean, on the other hand, is exerted primarily through its relationship with backfat; that is, length has little **independent** influence on the index of lean.

Since the addition of the body length variable resulted in only slight improvement over backfat alone, it was decided to eliminate this factor from further consideration. The other measures gave even less promise than body length, so that there appeared to be little justification for giving the other variables the detailed treatment involved in correlation procedures. Consequently, the backfat measure was used as the primary determinant of carcass merit in the development of a carcass grade standard for butcher hogs.

## DEVELOPING HOG CARCASS GRADE SPECIFICATIONS

**Relationships Between Backfat Thickness and the Index of Lean.** Having eliminated the physical measures other than backfat from further consideration, it will be well to examine some of the data arising out of the basic analyses from which grade standards are to be developed (table 2).[26] Carcasses in the lighter weight groups tended to have a higher proportion of lean (column 5) and less backfat (column 7) than the heavier carcasses. The average rate of change[27] (column 10) shows the change in the index of lean associated with a change of one millimeter of backfat thickness. In Group I, for example, an increase of one millimeter of

[25] The theoretical average simple correlation of backfat thickness to the index of lean ($\rho_{12}$) was .8589. The comparable multiple correlation of backfat and body length to the index of lean ($R_{1.23}$) was .8656. The theoretical average intercorrelation between backfat thickness and body length was .6648 (table 20, Appendix G).

[26] See Appendix C for the distribution of the entire sample by index of lean and carcass weight.

[27] In statistical terms the average rate of change is the regression coefficient.

Table 2. Statistical Measures from the Analyses of Backfat Thickness and Index of Lean, and Computed Backfat Thickness at an Index of Lean of 70.0

| Weight group | Carcass weights | Number of carcasses | Average weight of carcasses | Index of lean: Average $M_1$ | Index of lean: Standard deviation $\sigma_1$ | Backfat thickness: Average $M_2$ | Backfat thickness: Standard deviation $\sigma_2$ | Correlation ($r_{12}$) | Average rate of change* ($b_{12}$) | Standard error ($S_{1.2}$) | Computed backfat thickness at an index of lean of 70.0† |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | pounds | | pounds | per cent | per cent | millimeter | millimeter | | | per cent | millimeter |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| I | Under 125 | 79 | 120.7 | 71.70 | 3.2272 | 33.66 | 7.66 | —.8797 | —.3708 | 1.5347 | 38.24 |
| II | 125-35 | 85 | 129.5 | 71.31 | 2.9695 | 36.62 | 6.82 | —.8036 | —.3499 | 1.7674 | 40.36 |
| III | 135-45 | 75 | 139.4 | 70.54 | 3.3775 | 39.41 | 7.95 | —.8940 | —.3798 | 1.5094 | 40.83 |
| IV | 145-55 | 75 | 150.2 | 70.28 | 3.2310 | 39.65 | 7.69 | —.9089 | —.3817 | 1.3527 | 40.38 |
| V | 155-65 | 95 | 159.8 | 70.05 | 3.1966 | 41.69 | 7.44 | —.8613 | —.3696 | 1.6242 | 41.83 |
| VI | 165-75 | 82 | 170.6 | 69.89 | 3.5103 | 43.23 | 8.40 | —.8934 | —.3735 | 1.5619 | 42.95 |
| VII | 175-85 | 72 | 179.3 | 69.46 | 3.2444 | 44.57 | 7.58 | —.8740 | —.3739 | 1.5768 | 43.13 |
| VIII | 185-95 | 50 | 189.4 | 70.50 | 2.4441 | 43.56 | 5.93 | —.7728 | —.3183 | 1.5513 | 45.12 |
| IX | 195-205 | 45 | 199.1 | 68.90 | 2.8466 | 47.73 | 6.72 | —.7953 | —.3367 | 1.7257 | 44.46 |
| X | Over 205 | 37 | 214.6 | 67.77 | 3.2754 | 50.86 | 7.17 | —.7419 | —.3387 | 2.1962 | 44.29 |
| All weights | | 695 | 159.4 | 70.23 | 3.3172 | 41.19 | 8.68 | —.8475 | —.3240 | 1.7613 | ..... |

* Regression coefficient.

† Backfat thickness at an index of lean of 70.0 $= M_2 - \left(\frac{M_1 - 70.0}{b_{12}}\right)$.

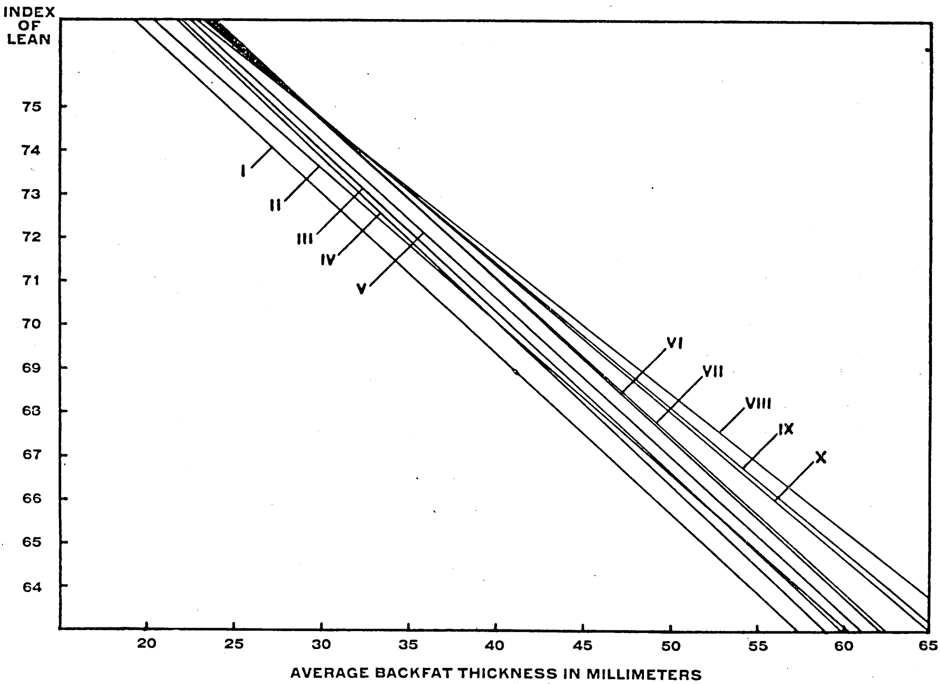


FIG. 4. Relationships between average backfat thickness and index of lean for 10 weight groups of butcher hog carcasses.

backfat is associated with a decrease of 0.37 in the index of lean. In terms of inches, since there are approximately 25 millimeters to an inch,[28] two carcasses of this particular weight group which differ by 1 inch in average backfat thickness would be expected to differ by 9.2 points in the index of lean, or 9.2 per cent in the percentage of the four lean cuts, lean trimmings, and bellies the carcasses will yield.

The lines of average relationship for the 10 weight groups are shown in figure 4. Line IV is the line for weight Group IV which was shown in figure 2. Similarly, the other lines are the lines of average relationship of the index of lean to backfat thickness for the other weight groups of hog carcasses. The lines of relationship for the heavier weight carcasses tend to be to the right of those for the lighter weight carcasses. In other words, among carcasses of unlike weight, but of like degree of finish, as measured by the index of lean, the heavier carcasses will be longer, deeper, thicker, and accordingly, will tend to have a thicker backfat. The expected relationship, however, was not a consistent one. The lines of relationship for Groups VIII, IX, and X lie in positions just in reverse of that expected.[29] Other

[28] 1 inch = 25.39876 millimeters; 1 millimeter = 0.039372 inch.

[29] The sharp drop in the correlation and regression coefficients (table 2) in Groups VIII, IX, and X, may be explained in part by the fact that a larger proportion of these carcasses was obtained during the fall and winter of 1946-47, and at rather infrequent intervals. In many cases during this period a small crew of four or five men was assigned the task of cutting these carcasses separately while the main plant cutting operations were under way. It is quite possible that the cutting procedures were not adhered to as rigidly by these men during this period as was the case with the 570 carcasses cut earlier in 1946.

discrepancies are noted in the positions of Groups II, III, and IV which lie very close to each other.

The slopes of the several lines of the heavier weight groups tend to be less steep than the slopes of the lines of the lighter weight groups (figure 4). This was expected because a given change in backfat thickness should have considerably more influence on the index of lean on 120-pound carcasses than on 200-pound carcasses. Group I would be expected to have the highest average rate of change (table 2, column 10) and Group X the lowest. Although there was a trend in this direction, the relationship was not always consistent.

These data suggest that, at any given degree of finish or index of lean, average backfat thickness increases with carcass weight, but probably at a decreasing rate. They also suggest that the rate of change in the relationship of the index of lean to backfat thickness for hogs of all degrees of finish decreases as carcass weight increases. The determination of these relationships is essential to the construction of objective carcass grade standards.

In order to determine the expected relationship between backfat thickness and carcass weight, it was necessary to compute the expected backfat thickness at some standardized index of lean for each of the 10 weight groups of carcasses. The purpose of this section of the analysis was to make possible the comparison of carcasses having a like proportional composition of the several wholesale cuts and trimmings, but differing in carcass weight. The **independent** effect of carcass weight on the backfat thickness can then be determined.

The carcasses within each weight group were standardized at an index of lean equal to 70.0, and the respective expected backfat thicknesses were computed as is shown in the last column of table 2.[30] The locations of these adjusted backfat thicknesses are shown in figure 5 as they are related to carcass weight. The curve indicates the expected or theoretical relation of backfat thickness to carcass weight of comparable carcasses standardized in this manner. Columns 2 and 3 of table 3 give these expected backfat thicknesses for all carcass weights from 100 to 350 pounds at 5-pound intervals.

In this particular type of curvilinear relationship,[31] backfat thickness increases with carcass weight but at a decreasing rate. Thus, the difference in the backfat thickness between 100 and 120 pounds carcass weights would be 1.8 millimeters. With a similar 20-pound difference between 200 and 220 pounds, the comparable difference in backfat thickness would be only 1.1 millimeters.[32]

After having developed an explanation of the expected relation of backfat thickness to carcass weight when the index of lean is held constant, the next step is to determine how the relation of the index of lean to backfat thickness differs with different carcass weights. In other words, how does the effect of a given change in backfat thickness on the index of lean at 120 pounds carcass weight differ from the

[30] This particular standardized value was chosen because it approaches the average index of lean for the entire sample which was 70.23.

[31] The regression equation describing this relationship is the logarithmic expression:

$$\log Y = 1.0415302 + 0.263{,}574{,}704{,}408 \log X$$

where Y = expected backfat thickness when the index of the lean is equal to 70.0
and X = carcass weight

This curve expresses the relationship between the radius and volume of cylinders alike proportionally but differing in size where Y = the radius and X = the volume. In analogous terms, the standardized hog carcasses are similar to cylinders of constant proportions. Backfat thickness conceptually is similar to a function of the radius of the entire cylinder, and carcass weight is analogous to the volume of the cylinder.

[32] As the mass (volume or weight) of any standard physical form increases, whether it is a sphere, a square, a pyramid, or a cylinder, any single dimension will increase at a decreasing rate as long as the proportions (the ratios of the several dimensions to each other) are kept constant.

**Table 3. Relation of Theoretical Average Rate of Change (of the Index of Lean to Backfat) to Computed Backfat Thickness and Carcass Weight**

| Carcass weight | Computed backfat thickness* | | Theoretical average rate of change† | Carcass weight | Computed backfat thickness* | | Theoretical average rate of change† |
|---|---|---|---|---|---|---|---|
| pounds | millimeters | inches | millimeters | pounds | millimeters | inches | millimeters |
| (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) |
| 100 | 37.04 | 1.458 | .407634 | 230 | 46.13 | 1.816 | .327309 |
| 105 | 37.52 | 1.477 | .402420 | 235 | 46.40 | 1.827 | .325405 |
| 110 | 37.98 | 1.495 | .397546 | 240 | 46.65 | 1.837 | .323661 |
| 115 | 38.43 | 1.513 | .392890 | 245 | 46.91 | 1.847 | .321867 |
| 120 | 38.86 | 1.530 | .388543 | 250 | 47.16 | 1.857 | .320161 |
| 125 | 39.28 | 1.547 | .384388 | 255 | 47.41 | 1.867 | .318472 |
| 130 | 39.69 | 1.563 | .380418 | 260 | 47.65 | 1.876 | .316868 |
| 135 | 40.09 | 1.578 | .376622 | 265 | 47.89 | 1.886 | .315280 |
| 140 | 40.48 | 1.594 | .372994 | 270 | 48.13 | 1.895 | .313708 |
| 145 | 40.85 | 1.608 | .369615 | 275 | 48.36 | 1.904 | .312216 |
| 150 | 41.22 | 1.623 | .366297 | 280 | 48.59 | 1.913 | .310738 |
| 155 | 41.58 | 1.637 | .363126 | 285 | 48.82 | 1.922 | .309274 |
| 160 | 41.93 | 1.651 | .360095 | 290 | 49.04 | 1.931 | .307887 |
| 165 | 42.27 | 1.664 | .357198 | 295 | 49.26 | 1.939 | .306512 |
| 170 | 42.60 | 1.677 | .354431 | 300 | 49.48 | 1.948 | .305149 |
| 175 | 42.93 | 1.690 | .351221 | 305 | 49.70 | 1.957 | .303798 |
| 180 | 43.25 | 1.703 | .349105 | 310 | 49.91 | 1.965 | .302520 |
| 185 | 43.55 | 1.715 | .346700 | 315 | 50.12 | 1.973 | .301253 |
| 190 | 43.87 | 1.727 | .344171 | 320 | 50.33 | 1.982 | .299996 |
| 195 | 44.17 | 1.739 | .341833 | 325 | 50.54 | 1.990 | .298749 |
| 200 | 44.47 | 1.751 | .339527 | 330 | 50.74 | 1.998 | .297572 |
| 205 | 44.76 | 1.762 | .337328 | 335 | 50.94 | 2.006 | .296403 |
| 210 | 45.04 | 1.773 | .335320 | 340 | 51.14 | 2.013 | .295244 |
| 215 | 45.32 | 1.784 | .333159 | 345 | 51.34 | 2.021 | .294094 |
| 220 | 45.60 | 1.795 | .331114 | 350 | 51.53 | 2.029 | .293011 |
| 225 | 45.87 | 1.806 | .329165 | | | | |

* At index of lean of 70.0

$$\text{Log } Y = 1.0415302 + 0.263{,}574{,}704{,}408 \text{ Log } X$$

Y = Backfat thickness when index of lean equals 70.0

X = Carcass weight

† In millimeters

$$y = \frac{1}{x} \times c$$

y = expected regression coefficient

x = computed backfat thickness (columns 2 and 3)

c = 15.09877992

effect of a similar change on the index at 200 pounds carcass weight? In the previous paragraphs the computed backfat thicknesses of standardized carcasses have been determined at 5-pound intervals in carcass weight. The task of this section is to provide the expected average rates of change of the index of lean in relation to backfat thickness at each of these same 5-pound weight intervals.

It would seem logical to expect that lighter weight carcasses would have a higher average rate of change than heavier carcasses. A given **absolute** change in backfat, for example an increase of 5 millimeters (0.2 inch) of backfat thickness, should have a greater effect on the **percentage** of lean cuts plus lean trimmings and bellies (index of lean) on 120-pound carcasses than would be expected on 200-pound carcasses. Rates of change should, therefore, decline with increasing carcass weight. It would also seem logical to expect that the rates of change would decline to a greater extent from 120 to 130 pounds than they would from 200 to 210 pounds. This would be true because the given 10-pound change in weight is

**relatively** greater on 120-pound carcasses than on 200-pound carcasses. Rates of change would decline by successively smaller amounts as carcass weight is successively increased by the addition of constant intervals. Our basic logical principle, therefore, is that decreases in average rates of change are associated with increases in carcass weight but that these decreases will take place at a declining rate. The curve which shows this relationship will be concave to the origin, as contrasted with the convex curve showing the relation of backfat to carcass weight at a constant index of lean (figure 5).[33]

The theoretical or expected average rates of change of backfat to the index of lean were computed for weights of carcasses from 100 to 350 pounds and are shown in column 4, table 3. The relation of these rates of change to the computed backfat thicknesses of the standardized carcasses is shown in figure 6.

The more relevant relation of the rates of change (of the index of lean to backfat thickness) to carcass weight is shown in figure 7. The location of the actual rates of change, as calculated for each of the 10 weight groups, are shown as dots in these diagrams.[34]

[33] The equation selected to express this relationship is as follows:

$$y = \frac{1}{x} \times 15.09877992 \text{ (constant)}$$

when y = expected regression coefficient at a given carcass weight
and x = computed backfat thickness at the same given carcass weight (see column 2, table 3)

This equation is that of the rectangular hyperbola (familiar to economists as the description of demand curves having an elasticity of unity) and is an expression of inversely proportionate relationships.

This approach relates the several regression coefficients shown in table 2 to the computed backfat thickness of standardized carcasses, instead of directly relating these regressions to carcass weight. In other words, in order to determine the expected regression values for carcass weights such as 120 and 200 pounds, this approach makes use of the computed backfat thicknesses for these particular carcass weights, 38.86 and 44.47 millimeters respectively. This is because we are attempting to state the relation of an *absolute* measure (backfat thickness) with a *proportional* concept (the percentage of lean cuts plus lean trimmings and bellies, or the index of lean). If standardized carcasses having 1 inch of backfat were compared with similar carcasses having 2 inches of backfat, a given absolute change in backfat, for example .25 inch, could be expected to have twice the effect on the index of lean on the first group of 1-inch standardized backfat carcasses than it would on the 2-inch group. This should be true since the change represents one-fourth of the backfat in the first group and only one-eighth of the backfat in the second. In other words, a given *increase* in computed backfat thickness should be associated with a proportionate *decrease* in the regression of backfat to the index of lean.

According to this equation the constant must be equal to all values of the cross product, xy. The computation of the value of this constant, therefore, provides the solution to the equation. The information required for this purpose includes the most representative regression coefficient for the entire sample and the computed backfat thickness of standardized carcasses of the most representative carcass weight. The basic data includes the 10 regression coefficients and the 10 average weights (table 2, columns 4 and 10).

To obtain the representative regression coefficient each group regression was weighted by its respective average carcass weight. These were summed and divided by the sum of the average weights as follows:

$$\text{The representative regression value} = \frac{\text{Sum of average weight times regression}}{\text{Sum of average weights}} = \frac{590.16136567}{1652.59} = .357113$$

The most representative carcass weight is simply the average of the average weights.

$$\text{The representative carcass weight} = \frac{\text{Sum of average weights}}{\text{Number of groups}} = \frac{1652.59}{10} = 165.26$$

According to the basic equation in footnote 30, page 23, the computed backfat thickness of a standardized carcass at 165.26 pounds would be 42.26 millimeters. The value of the constant will therefore be 42.26 times .357113, or 15.09877992.

[34] The observed scatter of the 10 regression coefficients does not fully substantiate the hypothesis of the rectangular hyperbolic relationship. Although the regression values do tend to decline with increasing carcass weight, this decline appears to take place at an increasing rate, instead of at a decreasing rate as would be expected under the above hypothesis. Because, however, the scatter of the observations is so great, it is highly probable that even a first degree curve of best fit would not yield a significant improvement in the standard error over that of the mean of the regression coefficients. The failure of the scatter to assume the expected pattern may, therefore, be regarded as due to either sampling or experimental error.

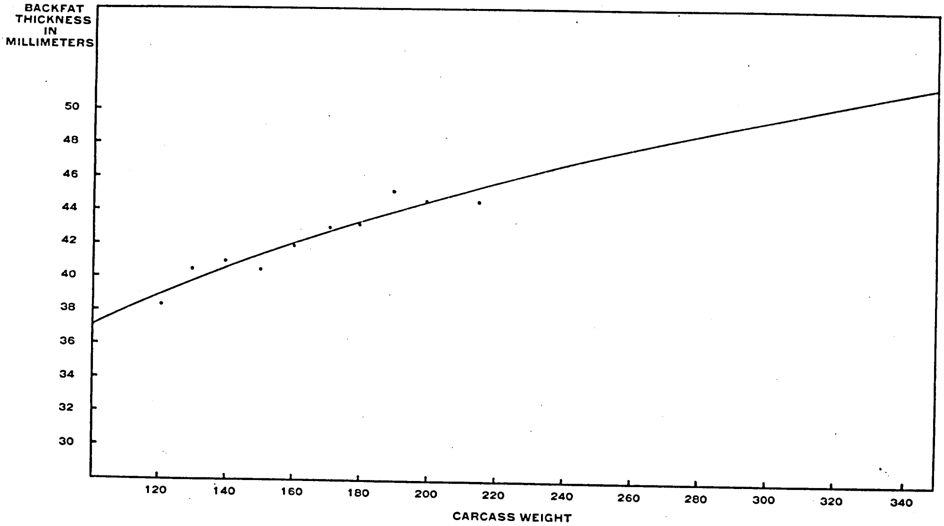


FIG. 5. Theoretical relationship between backfat thickness and carcass weight of a uniform index of lean of 70.0 per cent.

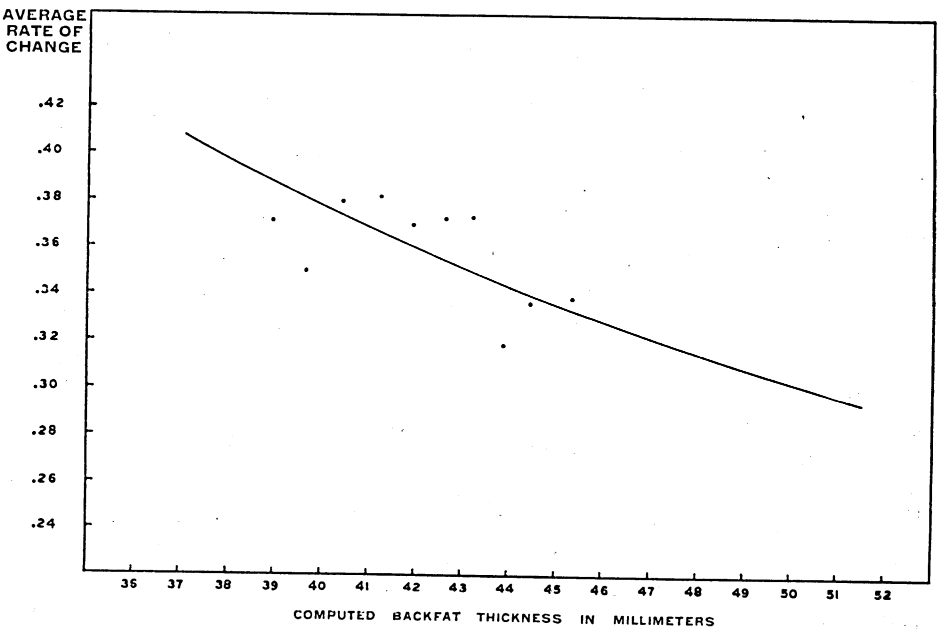


FIG. 6. Theoretical relationship between average rate of change (of the index of lean to backfat) and computed backfat thickness.

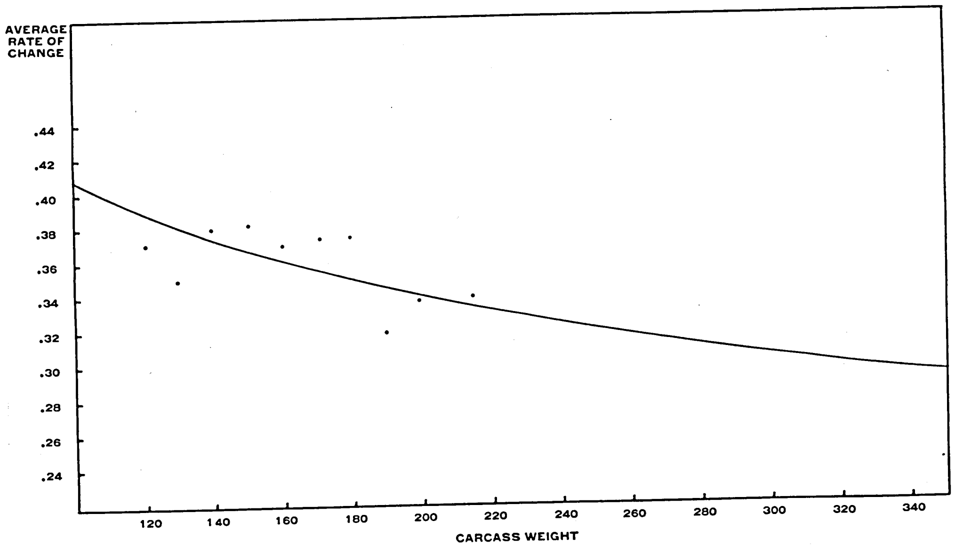


FIG. 7. Theoretical relationship between average rate of change (of the index of lean to backfat) and carcass weight.

The two equations used in table 3 state the relationship between backfat thickness and carcass weight on standardized carcasses and define the changing relationship between backfat thickness and the index of lean at different carcass weights. With this information the theoretical or expected lines of average relationship for each of the 10 weight groups can be drawn.

Figure 8 shows the expected positions of the lines of relationship for the 10 carcass weight groups located at 10-pound intervals from 120 to 210 pounds inclusive. These may be compared with the 10 actual lines of relationship shown in figure 4 which were calculated for each of the 10 weight groups located at approximate 10-pound intervals. These analyses have attempted to provide for a systematic shifting of the lines of relationship to the right and for an orderly lessening in the slope of the lines as carcass weight is increased. The relationships were shown only as tendencies in figure 4.

On the basis of the data in table 3, it was possible to show in tabular form the combined effect of backfat thickness and carcass weight on the index of lean as in table 4.[35] At 1/10-inch intervals of backfat thickness, the expected index of lean can be read for carcass weights from 100 to 250 pounds at 5-pound intervals and from 250 to 350 pounds at 10-pound intervals.[36]

[35] This table describes a curvilinear regression surface somewhat analogous to the multiple regression surface of a three variable multiple correlation problem.

[36] This tabulation of the expected or theoretical index of lean at various backfat thicknesses and carcass weights might be used for purposes other than the derivation of grade standards. Animal geneticists have recently made some progress in standardizing types of swine through the use of techniques similar to those used by plant breeders in developing strains of hybrid corn and other seeds. In addition to such objectives as greater prolificacy and economy of gains, animal geneticists have attempted to develop hogs that produce carcasses which can be expected to yield a high proportion of high-value cuts, such as hams, loins, etc., all with desired quality at specified live and carcass weights. This tabulation should enable the animal geneticist to score the carcasses more precisely, and to make more accurate comparisons between carcasses of different weights. A backfat thickness of a given magnitude on a 120-pound carcass will indicate a vastly different index of lean (degree of finish) if found on 200-pound carcasses, and this tabulation will enable the geneticist to properly assess that difference.

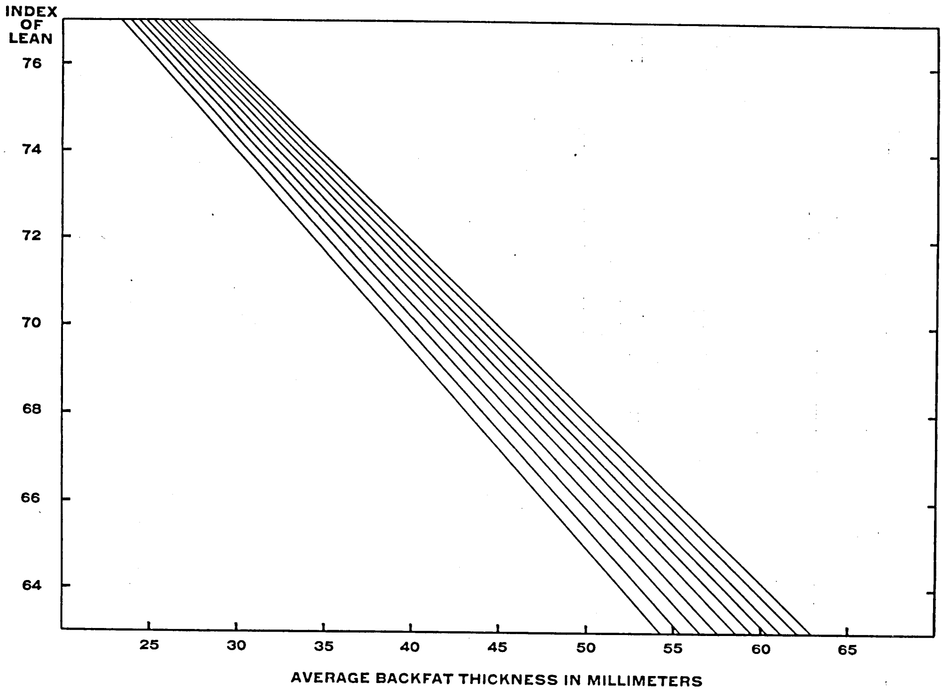


FIG. 8. Expected relationships between average backfat thickness and index of lean for carcass weights from 115 to 215 pounds, inclusive, at 10-pound intervals.

Thus, a 145-pound carcass having an average backfat thickness of 1.6 inches can be expected to have an index of lean of approximately 70.1. In other words, about 70.1 per cent of such a carcass would be made up of the hams, loins, picnics, butts, bellies, and lean trimmings. The average rates of change and the computed backfat thickness at the index of lean of 70 are shown in inches in the second and third columns of the table. At 100 pounds carcass weight, a difference of one inch in backfat thickness is associated with a difference of 10.4 in the index, while at 200 pounds, the 1-inch difference is associated with a difference in the index of 8.6.[37]

One of the more fundamental objectives in establishing grade standards is to provide a method of grouping like or similar carcasses together in the same grade classification regardless of their differences in weight. In order to set up the upper and lower limits of each grade, or the boundary lines between grades, some method will be required for specifying the particular

[37] With this type of table it was possible to test the efficacy of backfat thickness and carcass weight, in classifying carcasses according to their index of lean. For each of the 695 carcasses the difference (the deviation or residual) between the actual index of lean and that index which would be indicated by this table was recorded. These differences were squared separately, summed, and a standard error was calculated as shown in table 21, Appendix G. The correlation ratio for this scatter was computed and is shown in table 22, Appendix G and compared with other expressions of correlation previously developed. It is notable that the coefficient of determination was increased from 71.8 per cent when differences in carcass weight were ignored to 75.6 per cent when differences in carcass weight were considered. Thus, it appears that three-fourths of the variations in the index of lean can be explained by the variations in backfat thickness and carcass weight alone.

## Table 4. Indices of Lean at Various Backfat Thicknesses for Specified Carcass Weights

| Carcass weight, pounds | Change in index of lean per inch of backfat | Backfat in inches at 70.0% | Backfat thickness, inches | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 3.2 | 3.1 | 3.0 | 2.9 | 2.8 | 2.7 | 2.6 | 2.5 | 2.4 | 2.3 | 2.2 | 2.1 | 2.0 |
| 100 | —10.353398 | 1.458 | ... | ... | ... | ... | ... | ... | ... | ... | 60.25 | 61.28 | 62.32 | 63.35 | 64.39 |
| 105 | —10.220969 | 1.477 | ... | ... | ... | ... | ... | ... | ... | ... | 60.57 | 61.59 | 62.61 | 63.63 | 64.65 |
| 110 | —10.097175 | 1.495 | ... | ... | ... | ... | ... | ... | ... | 59.85 | 60.86 | 61.87 | 62.88 | 63.89 | 64.90 |
| 115 | —9.978919 | 1.513 | ... | ... | ... | ... | ... | ... | ... | 60.15 | 61.15 | 62.15 | 63.14 | 64.14 | 65.14 |
| 120 | —9.868510 | 1.530 | ... | ... | ... | ... | ... | ... | ... | 60.43 | 61.41 | 62.40 | 63.39 | 64.37 | 65.36 |
| 125 | —9.762979 | 1.547 | ... | ... | ... | ... | ... | ... | ... | 60.70 | 61.67 | 62.65 | 63.62 | 64.60 | 65.58 |
| 130 | —9.662145 | 1.563 | ... | ... | ... | ... | ... | ... | 59.98 | 60.95 | 61.91 | 62.88 | 63.85 | 64.81 | 65.78 |
| 135 | —9.565732 | 1.578 | ... | ... | ... | ... | ... | ... | 60.22 | 61.18 | 62.14 | 63.09 | 64.05 | 65.01 | 65.96 |
| 140 | —9.473585 | 1.594 | ... | ... | ... | ... | ... | ... | 60.47 | 61.42 | 62.36 | 63.31 | 64.26 | 65.21 | 66.15 |
| 145 | —9.387763 | 1.608 | ... | ... | ... | ... | ... | ... | 60.69 | 61.63 | 62.56 | 63.50 | 64.44 | 65.38 | 66.32 |
| 150 | —9.303610 | 1.623 | ... | ... | ... | ... | ... | 59.98 | 60.91 | 61.84 | 62.77 | 63.70 | 64.63 | 65.56 | 66.49 |
| 155 | —9.223070 | 1.637 | ... | ... | ... | ... | ... | 60.20 | 61.12 | 62.04 | 62.96 | 63.89 | 64.81 | 65.73 | 66.65 |
| 160 | —9.146086 | 1.651 | ... | ... | ... | ... | ... | 60.41 | 61.32 | 62.23 | 63.15 | 64.06 | 64.98 | 65.89 | 66.81 |
| 165 | —9.072506 | 1.664 | ... | ... | ... | ... | ... | 60.60 | 61.51 | 62.42 | 63.32 | 64.23 | 65.14 | 66.04 | 66.95 |
| 170 | —9.002228 | 1.677 | ... | ... | ... | ... | 59.89 | 60.79 | 61.69 | 62.59 | 63.49 | 64.39 | 65.29 | 66.19 | 67.09 |
| 175 | —8.928318 | 1.690 | ... | ... | ... | ... | 60.09 | 60.98 | 61.88 | 62.77 | 63.66 | 64.55 | 65.45 | 66.34 | 67.23 |
| 180 | —8.866954 | 1.703 | ... | ... | ... | ... | 60.27 | 61.16 | 62.05 | 62.93 | 63.82 | 64.71 | 65.59 | 66.48 | 67.37 |
| 185 | —8.805870 | 1.715 | ... | ... | ... | ... | 60.45 | 61.33 | 62.21 | 63.09 | 63.97 | 64.85 | 65.73 | 66.61 | 67.49 |
| 190 | —8.741637 | 1.727 | ... | ... | ... | ... | 60.62 | 61.49 | 62.37 | 63.24 | 64.12 | 64.99 | 65.87 | 66.74 | 67.61 |
| 195 | —8.682254 | 1.739 | ... | ... | ... | 59.92 | 60.79 | 61.66 | 62.52 | 63.39 | 64.26 | 65.13 | 66.00 | 66.87 | 67.73 |
| 200 | —8.623685 | 1.751 | ... | ... | ... | 60.09 | 60.95 | 61.82 | 62.68 | 63.54 | 64.40 | 65.27 | 66.13 | 66.99 | 67.85 |
| 205 | —8.567833 | 1.762 | ... | ... | ... | 60.25 | 61.11 | 61.96 | 62.82 | 63.68 | 64.53 | 65.39 | 66.25 | 67.10 | 67.96 |
| 210 | —8.514546 | 1.773 | ... | ... | ... | 60.40 | 61.26 | 62.11 | 62.96 | 63.81 | 64.66 | 65.51 | 66.36 | 67.22 | 68.07 |
| 215 | —8.461945 | 1.784 | ... | ... | ... | 60.56 | 61.40 | 62.25 | 63.10 | 63.94 | 64.79 | 65.63 | 66.48 | 67.33 | 68.17 |
| 220 | —8.410005 | 1.795 | ... | ... | 59.87 | 60.71 | 61.55 | 62.39 | 63.23 | 64.07 | 64.91 | 65.75 | 66.59 | 67.43 | 68.28 |
| 225 | —8.360503 | 1.806 | ... | ... | 60.02 | 60.85 | 61.69 | 62.53 | 63.36 | 64.20 | 65.03 | 65.87 | 66.71 | 67.54 | 68.38 |
| 230 | —8.313363 | 1.816 | ... | ... | 60.16 | 60.99 | 61.82 | 62.65 | 63.48 | 64.31 | 65.14 | 65.98 | 66.81 | 67.64 | 68.47 |
| 235 | —8.265003 | 1.827 | ... | ... | 60.31 | 61.13 | 61.96 | 62.78 | 63.61 | 64.44 | 65.26 | 66.09 | 66.92 | 67.74 | 68.57 |
| 240 | —8.220708 | 1.837 | ... | ... | 60.44 | 61.26 | 62.08 | 62.91 | 63.73 | 64.55 | 65.37 | 66.19 | 67.02 | 67.84 | 68.66 |
| 245 | —8.175143 | 1.847 | ... | ... | 60.57 | 61.39 | 62.21 | 63.03 | 63.84 | 64.66 | 65.48 | 66.30 | 67.11 | 67.93 | 68.75 |
| 250 | —8.131812 | 1.857 | ... | 59.89 | 60.71 | 61.52 | 62.33 | 63.14 | 63.96 | 64.77 | 65.58 | 66.40 | 67.21 | 68.02 | 68.84 |
| 260 | —8.048054 | 1.876 | ... | 60.15 | 60.95 | 61.76 | 62.56 | 63.37 | 64.17 | 64.98 | 65.78 | 66.59 | 67.39 | 68.20 | 69.00 |
| 270 | —7.967794 | 1.895 | ... | 60.40 | 61.20 | 61.99 | 62.79 | 63.59 | 64.38 | 65.18 | 65.98 | 66.77 | 67.57 | 68.37 | 69.16 |
| 280 | —7.892360 | 1.913 | 59.84 | 60.63 | 61.42 | 62.21 | 63.00 | 63.79 | 64.58 | 65.37 | 66.16 | 66.95 | 67.73 | 68.52 | 69.31 |
| 290 | —7.819948 | 1.931 | 60.08 | 60.86 | 61.64 | 62.42 | 63.20 | 63.99 | 64.77 | 65.55 | 66.33 | 67.11 | 67.90 | 68.68 | 69.46 |
| 300 | —7.750406 | 1.948 | 60.30 | 61.07 | 61.85 | 62.62 | 63.40 | 64.17 | 64.95 | 65.72 | 66.50 | 67.27 | 68.05 | 68.82 | 69.60 |
| 310 | —7.683633 | 1.965 | 60.51 | 61.28 | 62.05 | 62.82 | 63.58 | 64.35 | 65.12 | 65.89 | 66.66 | 67.43 | 68.19 | 68.96 | 69.73 |
| 320 | —7.619527 | 1.982 | 60.72 | 61.48 | 62.24 | 63.00 | 63.77 | 64.53 | 65.29 | 66.05 | 66.82 | 67.58 | 68.34 | 69.10 | 69.86 |
| 330 | —7.557960 | 1.998 | 60.92 | 61.68 | 62.43 | 63.19 | 63.94 | 64.70 | 65.46 | 66.21 | 66.97 | 67.72 | 68.48 | 69.23 | 69.99 |
| 340 | —7.498832 | 2.013 | 61.10 | 61.85 | 62.60 | 63.35 | 64.10 | 64.85 | 65.60 | 66.35 | 67.10 | 67.85 | 68.60 | 69.35 | 70.10 |
| 350 | —7.442091 | 2.029 | 61.29 | 62.03 | 62.78 | 63.52 | 64.26 | 65.01 | 65.75 | 66.50 | 67.24 | 67.99 | 68.73 | 69.48 | 70.22 |

### Table 4. Indices of Lean at Various Backfat Thicknesses for Specified Carcass Weights—Continued

| Carcass weight, pounds | Change in index of lean per inch of backfat | Backfat in inches at 70.0% | Backfat thickness, inches | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1.9 | 1.8 | 1.7 | 1.6 | 1.5 | 1.4 | 1.3 | 1.2 | 1.1 | 1.0 | .9 | .8 | .7 | .6 |
| 100 | —10.353398 | 1.458 | 65.42 | 66.46 | 67.49 | 68.53 | 69.57 | 70.60 | 71.64 | 72.67 | 73.71 | 74.74 | 75.78 | 76.81 | 77.85 | 78.88 |
| 105 | —10.220969 | 1.477 | 65.68 | 66.70 | 67.72 | 68.74 | 69.76 | 70.79 | 71.81 | 72.83 | 73.85 | 74.88 | 75.90 | 76.92 | 77.94 | 78.96 |
| 110 | —10.097175 | 1.495 | 65.91 | 66.92 | 67.93 | 68.94 | 69.95 | 70.96 | 71.97 | 72.98 | 73.99 | 75.00 | 76.01 | 77.02 | 78.03 | 79.04 |
| 115 | —9.978919 | 1.513 | 66.14 | 67.14 | 68.13 | 69.13 | 70.13 | 71.13 | 72.13 | 73.12 | 74.12 | 75.12 | 76.12 | 77.11 | 78.11 | ...... |
| 120 | —9.868510 | 1.530 | 66.35 | 67.34 | 68.32 | 69.31 | 70.30 | 71.28 | 72.27 | 73.26 | 74.24 | 75.23 | 76.22 | 77.20 | 78.19 | ...... |
| 125 | —9.762979 | 1.547 | 66.55 | 67.53 | 68.51 | 69.48 | 70.46 | 71.44 | 72.41 | 73.39 | 74.36 | 75.34 | 76.32 | 77.29 | 78.27 | ...... |
| 130 | —9.662145 | 1.563 | 66.74 | 67.71 | 68.68 | 69.64 | 70.61 | 71.57 | 72.54 | 73.51 | 74.47 | 75.44 | 76.41 | 77.37 | 78.34 | ...... |
| 135 | —9.565732 | 1.578 | 66.92 | 67.88 | 68.83 | 69.79 | 70.75 | 71.70 | 72.66 | 73.62 | 74.57 | 75.53 | 76.49 | 77.44 | 78.40 | ...... |
| 140 | —9.473585 | 1.594 | 67.10 | 68.05 | 69.00 | 69.94 | 70.89 | 71.84 | 72.79 | 73.73 | 74.68 | 75.63 | 76.57 | 77.52 | 78.47 | ...... |
| 145 | —9.387763 | 1.608 | 67.26 | 68.20 | 69.14 | 70.08 | 71.01 | 71.95 | 72.89 | 73.83 | 74.77 | 75.71 | 76.65 | 77.59 | 78.52 | ...... |
| 150 | —9.303610 | 1.623 | 67.42 | 68.35 | 69.28 | 70.21 | 71.14 | 72.07 | 73.01 | 73.94 | 74.87 | 75.80 | 76.73 | 77.66 | 78.59 | ...... |
| 155 | —9.223070 | 1.637 | 67.57 | 68.50 | 69.42 | 70.34 | 71.26 | 72.19 | 73.11 | 74.03 | 74.95 | 75.88 | 76.80 | 77.72 | 78.64 | ...... |
| 160 | —9.146086 | 1.651 | 67.72 | 68.64 | 69.55 | 70.47 | 71.38 | 72.30 | 73.21 | 74.12 | 75.04 | 75.95 | 76.87 | 77.78 | 78.70 | ...... |
| 165 | —9.072506 | 1.664 | 67.86 | 68.77 | 69.67 | 70.58 | 71.49 | 72.40 | 73.30 | 74.21 | 75.12 | 76.02 | 76.93 | 77.84 | 78.75 | ...... |
| 170 | —9.002228 | 1.677 | 67.99 | 68.89 | 69.79 | 70.69 | 71.59 | 72.49 | 73.39 | 74.29 | 75.19 | 76.09 | 76.99 | 77.89 | 78.80 | ...... |
| 175 | —8.928318 | 1.690 | 68.13 | 69.02 | 69.91 | 70.80 | 71.70 | 72.59 | 73.48 | 74.37 | 75.27 | 76.16 | 77.05 | 77.95 | 78.84 | ...... |
| 180 | —8.866954 | 1.703 | 68.25 | 69.14 | 70.03 | 70.91 | 71.80 | 72.69 | 73.57 | 74.46 | 75.35 | 76.23 | 77.12 | 78.01 | 78.89 | ...... |
| 185 | —8.805870 | 1.715 | 68.37 | 69.25 | 70.13 | 71.01 | 71.89 | 72.77 | 73.65 | 74.54 | 75.42 | 76.30 | 77.18 | 78.06 | 78.94 | ...... |
| 190 | —8.741637 | 1.727 | 68.49 | 69.36 | 70.24 | 71.11 | 71.98 | 72.86 | 73.73 | 74.61 | 75.48 | 76.36 | 77.23 | 78.10 | 78.98 | ...... |
| 195 | —8.682254 | 1.739 | 68.60 | 69.47 | 70.34 | 71.21 | 72.08 | 72.94 | 73.81 | 74.68 | 75.55 | 76.42 | 77.28 | 78.15 | 79.02 | ...... |
| 200 | —8.623685 | 1.751 | 68.72 | 69.58 | 70.44 | 71.30 | 72.16 | 73.03 | 73.89 | 74.75 | 75.61 | 76.48 | 77.34 | 78.20 | ...... | ...... |
| 205 | —8.567833 | 1.762 | 68.82 | 69.67 | 70.53 | 71.39 | 72.24 | 73.10 | 73.96 | 74.82 | 75.67 | 76.53 | 77.39 | 78.24 | ...... | ...... |
| 210 | —8.514546 | 1.773 | 68.92 | 69.77 | 70.62 | 71.47 | 72.32 | 73.18 | 74.03 | 74.88 | 75.73 | 76.58 | 77.43 | 78.28 | ...... | ...... |
| 215 | —8.461945 | 1.784 | 69.02 | 69.86 | 70.71 | 71.56 | 72.40 | 73.25 | 74.10 | 74.94 | 75.79 | 76.63 | 77.48 | 78.33 | ...... | ...... |
| 220 | —8.410005 | 1.795 | 69.12 | 69.96 | 70.80 | 71.64 | 72.48 | 73.32 | 74.16 | 75.00 | 75.84 | 76.69 | 77.53 | 78.37 | ...... | ...... |
| 225 | —8.360503 | 1.806 | 69.21 | 70.05 | 70.89 | 71.72 | 72.56 | 73.39 | 74.23 | 75.07 | 75.90 | 76.74 | 77.57 | 78.41 | ...... | ...... |
| 230 | —8.313363 | 1.816 | 69.30 | 70.13 | 70.96 | 71.80 | 72.63 | 73.46 | 74.29 | 75.12 | 75.95 | 76.78 | 77.62 | 78.45 | ...... | ...... |
| 235 | —8.265003 | 1.827 | 69.40 | 70.22 | 71.05 | 71.88 | 72.70 | 73.53 | 74.36 | 75.18 | 76.01 | 76.84 | 77.66 | 78.49 | ...... | ...... |
| 240 | —8.220708 | 1.837 | 69.48 | 70.30 | 71.13 | 71.95 | 72.77 | 73.59 | 74.41 | 75.24 | 76.06 | 76.88 | 77.70 | 78.52 | ...... | ...... |
| 245 | —8.175143 | 1.847 | 69.57 | 70.38 | 71.20 | 72.02 | 72.84 | 73.65 | 74.47 | 75.29 | 76.11 | 76.92 | 77.74 | 78.56 | ...... | ...... |
| 250 | —8.131812 | 1.857 | 69.65 | 70.46 | 71.28 | 72.09 | 72.90 | 73.72 | 74.53 | 75.34 | 76.16 | 76.97 | 77.78 | 78.60 | ...... | ...... |
| 260 | —8.048054 | 1.876 | 69.81 | 70.61 | 71.42 | 72.22 | 73.03 | 73.83 | 74.64 | 75.44 | 76.25 | 77.05 | 77.85 | 78.66 | ...... | ...... |
| 270 | —7.967794 | 1.895 | 69.96 | 70.76 | 71.55 | 72.35 | 73.15 | 73.94 | 74.74 | 75.54 | 76.33 | 77.13 | 77.93 | 78.72 | ...... | ...... |
| 280 | —7.892360 | 1.913 | 70.10 | 70.89 | 71.68 | 72.47 | 73.26 | 74.05 | 74.84 | 75.63 | 76.42 | 77.21 | 77.99 | 78.78 | ...... | ...... |
| 290 | —7.819948 | 1.931 | 70.24 | 71.02 | 71.81 | 72.59 | 73.37 | 74.15 | 74.93 | 75.72 | 76.50 | 77.28 | 78.06 | 78.84 | ...... | ...... |
| 300 | —7.750406 | 1.948 | 70.37 | 71.15 | 71.92 | 72.70 | 73.47 | 74.25 | 75.02 | 75.80 | 76.57 | 77.35 | 78.12 | 78.90 | ...... | ...... |
| 310 | —7.683633 | 1.965 | 70.50 | 71.27 | 72.04 | 72.80 | 73.57 | 74.34 | 75.11 | 75.88 | 76.65 | 77.41 | 78.18 | 78.95 | ...... | ...... |
| 320 | —7.619527 | 1.982 | 70.62 | 71.39 | 72.15 | 72.91 | 73.67 | 74.43 | 75.20 | 75.96 | 76.72 | 77.48 | 78.24 | 79.00 | ...... | ...... |
| 330 | —7.557960 | 1.998 | 70.75 | 71.50 | 72.26 | 73.01 | 73.77 | 74.52 | 75.28 | 76.04 | 76.79 | 77.55 | 78.30 | ...... | ...... | ...... |
| 340 | —7.498832 | 2.013 | 70.85 | 71.60 | 72.35 | 73.10 | 73.85 | 74.60 | 75.35 | 76.10 | 76.85 | 77.60 | 78.35 | ...... | ...... | ...... |
| 350 | —7.442091 | 2.029 | 70.96 | 71.71 | 72.45 | 73.20 | 73.94 | 74.69 | 75.43 | 76.17 | 76.92 | 77.66 | 78.41 | ...... | ...... | ...... |

average backfat thickness at each carcass weight which has the greatest likelihood of predicting a certain value of the index of lean. The various backfat thicknesses required to predict an index of lean equal to 70.0 have been computed for 5-pound intervals of carcass weight from 100 to 350 pounds inclusive (column 3, table 3).

Similar data are needed giving the backfat thickness at each of these carcass weights for other values of the index of lean, such as 67.0, 68.0, 69.0, 71.0, etc. Each line of average relationship states the relationship for one particular carcass weight. By relating the several lines together, a tabulation can be made which will provide a complete description within certain limits of all possible combinations of the two variables affecting the index. The data in table 5 were computed for this purpose.[38]

Such a tabulation shows the backfat thicknesses in inches required to predict all values of the index of lean at intervals of 1.0 from 60.0 to 78.0 inclusive, and from 100 to 250 pounds carcass weight at 5-pound intervals and from 250 to 350 pounds at 10-pound intervals.

## Alternative Standards

It is obvious that the schedules presented in tables 4 and 5 could not be used to classify or grade hog carcasses in a packing plant due to the minute gradations in backfat thickness between carcasses within a given weight group and between carcasses in different weight groups.[39] The problem at this point is to combine carcass weights and backfat thicknesses in such a way as to provide a hog carcass standard that is practicable and, at the same time, one that has economic significance.

The first step toward the development of a grade standard is shown in table 6. This classification, which we have called Hog Carcass Grade Standard A, has 10 weight groups, with carcasses weighing from 110 to 220 pounds, and 5 grades within each group. A range of 3.0 points in the index of lean is used for each grade. Grade 8 carcasses are very fat as indicated by relatively thick backfat and low index of lean. Each succeeding grade to the right in the table has less backfat and a higher index of lean. Grade 8 carcasses have a range in index of lean of 62.5-65.5, while the range of Grade 12 carcasses is 74.5-77.5. It is quite probable that some carcasses, particularly of the heavier weights, might have a lower index of lean than 62.5. A Grade 7 could be added if the number of such carcasses justifies the additional grade. Carcasses which exceed an index of lean of 77.5, which is the upper limit of Grade 12, will be very rare so that the addition of another grade at this extreme would probably not be justified.

Numbers are used to designate the hog carcass grades because a continuous physical change in a given direc-

[38] In order to find the backfat thickness which would predict an index of lean other than 70.0 at any particular carcass weight, it was necessary to multiply the reciprocal of the average rate of change by the difference between 70.0 and the desired index. The result of this calculation was the change in backfat associated with the required change in the index of lean. This was added algebraically to the computed backfat thickness when the index equals 70.0. The result of this algebraic addition gives the particular backfat thickness required. For example: at 115 pounds carcass weight, the computed backfat thickness of standardized hog carcasses is 1.513 inches. The expected average rate of change (regression coefficient) at that weight is −9.978919. What backfat thickness will be required to predict an index of lean equal to 67.0? The reciprocal of the rate of change (regression), −0.100211, must be multiplied by the desired change in the index of lean, −3.0. The result of this calculation, 0.301 in this case, is the additional backfat required to bring the index down from 70.0 to 67.0. This is added to the computed backfat thickness with the result that 1.814 inches of backfat thickness are required for 115-pound carcasses to have an indicated index of lean of 67.0.

[39] Table 4 may be considered as a Theoretical Grade Standard.

## Table 5. Backfat Thickness in Inches at Specified Indices of Lean and Carcass Weights

| Carcass weight, pounds | Change in index of lean per inch of backfat, inches | Reciprocal of preceding column | Indices of lean | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 60.0 | 61.0 | 62.0 | 63.0 | 64.0 | 65.0 | 66.0 | 67.0 | 68.0 | 69.0 | 70.0 | 71.0 | 72.0 | 73.0 | 74.0 | 75.0 | 76.0 | 77.0 | 78.0 |
| 100 | −10.353398 | .096587 | 2.424 | 2.327 | 2.231 | 2.134 | 2.038 | 1.941 | 1.844 | 1.748 | 1.651 | 1.555 | 1.458 | 1.361 | 1.265 | 1.168 | 1.072 | .975 | .878 | .782 | .685 |
| 105 | −10.220969 | .097838 | 2.455 | 2.358 | 2.260 | 2.162 | 2.064 | 1.966 | 1.868 | 1.771 | 1.673 | 1.575 | 1.477 | 1.379 | 1.281 | 1.183 | 1.086 | .988 | .890 | .792 | .694 |
| 110 | −10.097175 | .099038 | 2.485 | 2.386 | 2.287 | 2.188 | 2.089 | 1.990 | 1.891 | 1.792 | 1.693 | 1.594 | 1.495 | 1.396 | 1.297 | 1.198 | 1.099 | 1.000 | .901 | .802 | .703 |
| 115 | −9.978919 | .100211 | 2.515 | 2.415 | 2.315 | 2.214 | 2.114 | 2.014 | 1.914 | 1.814 | 1.713 | 1.613 | 1.513 | 1.413 | 1.313 | 1.212 | 1.112 | 1.012 | .912 | .812 | .711 |
| 120 | −9.868510 | .101332 | 2.543 | 2.442 | 2.341 | 2.239 | 2.138 | 2.037 | 1.935 | 1.834 | 1.733 | 1.631 | 1.530 | 1.429 | 1.327 | 1.226 | 1.125 | 1.023 | .922 | .821 | .719 |
| 125 | −9.762979 | .102428 | 2.571 | 2.469 | 2.366 | 2.264 | 2.162 | 2.059 | 1.957 | 1.854 | 1.752 | 1.649 | 1.547 | 1.446 | 1.342 | 1.240 | 1.137 | 1.035 | .932 | .830 | .728 |
| 130 | −9.662145 | .103497 | 2.598 | 2.494 | 2.391 | 2.287 | 2.184 | 2.080 | 1.977 | 1.873 | 1.770 | 1.666 | 1.563 | 1.460 | 1.356 | 1.253 | 1.149 | 1.046 | .942 | .839 | .735 |
| 135 | −9.565732 | .104540 | 2.623 | 2.519 | 2.414 | 2.310 | 2.205 | 2.101 | 1.996 | 1.892 | 1.787 | 1.683 | 1.578 | 1.473 | 1.369 | 1.264 | 1.160 | 1.055 | .951 | .846 | .742 |
| 140 | −9.473585 | .105557 | 2.650 | 2.544 | 2.438 | 2.333 | 2.227 | 2.122 | 2.016 | 1.911 | 1.805 | 1.700 | 1.594 | 1.488 | 1.383 | 1.277 | 1.172 | 1.066 | .961 | .855 | .750 |
| 145 | −9.387763 | .106522 | 2.673 | 2.567 | 2.460 | 2.354 | 2.247 | 2.141 | 2.034 | 1.928 | 1.821 | 1.715 | 1.608 | 1.501 | 1.395 | 1.288 | 1.182 | 1.075 | .969 | .862 | .756 |
| 150 | −9.303610 | .107485 | 2.698 | 2.590 | 2.483 | 2.375 | 2.268 | 2.160 | 2.053 | 1.945 | 1.838 | 1.730 | 1.623 | 1.516 | 1.408 | 1.301 | 1.193 | 1.086 | .978 | .871 | .763 |
| 155 | −9.223070 | .108424 | 2.721 | 2.613 | 2.504 | 2.396 | 2.288 | 2.179 | 2.071 | 1.962 | 1.854 | 1.745 | 1.637 | 1.529 | 1.420 | 1.312 | 1.203 | 1.095 | .986 | .878 | .770 |
| 160 | −9.146086 | .109336 | 2.744 | 2.635 | 2.526 | 2.416 | 2.307 | 2.198 | 2.088 | 1.979 | 1.870 | 1.760 | 1.651 | 1.542 | 1.432 | 1.323 | 1.214 | 1.104 | .995 | .886 | .776 |
| 165 | −9.072506 | .110223 | 2.766 | 2.656 | 2.546 | 2.436 | 2.325 | 2.215 | 2.105 | 1.995 | 1.884 | 1.774 | 1.664 | 1.554 | 1.444 | 1.333 | 1.223 | 1.113 | 1.003 | .892 | .782 |
| 170 | −9.002228 | .111084 | 2.788 | 2.677 | 2.566 | 2.455 | 2.344 | 2.232 | 2.121 | 2.010 | 1.899 | 1.788 | 1.677 | 1.566 | 1.455 | 1.344 | 1.233 | 1.122 | 1.010 | .899 | .788 |
| 175 | −8.928313 | .112003 | 2.810 | 2.698 | 2.586 | 2.474 | 2.362 | 2.250 | 2.138 | 2.026 | 1.914 | 1.802 | 1.690 | 1.578 | 1.466 | 1.354 | 1.242 | 1.130 | 1.018 | .906 | .794 |
| 180 | −8.866954 | .112778 | 2.831 | 2.718 | 2.605 | 2.492 | 2.380 | 2.267 | 2.154 | 2.041 | 1.929 | 1.816 | 1.703 | 1.590 | 1.477 | 1.365 | 1.252 | 1.139 | 1.026 | .914 | .801 |
| 185 | −8.805870 | .113561 | 2.851 | 2.737 | 2.623 | 2.510 | 2.396 | 2.283 | 2.169 | 2.056 | 1.942 | 1.829 | 1.715 | 1.601 | 1.488 | 1.374 | 1.261 | 1.147 | 1.034 | .920 | .807 |
| 190 | −8.741637 | .114396 | 2.871 | 2.757 | 2.642 | 2.528 | 2.413 | 2.299 | 2.185 | 2.070 | 1.956 | 1.841 | 1.727 | 1.613 | 1.498 | 1.384 | 1.269 | 1.155 | 1.041 | .926 | .812 |
| 195 | −8.682254 | .115177 | 2.891 | 2.776 | 2.660 | 2.545 | 2.430 | 2.315 | 2.200 | 2.085 | 1.969 | 1.854 | 1.739 | 1.624 | 1.509 | 1.393 | 1.278 | 1.163 | 1.048 | .933 | .818 |
| 200 | −8.623685 | .115960 | 2.911 | 2.795 | 2.679 | 2.563 | 2.447 | 2.331 | 2.215 | 2.099 | 1.983 | 1.867 | 1.751 | 1.635 | 1.519 | 1.403 | 1.287 | 1.171 | 1.055 | .939 | .823 |
| 205 | −8.567833 | .116716 | 2.929 | 2.812 | 2.696 | 2.579 | 2.462 | 2.346 | 2.229 | 2.112 | 1.995 | 1.879 | 1.762 | 1.645 | 1.529 | 1.412 | 1.295 | 1.178 | 1.062 | .945 | .828 |
| 210 | −8.514546 | .117446 | 2.947 | 2.830 | 2.713 | 2.595 | 2.478 | 2.360 | 2.243 | 2.125 | 2.008 | 1.890 | 1.773 | 1.656 | 1.538 | 1.421 | 1.303 | 1.186 | 1.068 | .951 | .833 |
| 215 | −8.461945 | .118176 | 2.966 | 2.848 | 2.729 | 2.611 | 2.493 | 2.375 | 2.257 | 2.139 | 2.020 | 1.902 | 1.784 | 1.666 | 1.548 | 1.429 | 1.311 | 1.193 | 1.075 | .957 | .839 |
| 220 | −8.410005 | .118906 | 2.984 | 2.865 | 2.746 | 2.627 | 2.508 | 2.390 | 2.271 | 2.152 | 2.033 | 1.914 | 1.795 | 1.676 | 1.557 | 1.438 | 1.319 | 1.200 | 1.082 | .963 | .844 |
| 225 | −8.360503 | .119610 | 3.002 | 2.882 | 2.763 | 2.643 | 2.524 | 2.404 | 2.284 | 2.165 | 2.045 | 1.926 | 1.806 | 1.686 | 1.567 | 1.447 | 1.328 | 1.208 | 1.088 | .969 | .849 |
| 230 | −8.313363 | .120289 | 3.019 | 2.899 | 2.778 | 2.658 | 2.538 | 2.417 | 2.297 | 2.177 | 2.057 | 1.936 | 1.816 | 1.696 | 1.575 | 1.455 | 1.335 | 1.215 | 1.094 | .974 | .854 |
| 235 | −8.265003 | .120992 | 3.037 | 2.916 | 2.795 | 2.674 | 2.553 | 2.432 | 2.311 | 2.190 | 2.069 | 1.948 | 1.827 | 1.706 | 1.585 | 1.464 | 1.343 | 1.222 | 1.101 | .980 | .859 |
| 240 | −8.220708 | .121644 | 3.053 | 2.932 | 2.810 | 2.689 | 2.567 | 2.445 | 2.324 | 2.202 | 2.080 | 1.959 | 1.837 | 1.715 | 1.594 | 1.472 | 1.350 | 1.229 | 1.107 | .985 | .864 |
| 245 | −8.175143 | .122322 | 3.070 | 2.948 | 2.826 | 2.703 | 2.581 | 2.459 | 2.336 | 2.214 | 2.092 | 1.969 | 1.847 | 1.725 | 1.602 | 1.480 | 1.358 | 1.235 | 1.113 | .991 | .868 |
| 250 | −8.131812 | .122974 | 3.087 | 2.964 | 2.841 | 2.718 | 2.595 | 2.472 | 2.349 | 2.226 | 2.103 | 1.980 | 1.857 | 1.734 | 1.611 | 1.488 | 1.365 | 1.242 | 1.119 | .996 | .873 |
| 260 | −8.048054 | .124254 | 3.119 | 2.994 | 2.870 | 2.746 | 2.622 | 2.497 | 2.373 | 2.249 | 2.125 | 2.000 | 1.876 | 1.752 | 1.627 | 1.503 | 1.379 | 1.255 | 1.130 | 1.006 | .882 |
| 270 | −7.967794 | .125505 | 3.150 | 3.025 | 2.899 | 2.774 | 2.648 | 2.523 | 2.397 | 2.272 | 2.146 | 2.021 | 1.895 | 1.769 | 1.644 | 1.518 | 1.393 | 1.267 | 1.142 | 1.016 | .891 |
| 280 | −7.892360 | .126705 | 3.180 | 3.053 | 2.927 | 2.800 | 2.673 | 2.547 | 2.420 | 2.293 | 2.166 | 2.040 | 1.913 | 1.786 | 1.660 | 1.533 | 1.406 | 1.279 | 1.153 | 1.026 | .899 |
| 290 | −7.819948 | .127878 | 3.210 | 3.082 | 2.954 | 2.826 | 2.698 | 2.570 | 2.443 | 2.315 | 2.187 | 2.059 | 1.931 | 1.803 | 1.675 | 1.547 | 1.419 | 1.292 | 1.164 | 1.036 | .908 |
| 300 | −7.750406 | .129025 | 3.238 | 3.109 | 2.980 | 2.851 | 2.722 | 2.593 | 2.464 | 2.335 | 2.206 | 2.077 | 1.948 | 1.819 | 1.690 | 1.561 | 1.432 | 1.303 | 1.174 | 1.045 | .916 |
| 310 | −7.683633 | .130147 | 3.266 | 3.136 | 3.006 | 2.876 | 2.746 | 2.616 | 2.486 | 2.355 | 2.225 | 2.095 | 1.965 | 1.835 | 1.705 | 1.575 | 1.444 | 1.314 | 1.184 | 1.054 | .924 |
| 320 | −7.619527 | .131242 | 3.294 | 3.163 | 3.032 | 2.901 | 2.769 | 2.638 | 2.507 | 2.376 | 2.244 | 2.113 | 1.982 | 1.851 | 1.720 | 1.588 | 1.457 | 1.326 | 1.195 | 1.063 | .932 |
| 330 | −7.557960 | .132311 | 3.321 | 3.189 | 3.056 | 2.924 | 2.792 | 2.660 | 2.527 | 2.395 | 2.263 | 2.130 | 1.998 | 1.866 | 1.733 | 1.601 | 1.469 | 1.336 | 1.204 | 1.072 | .940 |
| 340 | −7.498832 | .133354 | 3.347 | 3.213 | 3.080 | 2.946 | 2.813 | 2.680 | 2.546 | 2.413 | 2.280 | 2.146 | 2.013 | 1.880 | 1.746 | 1.613 | 1.480 | 1.346 | 1.213 | 1.080 | .946 |
| 350 | −7.442091 | .134371 | 3.373 | 3.238 | 3.104 | 2.970 | 2.835 | 2.701 | 2.566 | 2.432 | 2.298 | 2.163 | 2.029 | 1.894 | 1.760 | 1.626 | 1.492 | 1.357 | 1.223 | 1.088 | .954 |

**Table 6. Hog Carcass Grade Standard A Based on Backfat Thickness and Carcass Weight, with Three-point Range in Index of Lean per Grade, and with Grade 10 Centered at Index of Lean of 70.0**

| Grade<br>Index of lean | 8<br>64.0 | 9<br>67.0 | 10<br>70.0 | 11<br>73.0 | 12<br>76.0 |
|---|---|---|---|---|---|
| Carcass weight, pounds | Backfat thickness, inches | Backfat thickness, inches | Backfat thickness, inches | Backfat thickness, inches | Backfat thickness inches |
| 110-120 | 2.26 | 1.96 | 1.66 | 1.36 | 1.06 | 0.76 |
| 120-130 | 2.32 | 2.01 | 1.70 | 1.39 | 1.09 | 0.78 |
| 130-140 | 2.36 | 2.05 | 1.74 | 1.42 | 1.11 | 0.80 |
| 140-150 | 2.40 | 2.09 | 1.77 | 1.45 | 1.13 | 0.81 |
| 150-160 | 2.45 | 2.13 | 1.80 | 1.47 | 1.15 | 0.82 |
| 160-170 | 2.49 | 2.16 | 1.83 | 1.50 | 1.17 | 0.84 |
| 170-180 | 2.53 | 2.19 | 1.86 | 1.52 | 1.19 | 0.85 |
| 180-190 | 2.57 | 2.22 | 1.89 | 1.54 | 1.20 | 0.86 |
| 190-200 | 2.60 | 2.25 | 1.91 | 1.56 | 1.22 | 0.87 |
| 200-210 | 2.63 | 2.28 | 1.94 | 1.59 | 1.24 | 0.88 |
| 210-220 | 2.67 | 2.31 | 1.96 | 1.61 | 1.25 | 0.89 |

tion is not related to a continuous increase or decrease in value differences. In the cases of beef, veal, and lamb carcasses, the most desirable grade, Prime, includes carcasses which are more compact and have a higher degree of finish and quality than Choice, which is the next lower grade. Similarly, Choice grade carcasses are more compact, have higher finish and quality, and are more valuable than Good grade carcasses.

This is not the case with hog carcasses. Highly finished, compact hog carcasses and the very long, lean carcasses are less valuable than carcasses in between these extremes.[40] For example, carcasses in Grade 8 of Grade Standard A (table 6) are worth less per pound than those in Grade 9 because they contain less of the higher priced cuts and more of the lower price lard. Similarly Grade 9 carcasses are worth less per pound than those in Grade 10. An increase in the index of lean adds to the value of the carcasses up to the point where some of the wholesale cuts are discounted for lack of finish or quality. Some cuts from Grade 11 carcasses probably are discounted, and this certainly will be the case with many cuts from Grade 12 carcasses. Grade 10, which is suggested as the optimum grade, has been centered tentatively at an index of lean of 70.0.

The backfat margins between grades in Grade Standard A are defined to the nearest one-hundredth of an inch. Such refinement would be impracticable under usual packing house conditions. Obviously, some further grouping is required. Table 4 (the Theoretical Grade Standard) supplies the necessary data for this purpose. Given the carcass weight and backfat thickness, the expected index of lean can be readily located.

A suggested grouping is shown in Grade Standard B (table 7) where the 11 weight groups in Grade Standard A are combined into 3, and 2 additional weight groups have been added. These 5 weight groups include carcasses weighing from 110 to 330 pounds.

[40] Under such circumstances, neither name grades, such as Prime, Choice, Good, Commercial, etc. which are used for beef, veal, and lamb, nor the usual number grades such as 1, 2, 3, 4, etc., appear to be appropriate. For that reason the presumably optimum grade was designated as Grade 10. Grade designations under 10 are reserved for those carcasses which carry excess finish, while grade designations over 10 are for underfinished carcasses. The number of grades used in this classification will depend upon the desired range for each grade and the range of finish for all carcasses.

**Table 7. Hog Carcass Grade Standard B, Based on Backfat Thickness and Carcass Weight, Modified 0.3 Inch Range of Backfat per Grade,* with Grade 10 Centered at Index of Lean of 70.0**

| Carcass weights, pounds | Equivalent liveweight (approx.), pounds | | Carcass Grades | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 8 | | 9 | | 10 | | 11 | | 12 | |
| | | | margins | midpoints | margins | midpoints | margins | midpoints | margins | midpoints | margins | midpoints | margins |
| 110-140 | 165-205 | Backfat thickness, inches | 2.3 | | 2.0 | | 1.7 | | 1.4 | | 1.1 | | 0.8 |
| (125 average) | | Index of lean | 62.6 | 64.1 | 65.6 | 67.0 | 68.5 | 70.0 | 71.4 | 72.9 | 74.4 | 75.8 | 77.3 |
| 140-180 | 205-260 | Backfat thickness, inches | 2.5 | | 2.1 | | 1.8 | | 1.5 | | 1.2 | | 0.9 |
| (160 average) | | Index of lean | 62.2 | 64.1 | 65.9 | 67.3 | 68.6 | 70.0 | 71.4 | 72.7 | 74.1 | 75.5 | 76.9 |
| 180-220 | 260-310 | Backfat thickness, inches | 2.6 | | 2.2 | | 1.9 | | 1.6 | | 1.3 | | 0.9 |
| (200 average) | | Index of lean | 62.7 | 64.4 | 66.1 | 67.4 | 68.7 | 70.0 | 71.3 | 72.6 | 73.9 | 75.6 | 77.3 |
| 220-270 | 310-375 | Backfat thickness, inches | 2.7 | | 2.4 | | 2.0 | | 1.7 | | 1.3 | | 1.0 |
| (245 average) | | Index of lean | 63.0 | 64.2 | 65.5 | 67.1 | 68.8 | 70.0 | 71.2 | 72.8 | 74.5 | 75.7 | 76.9 |
| 270-330 | 375-460 | Backfat thickness, inches | 2.9 | | 2.5 | | 2.1 | | 1.8 | | 1.4 | | 1.0 |
| (300 average) | | Index of lean | 62.6 | 64.2 | 65.7 | 67.3 | 68.8 | 70.0 | 71.2 | 72.7 | 74.2 | 75.8 | 77.4 |

* Except for following weights and grades which have 0.4 inch range:
140-180 pounds—Grade 8; 180-220 pounds—Grades 8 and 12; 220-270 pounds—Grades 9 and 11;
270-330 pounds—Grades 8, 9, 11, and 12.

Some explanation of the manner in which this table was developed will contribute to a better understanding of it. The range of 3.0 points in the index of lean for each grade in Grade Standard A appeared to be satisfactory, so it served as a starting point for the development of Grade Standard B. Since the carcasses are to be graded on the basis of backfat thickness and carcass weight, the first step here was to select the particular variation in backfat thickness which most closely approximates the variation of 3.0 in the index of lean. The range in backfat required for a variation of 3.0 in the index of lean was approximately .30 inch for 115-pound carcasses and .35 inch for 215-pound carcasses. Thus, it appeared that a range of .3 inch in backfat thickness would provide a logical starting point.

The next step was to locate the precise midpoint of each .3-inch range of backfat associated with the expected index of lean of 70.0 for Grade 10 of each weight group. It will be noted that the backfat thicknesses at both margins of Grade 10, and consequently at the midpoint, increase by .1 inch from one weight group to the next, extending from the lightest to the heaviest. The carcass weight groups shown in Grade Standard B were selected with that in mind.[41]

The backfat margins for the grades to the right and left of Grade 10 were established by moving out at successive intervals of .3 inch for each carcass weight insofar as this was practical. Some alterations in the range of backfat thickness were necessary in order to maintain homogeneity of the index of lean within grades among different carcass weights, since the fundamental relationship between backfat and index of lean changes with increasing carcass weight.

It is believed that most carcasses can be classified readily by an experienced grader according to Grade Standard B. It would be necessary to measure only those carcasses with backfat thickness near the margins between grades.

[41] Since a range in backfat thickness of 0.3 inch was accepted as the basic range, it obviously follows that the midpoint, which is to indicate an index of 70.0, must be located at some one-half of 0.1 inch point, such as 1.55, 1.65, 1.75 inches, etc. The next step is to find the carcass weight at which these midpoints of one-half of 0.1 inch (when the index is held at 70.0) can be found. The backfat thicknesses which will predict any given index at different carcass weights are shown in table 5. The backfat thicknesses nearest one-half of 0.1 inch that will predict an index of 70.0 are shown in column (1) of the tabulation below. The carcass weights associated with these particular backfat thicknesses and which now will become the midweights of our weight group classifications are shown in column (2). Column (3) supplies the weight ranges of each weight group which are derived from the midweights in column (2). Column (4) shows the backfat thicknesses rounded-off to the nearest one-half of 0.1 inch which now become the midpoints of the backfat ranges for the different weight groups of Grade 10 shown in column (5).

| (1) Backfat thickness at 70.0 index of lean from table 5 (inches) | (2) Carcass weight from table 5 (midpoint of weight group in pounds) | (3) Appropriate range of weights per weight group (pounds) | (4) Midpoint backfat thickness (inches) | (5) Appropriate 0.3 inch range of backfat thickness for Grade 10 |
|---|---|---|---|---|
| 1.547 | 125 | 110-140 | 1.55 | 1.4-1.7 |
| 1.651 | 160 | 140-180 | 1.65 | 1.5-1.8 |
| 1.751 | 200 | 180-220 | 1.75 | 1.6-1.9 |
| 1.847 | 245 | 220-270 | 1.85 | 1.7-2.0 |
| 1.948 | 300 | 270-330 | 1.95 | 1.8-2.1 |

Column (3) specifies the boundaries of the weight groups for all grades and column (5) specifies the limits or margins of backfat thickness for Grade 10 within these weight groups when Grade 10 is centered on an index of 70.0. If on the basis of actual experience and additional information it should be decided that the optimum grade should include carcasses with a higher index of lean, Grade 10 could be centered on 70.5, 71.0, 71.5 or some other index. The same method that was used to establish the weight group limits and the backfat margins for Grade 10 at 70.0 could be used to center this grade on any other index. For an example of an alternative Grade Standard with Grade 10 centered at an index of 71.0 see table 23, Appendix G.

**Table 8. Distribution of 695 Carcasses as Classified by Two Different Grade Standards**

| Grade Standard | Distribution of Carcasses by Grades | | | | | Total |
|---|---|---|---|---|---|---|
| | 8 | 9 | 10 | 11 | 12 | |
| | number | number | number | number | number | number |
| Grade Standard A (table 6) | 35 | 157 | 259 | 203 | 41 | 695 |
| Grade Standard B (table 7) | 53 | 143 | 248 | 197 | 54 | 695 |

## Effectiveness of Alternative Standards

Before attempting to analyze the economic effectiveness of various carcass standards in sorting or classifying carcasses into homogeneous groups with respect to value differences, an evaluation of these standards according to their ability to distinguish physical differences will be required. One approach to this problem is to determine how accurately each alternative standard classifies carcasses. Another approach is to compare the proportion of the total variability of the index of lean that each of these grade standards is able to account for or explain.

The cards for the 695 carcasses were sorted according to each of the two Grade Standards, A and B.[42] In each case they were first sorted according to their particular carcass weight group and then placed in their respective grade categories on the basis of backfat thickness. There was considerable similarity in the distribution among grades for both grade standards (table 8). A few more carcasses, however, were placed in Grade 10, and a few less in Grades 8 and 12 under Grade Standard A than under Grade Standard B.

The next step was to determine the relative frequency with which carcasses were placed according to their indices of lean into the classes indicated by their backfat thicknesses. The actual index of lean for each carcass was noted and the extent of the grade error by number of grades was recorded. Grade Standard A appears to be slightly superior to Grade Standard B according to this tabulation (table 9). This was to be expected since under Grade Standard A, a constant interval of 3.0 points in the index of lean was maintained for each grade by defining backfat margins to the nearest one-hundredth of an inch. Grade Standard A, however, was rejected as being impracticable under usual packing house conditions. Grade Standard B probably would place nearly 60 per cent of the carcasses in the particular grades indicated by backfat thickness, compared with over 61 per cent for Grade Stand-

**Table 9. Analysis of Grading Accuracy by Type of Grade Standard**

| Grade Standard | Number and Per Cent of Carcasses | | | | | Total |
|---|---|---|---|---|---|---|
| | Under-graded | | Graded accurately | Over-graded | | |
| | number of grades | | | number of grades | | |
| | 2 | 1 | | 1 | 2 | |
| | number | number | number | number | number | number |
| Grade Standard A | 7 | 119 | 427 | 135 | 7 | 695 |
| Grade Standard B | 14 | 126 | 413 | 130 | 12 | 695 |
| | per cent | per cent | per cent | per cent | per cent | per cent |
| Grade Standard A | 1.0 | 17.1 | 61.5 | 19.4 | 1.0 | 100.0 |
| Grade Standard B | 2.0 | 18.2 | 59.4 | 18.7 | 1.7 | 100.0 |

[42] See Appendix C for description of the entire sample.

**Table 10. Comparison of Standard Errors of Estimate, Correlation Ratios, and Percentages of Variability Explained for Various Hog Carcass Standards**

| Grade standard | Standard error of estimate | Correlation ratio | Percentage of variability explained |
|---|---|---|---|
| | $S_y$ | $\eta$ | $\eta^2$ |
| Theoretical Grade Standard (table 4) | 1.6393 | .8694 | 75.59 |
| Grade Standard A (table 6) | 1.8558 | .8289 | 68.70 |
| Grade Standard B (table 7) | 1.8439 | .8313 | 69.10 |

ard A. About 37 per cent would be under-graded or over-graded one grade in each standard, while about 2 per cent would be under-graded or over-graded two grades in Grade Standard A compared with about 4 per cent in Grade Standard B.

Another method of evaluating the ability of carcass standards to distinguish carcasses according to physical differences is to determine the proportion of the variability of the index of lean the standards are able to explain. The data in table 4 provide the best prediction possible of the index of lean on the basis of backfat thickness and carcass weight. As was indicated earlier, on the basis of this table, about 76 per cent of the variability of the index of lean is explained by backfat thickness and carcass weight alone. In other words, variations in backfat and in carcass weight account for 76 per cent of the variations in the index of lean. Table 4 may be considered as a Theoretical Grade Standard, since it provides the best prediction of the index of lean, and may be used as a criterion against which the other standards may be compared.

The proportion of the total variability of the index of lean which is explained by each of the three grade standards is shown in the last column of table 10.[43] On the basis of this comparison, there was little difference between Grade Standards A and B in their ability to account for variations in the index, and hence in their relative accuracy of grading. Both of these standards were able to explain about 69 per cent of the variability compared with nearly 76 per cent for the Theoretical Grade Standard (table 4). On the basis of this test, it appears that Grade Standard B, which it is believed would be practicable under usual packing house conditions, would differentiate carcasses quite satisfactorily according to their degree of finish as measured by the indicated index of lean.

**The Optimum Magnitude of the Index of Lean.** It has been stated at various points in this bulletin that carcasses which have an excessively high degree of finish are worth less per pound than those with more moderate finish because they tend to yield a smaller proportion of the high value lean cuts and a correspondingly larger proportion of the lower value lard. It is true also that excessively underfinished carcasses should be discounted because they tend to yield some cuts which lack firmness

[43] The calculation of the standard error of estimate and the correlation ratio for the theoretical grade standard was explained in footnote 37, page 23, and in table 21, Appendix G. This standard error is a measure of the dispersion of the actual indices of lean from the predicted values shown in table 4. These predicted values are somewhat analogous to a curvilinear regression surface of a three variable multiple correlation problem. The standard errors of estimate for Grade Standards A and B are measures of the dispersion of indices of lean about the average index of each carcass grade. The standard deviation ($\sigma$) of index of lean for the entire sample was 3.3172. The calculation of the correlation ratios was based on the conventional correlation formula:

$$\eta = \sqrt{1 - \frac{S_y{}^2}{\sigma^2}}$$

in the texture of meat and cannot be sold in the wholesale trade as first quality products.

The higher the index of lean, the greater is the probability or likelihood of discounted cuts from the carcass due to lack of finish. The fundamental problem is to locate the point on the index of lean scale at which carcass values will be the highest. It is at this optimum point that, with a small increase in the index of lean, the value-decreasing effect of the additional discounted cuts will just offset the value-increasing effects of the lower proportion of lard. As carcasses move up the index of lean scale beyond this point, the additional numbers of discounted cuts will more than offset the decreased yield of lard, and carcass values will decline.

An attempt was made to obtain data which would provide the basis for determining the optimum index of lean. Hams, loins, and bellies were graded by an employee of the plant as they were separated from each carcass and the discounted cuts were recorded. Under the price ceiling regulations established and administered by the Office of Price Administration during and immediately following the war, quality standards were relaxed considerably. Many cuts which under more normal conditions would have been discounted and sold as second grade products were sold at ceiling prices. Consequently, the grading was more tolerant than would have been desired for a study of this kind.

The numbers of carcasses having discounted hams or bellies are shown in table 11, classified according to the index of lean. The total number of carcasses in each class also is shown. A distinct relationship between the probability of discounted cuts and the index of lean will be observed—in general, the higher the index of lean, the higher the proportion of carcasses with discounted cuts. All hams and bellies from the few carcasses in the two highest index classes were discounted for lack of quality due to inadequate finish.

It will be observed that bellies from 8 carcasses with indices of lean from 69.0 to 71.9 were discounted.[44] It is believed that more discounted cuts would have appeared at all points along that portion of the index of lean scale shown in table 11 if the grading of cuts had been less tolerant. In addition, it is believed that a considerably larger number of bellies at the lower end of the index scale, below that portion shown in table 11, should have been discounted in grade for carrying excess finish.

**Table 11. Numbers of Bellies and Hams Discounted for Quality from Carcasses Classified According to the Index of Lean**

| | Index of lean | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 69.0-69.9 | 70.0-70.9 | 71.0-71.9 | 72.0-72.9 | 73.0-73.9 | 74.0-74.9 | 75.0-75.9 | 76.0-76.9 | 77.0-77.9 | 78.0-78.9 | 79.0-79.9 |
| Number of carcasses | 88 | 77 | 65 | 73 | 62 | 41 | 25 | 16 | 6 | 2 | 1 |
| Number of carcasses having bellies discounted for lack of quality* | 2 | 2 | 4 | 2 | 8 | 9 | 11 | 8 | 3 | 2 | 1 |
| Number of carcasses having hams discounted for lack of quality | ...... | ...... | 1 | 2 | 7 | 15 | 15 | 12 | 5 | 2 | 1 |

* Two sets of bellies, at 63.8 and 67.8 indices of lean respectively, were discounted for having excess fat.

[44] The margin between Grades 10 and 11 in Grade Standard B is located approximately at an index of lean of 71.4

In Grade Standards A and B, Grade 10, with index of lean centered at 70.0, was assumed to be the most desirable grade. The carcasses within this grade were judged to have the optimum degree of finish by representatives of the packing plant. The data on discounted cuts in table 11 suggest that the optimum magnitude of the index of lean may be somewhat above 70.0. Because of the inadequacy of these data, however, and because they probably understate the expected frequency, it is believed that centering Grade 10 at 70.0 will be the safer course to follow for the present, especially if carcasses are graded entirely by objective measures.

It is very likely that with a little additional attention carcass graders could detect a substantial proportion of the discounted hams and bellies on the hanging carcasses. It might be desirable to center Grade 10, the presumably desirable grade, at some index higher than 70.0, for example, at 70.5 or 71.0. Each of the other grades would be moved up the index of lean scale by a similar amount. When a grader noted a carcass with a discounted cut, he could place the carcass in one of the discounted grades regardless of the fact that it would have been placed in Grade 10 on the basis of backfat thickness and carcass weight alone. If this were done, some subjective considerations would be added to the objective criteria for grading carcasses presented earlier.[45]

Although the optimum degree of finish has not been located precisely on the index of lean scale in this study, it seems logical to conclude that, in general, the value of the carcass per pound increases with the increase in the index of lean as long as it yields first quality cuts. This, of course, refers to the value of the carcass per pound to the packer as based upon consumer demand.[46]

It does not necessarily follow that the most desirable carcass to the packer will be the most profitable carcass for the farmer to produce. Maximum profit may be obtained from hogs which yield carcasses with an index of lean other than the optimum from the packer's standpoint. The maximum profit point on the index of lean scale might be expected to vary with variations in feed and hog carcass prices. Nevertheless, in order to reflect consumer preferences to farmers as effectively as possible, the relative prices paid by packers for different weights and grades of carcasses should reflect the price relationships of the various cuts and trimmings in the wholesale markets. The farmer can then weigh the premium for a hog of the particular type, weight, and finish, which the market desires against the expected returns from a hog of any other type, weight and/or finish which he believes would be more profitable to produce and adjust his production plans accordingly.

## VALUE DIFFERENCES BETWEEN DIFFERENT CARCASS GRADES

The analysis in the preceding sections has been concerned primarily with discovering certain objective factors which may be useful for estimating physical differences between hog carcasses, and for classifying carcasses on the basis of these differences into fairly homogeneous groups or grades. Average backfat thickness and carcass weight were used to estimate the per-

[45] Table 23, Appendix G suggests an alternative grade standard with Grade 10 centered at an index of lean of 71.0. This standard may be used if it is found that an index of 71.0 is more nearly the optimum magnitude index of lean than an index of 70.0 as in Grade Standard B (table 7). It may also be used if graders are subjectively eliminating carcasses which have obviously discounted cuts from the Grade 10 category.

[46] It is assumed that the palatability of the meat from some cuts remains constant over a considerable range on the index of lean scale. Cuts, such as hams and loins, are standardized over a considerable range by removing excess fat.

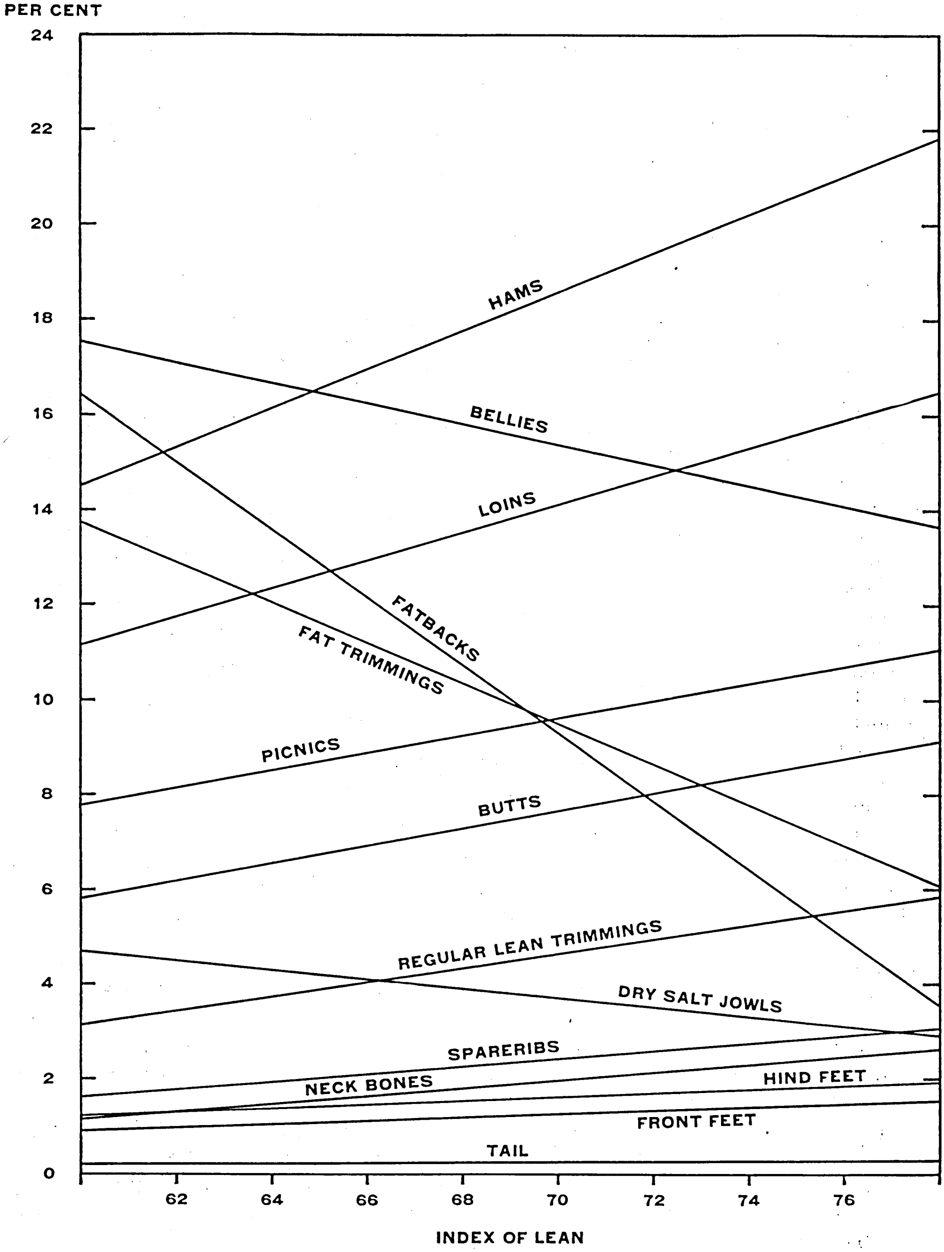


FIG. 9. Percentage relationship of the various wholesale cuts and trimmings to the index of lean.

centage of the carcass which consists of the high value components, which we have termed the "index of lean," and to classify hog carcasses into grades on the basis of expected index of lean.

The next step is to determine the relation of the index of lean to actual carcass value. It has been assumed that carcass value increases with the index of lean, because of the increasing percentage of the high value components and the decreasing percentage of low value lard, up to the point where carcasses yield a significant number of cuts which are discounted because they lack quality. But what is the difference in value between one carcass having an index of lean of 64.0 and another of identical weight but with an index of 70.0? Just how much more is a Grade 10 carcass worth than a Grade 9 or a Grade 8 carcass?

The answers to these questions will depend upon (1) the average physical composition of the carcass at the different indices of lean and (2) the price relationships of the several component wholesale cuts and trimmings to each other. Because the price relationships are constantly changing, the differences in value between the various grades of carcasses will vary from time to time. In general, the greater the margin is between the prices of the high value cuts and lard, the greater will be the premium which can be paid for Grade 10 carcasses over Grades 8 and 9 carcasses. If, however, the physical composition of the carcass (in terms of the various component cuts and trimmings) at the different indices of lean can be determined, it will be possible to build up the values of the different carcass grades with any given schedule of prices of wholesale cuts and trimmings.

**Distribution of Wholesale Cuts and Trimmings.** Each of the components of the hog carcass varies with the index of lean and each has its own price. In order to properly evaluate a hog carcass at any given index of lean, it was necessary to determine the separate and individual percentages of each of the lean, fat, and skeletal cuts and trimmings of the carcass. The relation of each of these cuts and trimmings to the index was individually determined. The percentage composition of the carcass at all indices of lean from 60.0 to 78.0, the limits which encompassed the range of carcasses used in this study, are given in table 12, and are shown graphically in figure 9.

It will be noted that of the six components of the index of lean, (hams, loins, picnics, butts, bellies, and lean trimmings) only the belly has a negative relationship with the index. All of the fat cuts had the expected negative relationship. The fatback and fat trimmings combined, which together are raw materials from which lard is rendered, comprised about 30.1 per cent of the carcass when the index was equal to 60.0, 18.7 per cent at an index of 70.0, and about 9.6 per cent at an index of 78.0. This relationship emphasizes the sharp reduction in the amount of lard yielded from the carcass as the index of lean is increased.

**Pricing Cuts and Determining Carcass Values.** Table 12 can be used to predict the average composition of hog carcasses in percentage terms at any given index of lean within the indicated limits. It thereby provides the basis for evaluating carcasses according to their indices of lean. If both the index and the prices for each of the component cuts are known, the value of the carcass can be readily determined. The several percentage components of the carcass are multiplied by their respective prices and the sum of the value products will be equal to the carcass value per 100 pounds carcass weight. This will always be true regardless of the weight of the carcass. The carcass value per 100 pounds can then be multiplied by the weight of the carcass to obtain the value of the entire carcass.

Table 12. Percentage Distribution of Wholesale Cuts of Hog Carcasses Classified by Index of Lean

| Wholesale cuts and trimmings | Rate of change* | Index of lean 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Lean Cuts and Bellies and Lean Trimmings** | | | | | | | | | | | | | | | | | | | | |
| Hams | +.405 | 14.51 | 14.91 | 15.32 | 15.73 | 16.13 | 16.54 | 16.94 | 17.34 | 17.75 | 18.16 | 18.560 | 18.96 | 19.37 | 19.78 | 20.18 | 20.58 | 20.99 | 21.39 | 21.80 |
| Loins | +.296 | 11.15 | 11.44 | 11.74 | 12.03 | 12.33 | 12.62 | 12.92 | 13.22 | 13.51 | 13.81 | 14.105 | 14.40 | 14.70 | 14.99 | 15.29 | 15.58 | 15.88 | 16.18 | 16.47 |
| Picnics | +.181 | 7.80 | 7.98 | 8.16 | 8.34 | 8.52 | 8.70 | 8.89 | 9.07 | 9.25 | 9.43 | 9.610 | 9.79 | 9.97 | 10.15 | 10.33 | 10.52 | 10.70 | 10.88 | 11.06 |
| Boston butts | +.183 | 5.84 | 6.03 | 6.21 | 6.39 | 6.58 | 6.76 | 6.94 | 7.13 | 7.31 | 7.49 | 7.675 | 7.86 | 8.04 | 8.22 | 8.41 | 8.59 | 8.77 | 8.96 | 9.14 |
| Bellies | —.216 | 17.55 | 17.34 | 17.12 | 16.91 | 16.69 | 16.48 | 16.26 | 16.04 | 15.83 | 15.61 | 15.395 | 15.18 | 14.96 | 14.75 | 14.53 | 14.32 | 14.10 | 13.88 | 13.67 |
| Regular lean trimmings | +.151 | 3.15 | 3.30 | 3.45 | 3.60 | 3.75 | 3.90 | 4.05 | 4.20 | 4.35 | 4.50 | 4.655 | 4.81 | 4.96 | 5.11 | 5.26 | 5.41 | 5.56 | 5.71 | 5.86 |
| Total: Lean cuts, bellies, and lean trimmings | | 60.00 | 61.00 | 62.00 | 63.00 | 64.00 | 65.00 | 66.00 | 67.00 | 68.00 | 69.00 | 70.00 | 71.00 | 72.00 | 73.00 | 74.00 | 75.00 | 76.00 | 77.00 | 78.00 |
| **Fat Cuts** | | | | | | | | | | | | | | | | | | | | |
| Fat backs | —.714 | 16.42 | 15.71 | 15.00 | 14.28 | 13.57 | 12.85 | 12.14 | 11.43 | 10.71 | 9.99 | 9.283 | 8.57 | 7.85 | 7.14 | 6.43 | 5.71 | 5.00 | 4.29 | 3.57 |
| Fat trimmings | —.425 | 13.73 | 13.31 | 12.88 | 12.45 | 12.02 | 11.60 | 11.17 | 10.74 | 10.32 | 9.89 | 9.462 | 9.04 | 8.61 | 8.18 | 7.75 | 7.32 | 6.90 | 6.47 | 6.04 |
| Dry salt jowls | —.100 | 4.70 | 4.60 | 4.50 | 4.40 | 4.30 | 4.20 | 4.10 | 4.00 | 3.90 | 3.80 | 3.700 | 3.60 | 3.50 | 3.40 | 3.30 | 3.20 | 3.10 | 3.00 | 2.90 |
| Total: Fat cuts | | 34.85 | 33.62 | 32.38 | 31.13 | 29.89 | 28.65 | 27.41 | 26.17 | 24.93 | 23.68 | 22.445 | 21.21 | 19.96 | 18.72 | 17.48 | 16.23 | 15.00 | 13.76 | 12.51 |
| **Miscellaneous Cuts** | | | | | | | | | | | | | | | | | | | | |
| Spareribs | +.080 | 1.63 | 1.71 | 1.79 | 1.87 | 1.95 | 2.03 | 2.11 | 2.19 | 2.27 | 2.35 | 2.427 | 2.51 | 2.59 | 2.67 | 2.75 | 2.83 | 2.91 | 2.99 | 3.07 |
| Neck bones | +.081 | 1.17 | 1.25 | 1.33 | 1.41 | 1.50 | 1.58 | 1.66 | 1.74 | 1.82 | 1.90 | 1.983 | 2.06 | 2.14 | 2.22 | 2.31 | 2.39 | 2.47 | 2.55 | 2.63 |
| Front feet | +.036 | .90 | .94 | .97 | 1.01 | 1.04 | 1.08 | 1.11 | 1.15 | 1.19 | 1.22 | 1.260 | 1.30 | 1.33 | 1.37 | 1.40 | 1.44 | 1.47 | 1.51 | 1.55 |
| Hind feet | +.041 | 1.23 | 1.26 | 1.31 | 1.35 | 1.39 | 1.43 | 1.47 | 1.51 | 1.55 | 1.60 | 1.635 | 1.67 | 1.72 | 1.76 | 1.80 | 1.84 | 1.88 | 1.92 | 1.96 |
| Tail | +.003 | .22 | .22 | .22 | .23 | .23 | .23 | .24 | .24 | .24 | .25 | .250 | .25 | .26 | .26 | .26 | .27 | .27 | .27 | .28 |
| Total: Miscellaneous cuts | | 5.15 | 5.38 | 5.62 | 5.87 | 6.11 | 6.35 | 6.59 | 6.83 | 7.07 | 7.32 | 7.555 | 7.79 | 8.04 | 8.28 | 8.52 | 8.77 | 9.00 | 9.24 | 9.49 |
| Grand Total | | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

* The regression coefficient, or the amount of change in each of the various wholesale cuts and trimmings associated with a change of 1 point in the index of lean.

The suggested Grade Standard B (table 7) gives the indicated indices of lean at the midpoint of the allowable range in backfat thickness for each grade and weight grouping. Thus, for the 110- to 140-pound group the range in backfat thickness is 1.4 to 1.7 inches for Grade 10. The midpoint of this range is 1.55 inches, and the indicated index at this midpoint is 70.0. The indices of lean for Grades 8 and 9, determined in the same manner, are 64.1 and 67.0 respectively. In order to compute the value of Grade 10 carcasses, the percentage components listed under 70.0 in table 12 are multiplied by their respective wholesale prices. The value of Grade 9 carcasses can be determined similarly by multiplying the percentage components under 67.0 by their respective prices. In order to compute the value of Grade 8 carcasses, with an indicated index of 64.1, the percentage of each cut and trimming must be obtained by interpolation. This will be necessary for other groupings as well, whenever the indicated index does not end in a full number.

The indices of lean shown in Grade Standard B apply only to the midweight of each weight group. The midweight of the 110- to 140-pound weight group is 125 pounds and the index of 70.0 shown in the table for Grade 10 of this group applies only to this particular weight with 1.55 inches of backfat. Carcasses at 115 pounds will have an index of 69.6 at 1.55 inches of backfat while 135-pound carcasses will have an index of about 70.3 at the same backfat thickness (interpolated from table 4). These minor variations of the index of lean by weight within a given weight and grade group are of importance in determining the value of different weights of carcasses in the same group and also will have some influence on the average weight of cut at any particular carcass weight.

Tables 27 to 37, Appendix G, show the median index and the distribution of cuts within each grade at different carcass weights. Table 27 shows this information for 115-pound carcasses, table 28 for 125-pound carcasses, etc. The last table in this series (table 37) gives this information for 215-pound carcasses. These tables provide the basic physical information required to build up carcass values from the values of the component parts of the carcass. The other information required is a price schedule for the various wholesale cuts and trimmings that make up the hog carcass.

Because of the extremely high demand for all meats following the removal of OPA price controls in September, 1946, the price relationships of the several wholesale cuts to each other during the period in which the data for this study were collected and analyzed are probably distorted and abnormal. For that reason it was decided to use the average of a five-year prewar series of prices to measure differences in carcass value between the several grades. Wholesale prices of these cuts and trimmings at Chicago were averaged for the five-year period from 1937-41. This is the last full five-year period in which the free market determined the prices of these cuts and trimmings prior to the imposition of price controls in 1942. This schedule of average prices is shown in table 13.

In this table of five-year average prices it will be noted that the heavier weights of hams, loins, picnics, and bellies are generally sold at lower prices in the wholesale trade.[47] This tendency somewhat complicates the method of building up carcass values from the prices and values of the component parts of the carcass. It is not enough to know that on Grade 10 carcasses at an index of 70 the hams will average 18.56 per cent of the carcass

[47] This discount for heavier weight of cut provides a partial explanation for the lower prices usually prevailing on the heavier weights of hogs. The other factor is the higher finish (lower index of lean) at which heavier hogs are usually marketed.

**Table 13. Five-Year Average Wholesale Prices: Pork Cuts and Trimmings, Chicago—1937-41***

| Wholesale cuts | Weight, pounds | Price per cwt. |
|---|---|---|
| Green skinned hams | 10-12 | $18.29 |
| | 12-14 | 18.12 |
| | 14-16 | 17.86 |
| | 16-18 | 17.47 |
| | 18-20 | 16.81 |
| | 20-22 | 16.06 |
| | 22-24 | 15.47 |
| Loins | 8-10 | 18.52 |
| | 10-12 | 18.07 |
| | 12-14 | 16.81 |
| | 14-16 | 15.78 |
| | 16-22 | 14.84 |
| Green bellies | 6- 8 | 15.01 |
| | 8-10 | 14.73 |
| | 10-12 | 14.04 |
| | 12-14 | 13.47 |
| | 14-16 | 12.89 |
| | 16-18 | 12.57 |
| Dry salt fatbacks | 6- 8 | (6.94)‡ |
| | 8-10 | (7.21) |
| | 10-12 | (7.56) |
| | 12-14 | (7.97) |
| | 14-16 | 8.41 |
| | 16-18 | 8.74 |
| | 18-20 | 9.11 |
| | 20-25 | 9.53 |

| Wholesale cuts | Weight, pounds | Price per cwt. |
|---|---|---|
| Green picnics | 4- 6 | $12.79 |
| | 6- 8 | 12.30 |
| | 8-10 | 11.67 |
| | 10-12 | 11.45 |
| Boston butts | | 16.69 |
| Regular pork trimmings | | 9.87 |
| Dry salt jowl butts | | 7.35 |
| Refined lard | | 9.60 |
| Spareribs | | 12.67 |
| Neck bones | | 4.25 |
| Front feet | | 4.01 |
| Tails | | 8.64 |

Conversion of fat to lard
(9.60 x conversion factor)

| Cut or Trimmings | Weight | Factor† | Price |
|---|---|---|---|
| Fat trimmings and fatbacks *under* 6 pounds | | 80.00% | 7.68 |
| Fatbacks | 6- 8 | 81.50% | 7.82 |
| | 8-10 | 82.25% | 7.90 |
| | 10-12 | 83.50% | 8.02 |
| | 12-14 | 84.50% | 8.11 |
| | 14-16 | 85.50% | (8.21)‡ |
| | 16-18 | 86.25% | (8.28) |

* The average prices for all cuts and trimmings other than loins and Boston butts were calculated from price data furnished by the Commodity Appraisal Service, which offers a private forecasting service for the meat packing industry. These in turn were taken from *The National Provisioner*, the weekly trade magazine of the packing industry. The average prices for loins and Boston butts were calculated from weekly price data furnished by the Market News office of the Production and Marketing Administration in the United States Department of Agriculture.

† The factors for converting fat to lard were taken from *The National Provisioner*, May 21, 1947, page 25.

‡ Fatback prices enclosed by parenthesis were not used in evaluating hog carcasses. During this period from 1937 to 1941 inclusive it will be observed that on the average it was profitable to convert all fatbacks under 14 pounds into lard. Fatbacks over 14 pounds could most profitably be merchandised in the wholesale trade.

(table 12). It is important to know also that at 175 pounds carcass weight, hams from Grade 10 carcasses can be expected to average 16.4 pounds. Although the average weight of ham falls within the 16- to 18-pound weight bracket, the price for 16 to 18 pounds still may not be entirely satisfactory for the purpose of building up carcass values. This is because not all of the hams from such carcasses will be within the 16- to 18-pound group. Some hams will weigh less than 16 pounds and others more than 18 pounds. Separate prices must be used for the cuts that exceed these limits to determine their specific value contribution to the carcass.

The reason why the weights of hams will vary around 18.56 per cent of the total carcass weight may be explained in terms of information shown in figure 9. In the first place, not all of the Grade 10 carcasses will have an index of lean exactly equal to 70.0, the point at which the line of average relationship for hams indicates that ham weights will average 18.56 per cent of the total carcass weight. Some carcasses will have a higher index, others a lower index. In the second place, not all of the ham percentages will lie exactly on the line shown. Since it is a line of the **average** relationship of percentage of hams to the index of lean, some hams will lie above the line and others below at any particular point on index of lean scale.[48]

The distribution of hams, loins, picnics, bellies, and fatbacks were computed for each of the five grades for carcass weights from 115 to 215 pounds at 10-pound intervals and are shown in Appendix G, tables 38 to 42.

The distribution of weights of hams, the 1937-41 average prices for the particular weight groups concerned, and the method of determining the weighted price which is to be used in calculating the value contribution of hams to carcass value are indicated below for 175-pound Grade 10 carcasses (see table 13, page 39, and table 38, page 77).

| Grade 10 carcass weight—175 pounds | | Average ham weight—16.4 pounds | |
|---|---|---|---|
| Weight group | Distribution of hams | Price per cwt. | Calculation of weighted price per cwt. |
| (pounds) | (per cent) | (dollars) | (dollars) |
| 12-14 | 0.6 | 18.12 | .109 |
| 14-16 | 33.9 | 17.86 | 6.054 |
| 16-18 | 61.2 | 17.47 | 10.692 |
| 18-20 | 4.3 | 16.81 | .723 |
| Total | 100.0 | | 17.578 |

Hams and Grade 10 carcasses weighing 175 pounds are priced, therefore, at $17.58 per 100 pounds. For precise determination of carcass values of the different grades and weights of carcasses, the prices for hams, loins, picnics, bellies, and fatbacks must all be computed in this manner. Prices for the remaining cuts and trimmings can be taken directly from the price schedule (table 13).

This information will enable a packer to determine the values of the various weights and grades of carcasses with any given schedule of wholesale prices of cuts and trimmings, insofar as value differences between the several weight and grade groupings are due either to (1) differences in the proportional physical composition of the carcass, or (2) differences in weights of wholesale cuts. As was indicated earlier, the data collected in this study were not considered to be adequate for estimating the probabilities of discounted cuts among carcasses in Grades 11 and 12.

In table 14 carcass values have been calculated for Grades 8, 9, and 10 and for weights from 110 to 220 pounds on the basis of the 1937-41 wholesale prices shown in table 13 inflated by the average liveweight price per hundredweight paid by packers for all slaughter hogs in 1947.[49] This table is, therefore, based on 1937-41 **price relationships**, but on 1947 **price levels.**

Several important tendencies are apparent in the data shown in this table. Within any given weight range Grades 8 and 9 carcasses have a lower value than Grade 10 carcasses because they yield a larger percentage of the low-value lard and a smaller percentage of the high-value lean cuts. This tabulation provides a demonstration of how

[48] At any particular carcass weight the variability in weight of cut arises from two sources of variation. There is a variability of the weight of a given cut about its regression line to the index of lean. In figure 9 this would be the vertical variation. Within each grade there is a variability of the index of lean of carcasses about the average index for the grade. In figure 9 this would be the horizontal variation. The standard error of estimate is a suitable expression for the first source of variability. The standard deviation of the indices of lean within grades was deflated by the regression coefficient of the particular cut to the index to arrive at an expression of the contribution of variability of the index to the total variability of weight of cut. The variances of the two dispersions were then added to obtain the total variance of the cut weight about the average weight for the grade. The calculation of the theoretical or expected dispersions for hams, loins, picnics, bellies, and fatbacks in percentage terms is demonstrated in table 24, Appendix G. These percentage distributions are converted to pounds in table 25, Appendix G.

[49] The factor used to inflate carcass values to 1947 price levels was 3.087. This was computed by dividing the United States average cost to packers in 1947 ($24.60 per 100 pounds liveweight) by the average cost to packers at Chicago for the five-year period, 1937-41 ($7.968). Chicago prices were used as the live price base since the average wholesale prices in table 13 were based on Chicago quotations.

**Table 14. Composite Carcass Values for Specified Carcass Grades***

| Carcass weight, pounds | | Equivalent liveweight (approximate), pounds | Carcass Grades | | | | |
|---|---|---|---|---|---|---|---|
| | | | 8 | 9 | 10 | 11† | 12† |
| 110-140 | | 165-205 | | | | | |
| | 110-120 | | 39.61 | 40.50 | 41.30 | ......... | ......... |
| | 120-130 | | 39.67 | 40.50 | 41.24 | ......... | ......... |
| | 130-140 | | 39.64 | 40.35 | 41.06 | ......... | ......... |
| | Average | | 39.64 | 40.45 | 41.20 | ......... | ......... |
| 140-160 | | 205-232 | | | | | |
| | 140-150 | | 39.17 | 40.01 | 40.62 | ......... | ......... |
| | 150-160 | | 39.08 | 39.79 | 40.41 | ......... | ......... |
| | Average | | 39.13 | 39.90 | 40.52 | ......... | ......... |
| 160-180 | | 232-260 | | | | | |
| | 160-170 | | 38.99 | 39.54 | 40.04 | ......... | ......... |
| | 170-180 | | 38.71 | 39.27 | 39.64 | ......... | ......... |
| | Average | | 38.85 | 39.40 | 39.84 | ......... | ......... |
| 180-200 | | 260-285 | | | | | |
| | 180-190 | | 38.34 | 38.71 | 39.11 | ......... | ......... |
| | 190-200 | | 38.09 | 38.43 | 38.71 | ......... | ......... |
| | Average | | 38.22 | 38.57 | 38.91 | ......... | ......... |
| 200-220 | | 285-310 | | | | | |
| | 200-210 | | 37.85 | 38.09 | 38.31 | ......... | ......... |
| | 210-220 | | 37.45 | 37.78 | 37.91 | ......... | ......... |
| | Average | | 37.65 | 37.93 | 38.11 | ......... | ......... |

* These prices are based upon the average price relationship for the several component cuts and trimmings to each other during 1937-41, and the average liveweight price paid by packers ($24.60 per 100 pounds liveweight) for all slaughter hogs bought in 1947.

† Prices were not calculated for these grades because insufficient data were available to determine accurately the expected frequency of discounted cuts.

these differences in value between grades can be determined.

Another important tendency revealed in these data is the apparent changing relation of carcass value to degree of finish at different carcass weights. Within the 110- to 140-pound group the difference in value between Grades 8 and 10 was $1.56. Within the 200- to 220-pound group the difference between the same grades is 46 cents. This is because at any given carcass weight as the index of lean declines the weights of hams, loins, and picnics also decline. Because lighter weight cuts sell for higher prices, the lower yield of the lean cuts from Grade 8 carcasses is partially offset by their higher price per pound. This is particularly true of the heavier weight carcasses because the price discounts for additional weight are considerably greater for the heavier cuts.

In the case of hams, for example, the difference between 10- to 12-pound and 12- to 14-pound hams was only 17 cents per 100 pounds in 1937-41 (see table 13), while the difference between 18- to 20 and 20- to 22-pound hams was 75 cents. This would indicate that within the 200- to 220-pound carcasses, hams from Grade 8 carcasses will enjoy a greater price advantage over Grade 10 carcasses than they will at the lighter weight. This is further demonstrated by the weighted prices on the 1937-41 base which were applied to hams of the two grades at the representative carcass weights indicated below.

| | Prices of hams from carcasses weighing: | |
|---|---|---|
| | 125 pounds | 205 pounds |
| Grade 8 | $18.29 | $17.22 |
| Grade 10 | 18.24 | 16.41 |
| Difference | $ 0.05 | $ 0.81 |

In terms of 1947 prices these differences would be approximately three times those shown. The same general situation is true with respect to loins, and to a somewhat lesser extent with picnics also. The bellies and fatbacks comprise a larger percentage of the carcass at the lower indices of lean. But the net price effect of the lower prices for heavier weight cuts is to reduce the margin between grades to a point less than that expected because of the increased yield of lard and fat.[50]

Still another important tendency shown in these data is the decline in value normally assocated with increasing weight within the same grades. Moreover, the decline appears to take place at an increasing rate in the lighter weight groups. For Grade 10 the interval between the 110- to 120- and the 120- to 130-pound weights is only 6 cents per hundred pounds, while the interval between the 200- to 210- and the 210- to 220-pound groups is 40 cents. The rate of decline in value is probably at a maximum from 180 to 220 pounds. A consistent decline of 40 cents per 10 pounds increase in carcass weight appears in this range. As carcasses increase in weight above 220 pounds, a larger percentage of the cuts will be above the weights where discounts are effective, and the margins between carcass weights could be expected to become less. Wholesale cuts yielded by a 275-pound carcass would practically all be in or above the heaviest weight classification listed on the price schedule and would no longer be subject to further discounts at heavier weights.

It should be remembered that this decline in value, associated with increasing carcass weight within grades, is due solely to the discounts at which the heavier weights of hams, loins, picnics, and bellies were sold in the wholesale market during the five-year period 1937-41. These discounts vary from time to time and from place to place. Sometimes they almost disappear, and all cuts sell at almost the same price.[51] At such times value differences be-

[50] The prices of the several high-value cuts used in building up the composite carcass values may overstate the values for Grade 8 and 9 carcasses within the heavier weight groups. For pricing purposes all of the cuts were considered to be of equal quality throughout the entire range of the index of lean. Since it was believed that the frequency of cuts discounted for quality within the underfinished Grades 11 and 12 would not warrant uniform pricing, no carcass values were entered for these grades in table 14. It is equally true that a certain number of carcasses in Grade 9 and a greater number in Grade 8 will yield cuts which are somewhat inferior because they carry excess fat. The surplus fat tissue surrounding the hams, loins, and butts can be and is trimmed off in the normal cutting procedure in the packing plant. Nevertheless, these cuts may have excess fat interlaced between the muscle tissues and between the muscle fibres themselves—fat which cannot readily be removed. Bellies from excessively overfinished carcasses may also carry enough additional fat tissue to warrant discounting for the inferior quality of bacon they could be expected to produce.

To illustrate this problem further: A Grade 10 carcass at 145 pounds is expected to yield hams averaging 13.34 pounds in weight (table 38, Appendix G). Grade 8 carcasses at 165 pounds, 20 pounds heavier, should yield hams averaging about the same weight, 13.37 pounds to be exact. Since hams were priced by weight only in this study, these hams made the same aggregate contribution to carcass value in both cases. Actually, however, some of the hams from Grade 8 carcasses carried excess fat to the extent that they should have been priced at a discount, thus reducing the composite value of Grade 8 carcasses. This problem of differential quality of wholesale cuts at different indices of lean lower than 70.0, may have some bearing with respect to all of the five primal cuts. The belly probably suffers most in value as the index of lean is lowered. Hence, the method of pricing used in this study very likely overstates the values of the highly finished grades and correspondingly understates the margin between grades within the same weight group. See Appendix D for other limitations to the determination of carcass value.

[51] From October 6 to 11, 1947, 10- to 12-pound hams sold for 50 cents a pound wholesale at Chicago while 22- to 24-pound hams sold for 49 cents. At the same time, green bellies were selling at a straight 52.5 cents per pound for all weights from 6 to 18 pounds. Picnics at 4 to 6 pounds sold for 38.5 cents while those at 10 to 12 pounds sold for 38 cents. See *The National Provisioner*, October 15, 1947.

tween carcass weights within the same grade are negligible. Differences reflected in liveweight prices of hogs are then primarily due to the lower indices of lean and associated greater yield of lard from the heavy hogs.

Past experience suggests that some discount for the heavier wholesale cuts, somewhat similar to the pattern in 1937-41, probably can be expected in the future. In Grade Standard B (table 7) hog carcasses weighing from 110 to 220 pounds were divided into three weight groups: 110 to 140 pounds, 140 to 180 pounds, and 180 to 220 pounds. Within Grade 10 the range of value differences due to weight alone was 98 cents in the 140- to 180-pound group and $1.20 in the 180- to 220-pound group. Because of the wide range of values due primarily to weight differences, it appears desirable for purposes of more accurate pricing to subdivide the two mentioned weight groups into four groups, each having a range of 20 pounds. Including the 110- to 140-pound group, a total of five weight groups would cover the range from 110 to 220 pounds carcass weight which was covered by three weight groups in Grade Standard B.

It is important to remember that this further breakdown is suggested for pricing purposes only. The more refined weight classification is simply a device to improve the economic homogeneity within grade and weight groupings for which a single price might be quoted.[52] The weight classifications shown in Grade Standard B would be unchanged for grading purposes. These weight groups enable the optimum classification of carcasses according to physical homogeneity when the 0.1-inch interval in backfat thickness is the smallest discrete unit used.

# PRICING ACCURACY OF LIVE AND CARCASS MARKETING METHODS

## Why Hog Values Vary

The most important factors which account for the variations in live hog values are (1) the variations in weight, (2) the variations in dressing percentage or carcass yield, and (3) the variations in carcass type (conformation, finish, and quality). The weight of hogs affects the value per 100 pounds because the heavier weights of wholesale cuts from the heavier carcasses normally sell at prices below those received for lighter weight cuts. The importance of dressing percentage (the percentage of the entire live animal which the carcass comprises) in accounting for live hog values is obvious. The type of carcass, including conformation, finish ,and quality, affects the value of live hogs because certain wholesale cuts and trimmings are more valuable than others. Some carcasses produce a larger proportion of the high-value cuts and trimmings of a satisfactory quality than others and yield a smaller proportion of the relatively low-value lard.

[52] Economic homogeneity could be maintained by simply expanding the allowable range of backfat thickness per grade until the value differences between grades were equal. This would involve having a larger number of grades for the lighter weight groups than the heavier weight groups. Physical homogeneity would, therefore, be sacrificed for economic homogeneity. Since the prices of the various carcass components are constantly fluctuating with respect to each other, however, the maintenance of economic homogeneity would require constantly changing physical specifications. Because such a changing standard would very likely prove to be unworkable, it would appear to be desirable to maintain physical homogeneity as the fundamental basis of carcass grade standards.

Grade Standard B (table 7) was developed to classify hog carcasses according to differences in their physical composition. It has been tested for its relative accuracy in classifying carcasses according to physical homogeneity. The purpose of the following paragraphs is to determine the relative pricing accuracy of the present live-weight method of marketing hogs, and a carcass weight and grade method when Grade Standard B is used as the basis for determining carcass values.

## DATA USED TO STUDY PRICING ACCURACY

The data required for this portion of the study were obtained at the Geo. A. Hormel & Co. plant, Austin, Minnesota, during a two-week period from September 29 to October 11, 1947. Information was obtained on 40 lots of 5 hogs each, or a total of 200 individual animals. In each case the 5 animals within the lot were separated by gate-cut from a truckload of hogs delivered from a farm located within a 20-mile radius of the plant. Test lots were selected from the first truckloads arriving at the plant during the day. In most cases only 5 lots of hogs were selected on any given day, but in all cases only one test lot was selected from any one farm.

Data collected on each lot included lot weight and live price paid. Individual animals were weighed separately and were tattooed to preserve the identity of the carcass. The hogs were killed on the day following purchase. Carcasses were permitted to chill overnight in the coolers and were weighed on the day following slaughter. Three backfat measurements, at the first and last ribs and at the last lumbar vertebrae, were recorded. Averages of these measures were recorded and the carcasses were graded according to the specifications established in Grade Standard B.

All of the hogs on which data were obtained were spring-farrowed butchers. Of the 40 lots, one weighed in the 180- to 200-pound weight group, 26 in the 200- to 220-pound weight group, and 13 in 220- to 240-pound weight group. The individual live hogs varied in weight from 165 pounds to 266 pounds. The individual carcass weight ranged from 111 to 184 pounds with an average weight for the 200 carcasses of 148.2 pounds. The distribution of individual carcasses classified by Grade Standard B included 16 in Grade 8, 55 in Grade 9, 102 in Grade 10, and 27 in Grade 11.

Prices used in this analysis for evaluating live animals were averages of prices which prevailed in the two-week period in which the data were collected. The top quotations varied from $27.60 to $28.85 and averaged $28.40 for the entire period. All weights from 200 to 270 pounds were quoted at the top price with consistent discounts of 50 cents from the top for 180- to 200-pound weights and 35 cents for 270- to 300-pound weights during this period. The average schedule of prices is shown below:

| Weight | Price |
|---|---|
| 180-200 pounds | $27.90 |
| 200-220 pounds | 28.40 |
| 220-240 pounds | 28.40 |
| 240-270 pounds | 28.40 |
| 270-300 pounds | 28.05 |

This schedule of prices was representative only for the cited two-week period and only at the particular geographical location where the hogs were purchased.

Average prices for wholesale cuts and trimmings for this period were computed from weekly price information contained in *The National Provisioner* and the U.S.D.A. *Livestock Market News* (table 26, Appendix G). During this period, discounts for heavy weight cuts were negligible except for the heaviest weight brackets. This relatively uniform pricing of cuts was reflected in the live hog market which accepted hogs from 200 to 270 pounds without discount for weight.

Because of the small variations in prices between weights, uniform prices of cuts were used in order to simplify the procedure of computing average values for the several carcass grades. This eliminated the need for calculating different average prices by weights for certain cuts and the distribution of weights of cuts for each of the carcass weight and grade groupings. The prices per 100 pounds of the various wholesale cuts and trimmings used in evaluating the different carcass grades were those indicated below:

| Wholesale Cut | Price per 100 pounds |
|---|---|
| Hams | $50.80 |
| Loins | 57.00 |
| Bellies | 53.90 |
| Picnics | 39.00 |
| Fatbacks and fat trimmings (80% lard) | 22.30 |
| Boston butts | 53.60 |
| Regular pork lean trimmings | 40.60 |
| Jowl butts | 29.80 |
| Spareribs | 47.00 |
| Neck bones | 18.50 |
| Front feet | 12.50 |
| Tails | 12.50 |

The method of computing carcass grade values from prices of wholesale cuts and trimmings has already been discussed (pages 34 to 43). The several percentages of the various cuts and trimmings at the midpoint of each weight and grade grouping were multiplied by their respective prices to obtain the value contribution of each component to the carcass as a whole. The sum of these calculations within each grade are the carcass values per 100 pounds for the respective grades.

Two additional steps were required to determine the carcass values which were applicable to this section of the study. The first involved arriving at the proper discount for Grade 11, the grade including carcasses that have a higher probability of yielding wholesale cuts of inferior quality. On the basis of previously described calculations which ignored the quality considerations, the computed price for Grade 11 carcasses was 70 cents higher than that for Grade 10 carcasses. Because of the lack of sufficient data regarding the number of discounted cuts to be expected from this grade, no precise determination of the proper discount was possible. For that reason an arbitrary discount of $1.00 below the computed price was applied. This is equivalent to a 30 cent discount below the value of Grade 10.[53]

The second step concerned the proper adjustment required to relate carcass values computed from Chicago wholesale price quotations to liveweight prices of hogs at Austin, Minnesota. An adjustment of 76 cuts per 100 pounds of carcass weight was required to equate carcass values with liveweight values as determined on the basis of the live prices paid at Austin.[54] The schedule of the resulting carcass prices which were finally used in making the comparison between live and carcass pricing is shown in table 15.

[53] It is believed that this discount is an understatement of the true differential in carcass values between the two grades. If, however, a larger discount had been applied, the advantage of carcass buying over liveweight buying would have been increased in the subsequent analysis. An understatement is to be preferred in this case in order to avoid the possibility of overstating the significance of the results.

[54] The arithmetic of this adjustment is as follows:

| | |
|---|---|
| Total sum paid to farmers for 200 hogs sold on the liveweight basis at Austin, Minnesota | $12,271.60 |
| Sum of approximate carcass values based on Chicago prices of wholesale cuts and trimmings | 12,497.25 |
| Difference | $ 225.65 |
| Divide by total carcass weight in hundredweights ($225.65÷296.62) | |
| Adjustment per 100 pounds required on all carcass prices | $ 0.76 |

The figure 76 cents represents the algebraic summation of (1) the transportation differential between the two locations; (2) the processing costs (including an allowance for profits; and (3) the by-product credits such as head, leaf fat, etc.

**Table 15. Hog Carcass Prices Used in Computing Carcass Values**

| Carcass weight group | Carcass Grades 8 | 9 | 10 | 11 |
|---|---|---|---|---|
| | (price per 100 pounds carcass weight) | | | |
| 110-140 pounds | $40.22 | $40.97 | $41.75 | $41.45 |
| 140-180 pounds | 40.22 | 41.05 | 41.75 | 41.45 |

On the basis of these data it was possible to measure the improvement in accuracy of pricing over live buying which can be accomplished by the carcass method of buying. The carcass value of each animal was determined on the basis of the carcass weight and grade. The carcass values of the animals within each lot were added to arrive at the carcass value for the entire lot of five animals. This lot carcass value was then divided by the total liveweight of the lot to arrive at the value per 100 pounds liveweight based on carcass price. Expressing the carcass value in liveweight terms enables the comparison of carcass value with the liveweight price paid for the lot.

## IMPROVEMENT IN PRICING ACCURACY

The first approach in measuring the accuracy of the liveweight method of marketing hogs would be to compare the liveweight price with the value, based on carcass prices for each lot. Live prices paid, live values based on carcass prices, and the difference between these two are shown in table 16 for each of the lots purchased in this study. In this table the live values per 100 pounds were computed on the basis of the carcass prices which would have been paid for the animals had they been sold on the carcass weight and grade basis. Lots overpriced by the liveweight method are shown as having positive differences. Lots underpriced by the live buying method are indicated by negative differences. The probable error of these differences was .3301. This means that on the basis of their computed values one-half of the lots of butcher hogs were worth 33 cents per 100 pounds liveweight or more above or below the price paid for them during the first half of October, 1947. Over 30 per cent of the lots were either underpriced or overpriced by 50 cents or more, 12.5 per cent by 75 cents or more, and over 4 per cent by $1.00 or more.

### Relative Pricing Accuracy

The foregoing analysis which measured the improvement in pricing accuracy of the carcass buying method over the live buying method has certain inherent limitations. It assumes that all of the carcasses within the same grade are worth exactly the same price, that there are no variations in value among carcasses of the same grade. As has been indicated earlier, this assumption is not valid. Because there are variations in the indices of lean at any given backfat thickness and carcass weight, and because each grade includes a range of backfat thicknesses and carcass weights, there must also be corresponding variations in value within carcass grades. Furthermore, since this approach assumes that the carcass method is completely accurate, it does not provide any clue as to the **relative** accuracy of the two methods of marketing hogs.

The most logical and comprehensive approach to the problem of measuring the relative pricing accuracy of the two methods of marketing butcher hogs would involve (1) weighing and pricing live hogs on foot, (2) weighing, grading (by Grade Standard B), and pricing the carcasses, and (3) cutting the carcasses and determining the value of the component cuts and trimmings. This cut-out value, the value of the cuts and trimmings, can be accepted as the true value of the hog. It can be

**Table 16. Comparison of Live Prices Paid and Live Values Based on Carcass Prices for 40 Lots of Butcher Hogs, October, 1947**

| Lot number | Price paid per 100 pounds liveweight | Live value based on carcass prices | Difference | Lot number | Price paid per 100 pounds liveweight | Live value based on carcass prices | Difference |
|---|---|---|---|---|---|---|---|
| 1 | $28.40 | $28.30 | $0.10 | 24 | $28.40 | $27.98 | $0.42 |
| 2 | 28.40 | 27.97 | .43 | 25 | 28.40 | 28.25 | .15 |
| 3 | 28.40 | 27.85 | .55 | 26 | 28.40 | 29.02 | —.62 |
| 4 | 28.40 | 28.94 | —.54 | 27 | 28.40 | 28.23 | .17 |
| 5 | 28.40 | 28.19 | .21 | 28 | 28.40 | 27.55 | .85 |
| 6 | 28.40 | 27.48 | .92 | 29 | 28.40 | 28.28 | .12 |
| 7 | 28.40 | 29.09 | —.69 | 30 | 28.40 | 28.58 | —.18 |
| 8 | 28.40 | 28.35 | .05 | 31 | 28.40 | 28.43 | —.03 |
| 9 | 28.40 | 28.33 | .07 | 32 | 28.40 | 28.33 | .07 |
| 10 | 28.40 | 27.88 | .52 | 33 | 28.40 | 29.73 | —1.33 |
| 11 | 28.40 | 27.55 | .85 | 34 | 28.40 | 28.76 | —.36 |
| 12 | 28.40 | 28.24 | .16 | 35 | 28.40 | 29.14 | —.74 |
| 13 | 28.40 | 28.82 | —.42 | 36 | 28.40 | 28.15 | .25 |
| 14 | 28.40 | 29.29 | —.89 | 37 | 28.40 | 28.75 | —.35 |
| 15 | 28.40 | 28.78 | —.38 | 38 | 28.40 | 28.41 | —.01 |
| 16 | 28.40 | 28.57 | —.17 | 39 | 28.40 | 28.09 | .31 |
| 17 | 28.40 | 28.16 | .24 | 40 | 28.40 | 28.95 | —.55 |
| 18 | 28.40 | 28.07 | .33 | | | | |
| 19 | 28.40 | 28.42 | —.02 | | | | |
| 20 | 28.40 | 27.83 | .57 | Standard deviation of differences ($\sigma$) = .4894 | | | |
| 21 | 28.40 | 28.51 | —.11 | | | | |
| 22 | 28.40 | 27.85 | .50 | Probable error = .3301 | | | |
| 23 | 27.90 | 28.08 | —.18 | (.6745$\sigma$) | | | |

used as the criterion against which the price paid on the liveweight basis and the price which would have been paid on the carcass weight basis can be compared for relative accuracy.

The analytical procedures used to measure the relative pricing accuracy would depend on a comparison of the variations of value at the several stages of the marketing process. The three value variations which are pertinent to this analysis are: (1) the total variation of individual animal values (based on cut-out value) about their average value ($V_T$), (2) the variation of values about live prices paid for lots ($V_L$), and (3) the variation of values about prices which would have been paid under the carcass grade and weight method ($V_C$).[55] The smaller the variation of values about prices paid under either method ($V_L$ or $V_C$), in relation to variation of individual values about their average ($V_T$), the greater is the accuracy of pricing.

The relative accuracy of the liveweight method could be measured by the amount of the reduction in the total variation accomplished by live buying; in other words, the difference between total variation of values (based on cut-out value) and the variation of values about live prices paid ($V_{T-L}$). Any improvement in pricing accuracy of the

[55] The measure of variation most useful for this type of analysis is the variance, the average of the squared deviations of value (deviations from average value of deviations from prices paid). This is because of the additive nature of variance in which the constituent portions of variability equal the total. In other words, the total variability can be broken down into certain constituent parts, each of which can be attributed to a different factor.
The variances with which this analysis is concerned are:
(1) $V_T$ = total variance of 200 individual live hog values (based on cut-out value) about their average value.
(2) $V_L$ = variance of 40 actual lot values (based on cut-out value) about liveweight prices paid.
(3) $V_C$ = variance of 40 actual lot values (based on cut-out value) about prices which would have been paid on the carcass basis. (This is the residual or remaining variance due to the variations in value within carcass grades.)

carcass method over the live method would be measured by the further reduction of value variations which could be accomplished by the carcass method, the difference between the variation of values about live prices paid and the variation of values about prices which would have been paid under the carcass method ($V_{L-C}$).[56] The remaining value variations would be the variations of value about the carcass prices ($V_C$). These are accounted for by the fact that not all of the carcasses within a given weight and grade group are worth the price assigned to that particular weight and grade group. Some variation in values about the grade price still remains.

Measuring relative accuracy of pricing by this method would involve breaking the total value variation into various parts. This would be done as follows:

| | | | | | | |
|---|---|---|---|---|---|---|
| Total variation of individual values | = | reduction in value variation accomplished by live buying | + | further reduction in value variation accomplished by carcass buying | + | remaining value variation about carcass prices (within grades) |

In terms of symbols the equation would be as follows:

$$V_T = V_{T-L} + V_{L-C} + V_C$$

This equation simply states that the total variation of individual live hog values (based on cut-out value) about the average is reduced by the present liveweight method of buying, would be further reduced by the carcass grade and weight method, and that some variation in values about carcass prices would remain after hogs had been settled for on the carcass basis.

The data collected for this portion of the study included the liveweight and price paid for each lot of hogs and the weight and grade of each carcass. Since the carcasses were not disassembled into wholesale cuts and trimmings, it was not possible to determine the variation of values within carcass grades nor the total variation of individual values from these data. It was possible, however, to estimate the variation of value about carcass prices (value variation within grades) on the basis of information obtained from the earlier study of 695 carcasses and thereby arrive at an estimate of the total variation of individual values. The method of estimating the variation of values within carcass grades and the method of building up the total variation of individual animal values are discussed in Appendix E.[57]

When the total variation of individual hog values was used as a base from which the relative accuracy of each method could be measured, the reductions in variation for each marketing method and the remaining value variations were as indicated below:

| | | Percentage of total variation of individual values (per cent) |
|---|---|---|
| $V_T$ | Total variation of individual animal values | 100.0 |
| $V_{T-L}$ | Reduction attributed to live buying | 45.0 |
| $V_{L-C}$ | Further reduction from live buying attributed to carcass buying | 37.9 |
| $V_C$ | Residual variation remaining after carcass buying (within grades) | 17.1 |

These figures supply the values for each of the elements in the basic equa-

[56] These reductions of variability are component portions of total variance as follows:
$V_{T-L}$ = reduction in total value variance accomplished by present live buying method ($V_T$-$V_L$ in terms of footnote 55, page 47).
$V_{L-C}$ = further reduction in value variance from live buying to carcass buying ($V_L$-$V_C$ in terms of footnote 55, page 47).

[57] For a discussion of factors affecting variations of value among hogs see Appendix F.

tion stated on page 48. They indicate that 45 per cent of the total variation of individual live animal values (based on cut-out value) was removed by the liveweight method of marketing alone. An additional 38 per cent, or a total of about 83 per cent, could be removed by the carcass weight and grade system. These two figures, 45 and 83 per cent, can be considered as measures of the relative pricing accuracy of the two marketing methods. The carcass method would leave about 17 per cent as the remaining variations which can be accounted for by the variations in value between different carcasses within each carcass grade.

Another method of expressing the possible improvement in pricing accuracy of the carcass method over the liveweight method may be based on the variation of values about the liveweight prices paid under the present system ($V_L$). When the value variation about live prices paid is used as the base, about 69 per cent of this variability of pricing errors or a little over two-thirds, can be removed by the adoption of a carcass method of marketing. This would leave about 31 per cent as the remaining variation of values within grades.

Another approach might be based on the extent of the errors of pricing (or inaccuracy of pricing) remaining after marketing under each of the two methods. Under the liveweight method 55 per cent of the total individual value variations remains after purchase in the form of a distribution of values above and below the prices paid. Under the carcass method, only 17 per cent of the total value variation would remain in a similar distribution about the carcass prices paid. This represents a substantial reduction in remaining pricing errors which can be attributed to the carcass weight and grade method of marketing hogs.

These several comparisons of pricing accuracy differ in the relative importance they attach to the improvement in pricing which appears to be inherent in the carcass method. Regardless of the particular comparison used, this study indicates that the carcass method would be substantially superior to the present liveweight method in paying farmers according to the value of product delivered. Some variation in value within grades would still remain under the carcass method, but this value variation would be much less than that around the liveweight prices paid under the present method. The value variations within grades could be completely removed only by cutting the carcasses from a single producer separately to arrive at the cut-out value of the entire lot. This would not be practicable, however, under usual packing house conditions in this country.

## SOME PROBABLE EFFECTS OF THE CARCASS METHOD OF MARKETING

One of the most important results that could be expected from the adoption of a carcass weight and grade method of marketing would be that farmers would be paid more nearly the true market value of the hogs they bring to the market place than under the present liveweight method. This does not necessarily mean that producers as a group would receive larger total returns for the hogs they market, although this might be true insofar as marketing efficiency is increased or the general quality of hogs is improved. Returns to producers, however, probably would be distributed differently. Farmers who market a superior product would be more likely to receive more, and farmers who market inferior animals would be more likely to receive less than under the present system.

The payment of market prices more closely related to the value of the hogs delivered will give producers a stronger incentive to improve the quality of the hogs they market. The only way that producers can interpret the demand for different grades of hogs is through the pricing mechanism. If approximately the same price is paid for all hogs of the same weight regardless of quality, farmers have little incentive to alter production methods and market the most desirable animals. On the other hand, if consumer preferences are fully reflected in prices paid for the product delivered, producers will tend to market the kind of product desired. To the extent that the carcass method of marketing more accurately reflects consumer preferences back to producers than the present liveweight method, farmers would have more incentive to produce desirable carcasses, an improvement in the general level of quality of market hogs would be encouraged, and the productive resources in agriculture would be more effectively allocated and utilized.

Sale on the basis of objective carcass standards would provide a more accurate language for price quotations. Alternative outlets could be more readily compared. Producers would have more information concerning the worth of their marketable product and would be placed in a stronger bargaining position. A qualitative improvement in the competitive pricing mechanism could be expected.

Sale on the carcass basis also would remove the incentive to fill animals excessively before they are sold. Under this method the amount of fill would not affect the weight of the carcass nor the overall returns for the lot, since prices paid would be based on the weight of the carcasses rather than on the weight of the live animals. Feed would be saved, marketing cost would be reduced, and net returns to hog producers would be increased.

The study of marketing is the study of the economics of distribution. The more important functions of any marketing system are (1) to provide a mechanism for the registering of prices which reflect and speedily transmit consumer preferences to the producer to enable him to allocate his productive resources most efficiently to meet these preferences, and (2) to move goods from the producer to the consumer as efficiently as possible. The possible contribution of a carcass method of marketing hogs must be evaluated ultimately by the manner in which it would facilitate the operation of both of these generalized functions.

## Problems Requiring Further Study

There are wide variations in the type, weight, and seasonality of marketing slaughter hogs in different parts of the United States. Consequently, additional research is needed in different parts of the country to verify or modify the findings reported in this study.

The basic relationships of the average backfat measure and carcass weight to the index of lean, on which the grade standards suggested in this study were constructed, should be thoroughly tested. Are there criteria of carcass merit other than the index of lean which will more effectively differentiate carcasses according to economic value? Are there other measures which may be used either singly or jointly with backfat and/or weight to measurably improve the physical classification of carcasses according to their index of lean or any other criterion of carcass merit? If so, can these alternative measures be used as the basis of objective specifications for a carcass grade standard which would be practical in actual use? What is the desirable range of physical differences which should be included within each grade?

Other questions requiring further investigation concern the desirable degree of finish, or the optimum magnitude of the index of lean, at which the Grade 10 of Grade Standard B (table 7) is centered and about which the other grades are oriented. What is the expected probability of discounted cuts of hams, loins, picnics and bellies at various points along the index of lean scale? What are the proper price discounts for cuts of inferior quality? At what precise point on the index of lean scale will the value-decreasing effect of additional discounted cuts, associated with a small increase in the index, just offset the value-increasing effect of the reduced yield of lard? What price discounts should be applied on the underfinished carcass grades at various price levels?

Further investigations are needed to determine the relative accuracy of the liveweight and carcass weight methods of marketing hogs. These studies should include the cutting of the carcasses to obtain information on the cut-out value of each individual hog and each lot of hogs. With this type of information the several variations of value can be determined more precisely than was possible in this study.

More fundamental research is required to supply information on several other questions which were not explored in this study. Is it practical to grade hog carcasses according to the specifications of the suggested standard, as they move by on the rail, under conditions prevailing in this country? What would be the best method of assessing losses from condemnations among farmers who deliver hogs to the market? What would be the relative accuracy of an improved liveweight method of marketing hogs in which buyers attempt to estimate carcass yield and carcass grade to arrive at the price to be paid? What would be the cost of marketing hogs by carcass weight and grade as compared with the liveweight method of marketing?

## SUMMARY

Slaughter hogs of the same class and within the same weight range usually sell at about the same price per hundredweight in the United States. Because little attention is given to quality in pricing hogs, producers have little incentive to improve the quality of the hogs they market.

Tentative standards have been issued by the United States Department of Agriculture for classes and grades of slaughter barrows and gilts and for pork carcasses and cuts and miscellaneous meats. No official standards have been promulgated, however, either for slaughter hogs or pork carcasses, as has been the case with slaughter cattle and calves and slaughter sheep and lambs and for the carcasses from such animals. The tentative specifications for slaughter hogs, pork carcasses, and cuts have had only a very limited acceptance. This may be because very few pork carcasses enter the wholesale trade as carcasses in this country. They are commonly disassembled into wholesale cuts before being merchandised. Furthermore, questions have been raised as to the effectiveness with which these specifications reflect cut-out values. In the absence of satisfactory live or carcass standards, hogs continue to be sold by liveweight with very little sorting other than for weight.

The objectives of this study were (1) to establish objective grade standards which can distribute carcasses into relatively homogeneous groups with respect to physical composition, (2) to establish methods of evaluating the several weights and grades of carcasses according to different price schedules for wholesale cuts and trimmings, and (3)

to measure the relative pricing accuracy of the live and carcass methods of marketing.

Data were obtained on 695 carcasses at the Geo. A. Hormel & Co. packing plant at Austin, Minnesota in 1946 and 1947. Several carcass measurements including average backfat thickness, length of body, length of ham, thickness through shoulders, thickness through hams, and belly pocket thickness, were recorded. After being measured, each carcass was subjected to a detailed cut-out test to determine the proportion of the various wholesale cuts and trimmings to the carcass as a whole.

Detailed statistical analyses were applied to these data to determine which measure or measures could best be used to estimate the percentage of high-value cuts (hams, loins, picnics, butts, and bellies) and lean trimmings in the carcass. The combined percentage of these high-value cuts and trimmings was called the "index of lean." Average backfat thickness proved to be the best single measure in explaining variations in the index of lean. Body length was second, and other measures were less important. At any specific carcass weight, the use of average backfat thickness and body length together gave little improvement over the use of backfat thickness alone. For that reason major emphasis in this study was placed on backfat thickness and carcass weight in the determination of objective specifications for the grade standards suggested for butcher hog carcasses.

On the basis of the fundamental relationships between the index of lean and average backfat thickness at varying carcass weights, a table was prepared showing the expected indices of lean for all weights of carcasses normally marketed and for all variations of backfat thicknesses at these carcass weights. Several suggested carcass grade standards were prepared by combining carcass weights and backfat thicknesses into weight and grade groups, each one of which has a specified range of carcass weights and backfat thicknesses.

In these standards Grade 10 was presumed to be the most desirable carcass grade, having the optimum index of lean. Carcasses in Grade 9 are more highly finished (have a lower index of lean) than those in Grade 10, and carcasses in Grade 8 are more highly finished than those in Grade 9. The more highly finished grades (with a low index of lean) are to be discounted because they yield more low-value lard and less of the high-value cuts such as the hams, loins, etc. Carcasses in Grades 11 and 12 have a higher index of lean than the optimum Grade 10 but lack adequate finish. They will yield a higher proportion of the high-value cuts than carcasses in Grade 10, but are to be discounted, nevertheless, because significant numbers of the hams, bellies, and loins these carcasses yield will be so lacking in quality that they cannot be sold as No. 1 cuts in the wholesale trade.

After developing analytical procedures to predict the combined percentage of hams, loins, picnics, butts, bellies, and lean trimmings the next step was to determine the individual percentages of each separate cut and kind of trimming. Each of the components of the hog carcass varies with the index of lean and each has its own price. Given the index of lean and a schedule of prices for the various wholesale cuts and trimmings, the value of the average carcass of each grade and weight group can be readily determined. The several percentage components of the carcass are simply multiplied by their respective prices and the sum of these value products will give the value of the carcass per 100 pounds regardless of its weight.

Carcasses within the overfinished grades (8 and 9) are discounted because they yield less of the high-value cuts and more of the low-value lard than those in Grade 10. Within each grade the heavier carcasses are discounted because the heavier cuts of hams, loins, picnics, and bellies that these carcasses yield usually sell at lower prices in the wholesale trade. Not enough data on the expected probability of cuts discounted due to inferior quality were available to determine the proper discounts for the underfinished Grades 11 and 12. Such carcasses are usually much less frequent than the overfinished kinds except when feed is extremely scarce and the ratio of hog-feed prices is decidedly unfavorable.

The economic significance of carcass standards depends upon the differences in carcass value between the several weight and grade groupings. These differences in turn will depend upon the expected average carcass composition within each of these groupings and the relations of the prices of the several wholesale cuts and trimmings to each other. In general, however, the greater the margin between lard prices and the prices of the high-value cuts, the greater will be the discounts for the overfinished grades. Similarly, the greater the discounts for heavier weights of certain wholesale cuts, such as hams, loins, picnics, and bellies, the greater will be the discounts for heavier weights of carcasses.

The most important factors which account for the variations in live hog values are (1) the variations in weights of wholesale cuts yielded from hogs of different weights, (2) the variations in dressing percentage or carcass yield, and (3) the variations of the relative proportion of high-value cuts and low-value lard yielded from hogs of different carcass type (conformation, finish, and quality).

The present liveweight marketing method gives little consideration to factors which contribute to value variations other than liveweight. The carcass method would go one step further and remove all value variations which are due to differences in dressing percentage. This is because sale would be based on the carcass weight rather than on the liveweight. By basing the price to be paid on the grade of the carcass, the carcass method would also minimize the value variations contributed by differences in carcass type.

In order to compare the relative pricing accuracy of the liveweight and the carcass weight and grade marketing methods, the reduction in the variability of liveweight value accomplished by each method of marketing was measured. Information for this analysis was obtained on 40 lots of hogs, 5 to a lot, or a total of 200 individual animals. The analysis was made during the first two weeks of October, 1947. The live hogs were priced on the basis of average prices for the respective weights for this two-week period. Carcasses were graded according to Grade Standard B (table 7). Carcass values for the different grades were computed on the basis of prices of wholesale cuts and trimmings. The average carcass value was adjusted to equate with the average live price paid, $28.39 per hundredweight, for the 200 individual animals.

It was found that 45 per cent of the total variation of individual values was removed by the liveweight method of marketing alone. An additional 38 per cent, or a total of 83 per cent, could be removed through the carcass weight and grade system. These two figures, 45 and 83 per cent, are measures of the relative accuracy of the two methods of grading and pricing hogs according to their actual value.

That would leave 17 per cent as a measure of the inaccuracy of pricing after selling hogs according to this carcass standard. This inaccuracy occurs because not all of the carcasses within the same grade have the same value per 100 pounds. This remaining 17 per cent inaccuracy could be completely removed only by cutting each carcass separately to arrive at individual cutout value, but this is impracticable under usual packing house conditions. Although some variation in values within grades would remain after carcass selling, it would be much less than the variation in values around the prices paid for hogs under the present liveweight method.

Other gains in marketing effectiveness may be associated with the sale of hogs on the carcass basis. Excessive filling prior to sale would be greatly reduced. A more accurate language for price quotations would be provided. Producers would then have more information concerning the worth of their marketable product and would be placed in a stronger competitive position. Farmers would also have greater economic incentive to improve the quality of the hogs they market, and resources on farms would be utilized more effectively.

Additional studies are needed to verify or modify these tentative findings. The practicability of marketing hogs by carcass weight and grade under conditions which prevail in this country also needs to be thoroughly explored.

# APPENDIX A
## Methods of Measuring Hog Carcasses

(All measurements in millimeters)

**Length of body**

Measured from the junction of the last cervical and first thoracic vartabra to the lowest point (as the carcass hangs) of the aitchbone.

**Thickness of backfat**

(All backfat measurements to include skin.)

Over first rib—At the junction of the last cervical and first thoracic vertebra.

Over last rib—At the junction of the seventh and eighth vertebrae below the last lumbar (include the last lumbar vertebra in the count).

Over last lumbar—At the center of the last lumbar vertebra.

**Thickness of belly pocket**

The thinnest portion of the belly opposite the junction of the second and third vertebrae counting down from the pelvic arch. To be measured with a skewer.

**Length of Ham**

Measured from lowest point of aitchbone to inside of hock joint on the center of the bony projection which may be felt beneath the skin just above (as the carcass hangs) the center of the hock joint itself.

**Width through ham**

Width from top point of aitchbone to the outside of ham on a line parallel to the floor. This measurement is the length of a line perpendicular to the sagittal plane bisecting the carcass. To be measured from the rear of the carcass with calipers. Sum of both measurements is recorded.

**Width through shoulders**

Width from center of first thoracic vertebra to outside of shoulder on a line parallel to the floor. This measurement is the length of a line perpendicular to the sagittal plane bisecting the carcass. To be measured from the rear of the carcass with calipers. Sum of both measurements is recorded.

# APPENDIX B

## Procedure for Cutting Pork Carcasses[58]

1. Separate front from middle through the upper end of the junction of the third and fourth thoracic vertebrae and on a line which is perpendicular to the skin surface along the backfat at this point. This cut will leave a very small portion of the third thoracic vertebra on the middle.

2. Separate ham from middle at a point approximately ¾ the distance from the end of the aitchbone to the rise in the pelvic arch and on a line which is perpendicular to the hind leg.

3. Cutting the front.

a. Before lifting the neck ribs and bones, score along the under side of the neck bones to mark the separation of the Boston butt and picnic.

b. Lift the neck ribs, leaving as little lean attached to them as possible. Neck bones are trimmed and the trimmings are weighed as lean trimmings.

c. Separate Boston butt and clear plate from picnic and jowl through the mark referred to in 3a and at an angle roughly parallel with the cut surface of the breast flap. This cut results in a rather wedge-shaped butt (wider on the loin end) and should cut through the scapula (shoulder blade) at its smallest point.

d. Remove clear plate from butt in such manner that the lean can definitely be seen showing through the fat on the front third of the butt. Two or three small scores in this area are ordinarily desired. The rear two-thirds of the butt should be almost entirely covered with fat which may range up to about ¾-inch thick in the center of this area but should taper off to about ¼-⅛-inch thick at the edges. The front end of the butt is not trimmed. The clear plate and all fat trimmings from the butt are weighed as fat trimmings.

e. The picnic is trimmed by removing the breast flap and other loose muscles from the inside of the cut. Separate the jowl from the picnic along a line which barely leaves all of the shoulder muscles intact. Fat surface around the outside is beveled at about a 45 degree angle. The front foot is removed just above the knee joint at a point which does not expose the marrow of the leg bones. Front feet are weighed and recorded. Fat and lean trimmings are separated and weighed as such.

f. The jowl is trimmed as a "dry salt" jowl—the rough edges merely trimmed off and any lean removed and weighed as lean trimmings.

4. Cutting the ham.

a. Regular ham:—Remove tail and surplus tail fat by making a smoothly beveled cut. Remove flank. Remove shank just above the center of the hock joint. This cut normally leaves the marrow of the shank just barely exposed. Weights of trimmed tail and hind feet should be recorded.

b. Skinned ham:—Skin ham by leaving approximately ½-inch of fat over the skinned surface. The collar should be 40 per cent of the length of the ham. Weigh fat trimmed from ham as fat trimmings.

5. Cutting the middle.

a. Loin:—Remove loin by scribing along a line which extends from the lower side of the tenderloin muscle on the rear end to a point just slightly farther down the rib than a point which is perpendicular from the lower edge

[58] Prepared by C. E. Murphey, Standardization and Grading Division, Livestock Branch, Production and Marketing Administration, U.S.D.A. This method of cutting pork carcasses is a record of the procedure followed at one large packing plant in Minnesota. It has not been approved for industry-wide use by the U.S.D.A. nor does it represent an accepted industry-wide type of cutting.

of the split thoracic vertebra as the middle lies normally on a flat surface. Pull the loin with a loin puller leaving the loin rather fat and necessitating further trim. The outside muscle over the front end of the loin should barely be scored for a distance of some 4-5 ribs back, and the rear end of the loin should also be scored along the lower edge for a short distance. The center of the loin should be covered with an average of about ⅜-inch of fat. Scoring in this area should be avoided. Fat trimming from the loin should be weighed as fatback. Lean trimming from the fatback or loin should be weighed as lean trimming. The hanging tenderloin and any leaf fat which may be adhering to the loin are removed and weighed as lean trimmings and fat trimmings.

b. Spareribs are lifted from belly, leaving as little lean on them as possible. All cartilages are left in belly.

c. The fatback should be separated on a straight line which passes through the scribe line at about the center of the upper side of the belly. This cut has all lean removed and includes any fat which may have been removed in trimming the loin.

d. The belly is trimmed as a "barrow belly" by merely trimming the rear end on a line through the forward point of the "boot jack" and at an angle which makes the flank side slightly longer than the back side. The bottom side is trimmed by merely removing enough to square this side. Bellies which show mammary development or seediness should also be trimmed in this fashion. The shoulder end of the belly should merely be trimmed square.

6. Separation of fat from lean trimmings. Excess fat should be removed from lean trimmings until the composition of lean trimmings is 50 per cent trimmable fat and 50 per cent lean.

# APPENDIX C

## Distribution of Carcasses

The distribution, by carcass weight and index of lean, of the 695 hog carcasses used in this study is shown in table 17. The mean index was 70.23 and the standard deviation about this mean was 3.3172. The indices at the extremes of the range were 60.6 and 79.0, making a total range of 18.4 points on the index of lean scale. The distribution of the entire sample by index of lean is shown in figure 10. It will be observed that this distribution quite obviously departs from the normal. The bulge to the right of the peak of the distribution, specifically from 72.0 to 76.0, probably can be explained by the assiduous efforts which were made to obtain adequate numbers of underfinished carcasses in the upper and middle weight groups.

Even if the sample had been purely random, it would not necessarily have been a representative sample of the entire universe of hog carcasses. The bulk of the carcasses, 570 to be exact, were selected during a 4-week period in August and September, 1946. Moreover, all of these carcasses were selected at only one packing plant having a trade area which comprises a relatively small part of the entire corn belt. For these reasons, no attempt should be made to specify the description of the universe of indices of lean with the two statistics at hand, the mean and the standard deviation.

For this study, the failure of the sample to be representative of the universe was not a limiting factor in the analysis. For the correlation analyses,

**Table 17. Distribution of 695 Butcher Hog Carcasses According to Index of Lean by Specified Weight Groups**

| Weight group | Average carcass weight, pounds | Index of Lean | | | | | | | | | | | | | | | | | | | | Average index of lean | Number of carcasses |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 60.0-60.9 | 61.0-61.9 | 62.0-62.9 | 63.0-63.9 | 64.0-64.9 | 65.0-65.9 | 66.0-66.9 | 67.0-67.9 | 68.0-68.9 | 69.0-69.9 | 70.0-70.9 | 71.0-71.9 | 72.0-72.9 | 73.0-73.9 | 74.0-74.9 | 75.0-75.9 | 76.0-76.9 | 77.0-77.9 | 78.0-78.9 | 79.0-79.9 | | |
| I | 120.7 | ...... | ...... | ...... | ...... | 3 | ...... | 3 | 3 | 6 | 10 | 7 | 8 | 8 | 12 | 4 | 10 | 1 | 3 | ...... | 1 | 71.7 | 79 |
| II | 129.5 | ...... | ...... | ...... | 1 | 2 | ...... | 2 | 6 | 6 | 13 | 12 | 6 | 13 | 8 | 5 | 5 | 4 | 1 | 1 | ...... | 71.3 | 85 |
| III | 139.4 | ...... | ...... | 1 | 1 | 2 | 4 | 3 | 9 | 6 | 5 | 7 | 6 | 11 | 8 | 7 | 3 | 2 | ...... | ...... | ...... | 70.5 | 75 |
| IV | 150.2 | ...... | ...... | 1 | 1 | ...... | 6 | 4 | 3 | 10 | 11 | 8 | 7 | 6 | 10 | 4 | 1 | 1 | 1 | 1 | ...... | 70.3 | 75 |
| V | 159.8 | ...... | ...... | ...... | 1 | 4 | 7 | 6 | 7 | 10 | 16 | 10 | 6 | 7 | 6 | 10 | 1 | 4 | ...... | ...... | ...... | 70.0 | 95 |
| VI | 170.6 | ...... | 1 | 1 | 2 | 4 | 7 | 3 | 2 | 9 | 10 | 9 | 12 | 8 | 5 | 3 | 2 | 3 | 1 | ...... | ...... | 69.9 | 82 |
| VII | 179.3 | 1 | ...... | ...... | 2 | 1 | 8 | 3 | 8 | 9 | 6 | 12 | 5 | 7 | 4 | 3 | 2 | 1 | ...... | ...... | ...... | 69.5 | 72 |
| VIII | 189.4 | ...... | ...... | ...... | 1 | 1 | ...... | 3 | 2 | 4 | 9 | 6 | 7 | 9 | 5 | 3 | ...... | ...... | ...... | ...... | ...... | 70.5 | 50 |
| IX | 199.1 | ...... | ...... | 1 | 2 | 1 | 3 | 4 | 4 | 10 | 4 | 5 | 5 | 2 | 2 | 1 | 1 | ...... | ...... | ...... | ...... | 68.9 | 45 |
| X | 214.6 | ...... | 1 | 2 | 3 | 1 | 3 | 6 | 5 | 3 | 4 | 1 | 3 | 2 | 2 | 1 | ...... | ...... | ...... | ...... | | 67.8 | 37 |
| Total | | 1 | 2 | 6 | 14 | 19 | 38 | 37 | 49 | 73 | 88 | 77 | 65 | 73 | 62 | 41 | 25 | 16 | 6 | 2 | 1 | 70.2 | 695 |

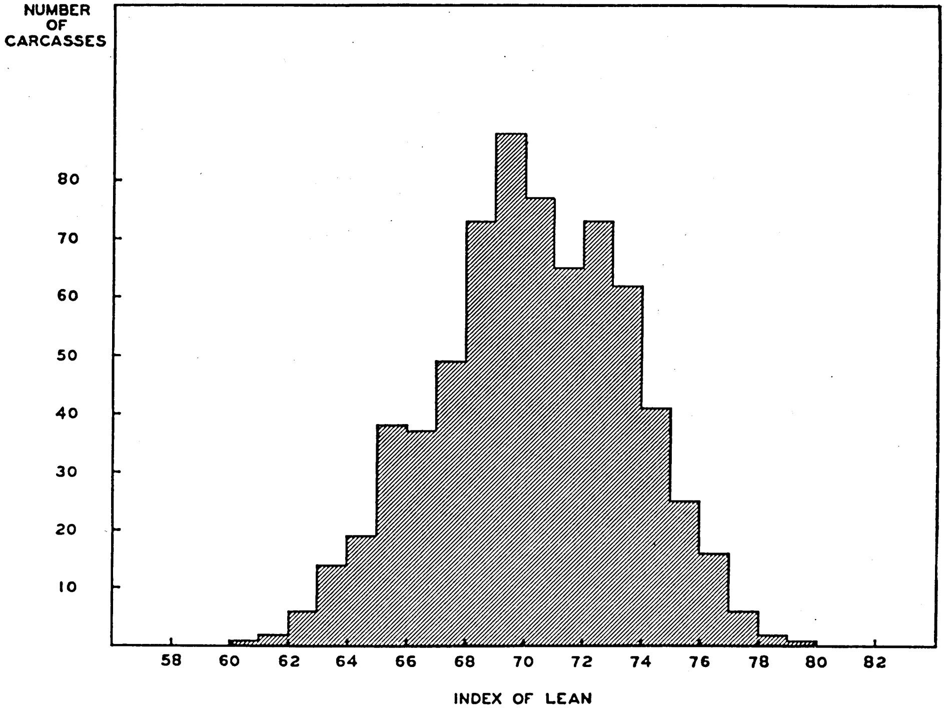


FIG. 10. Distribution of 695 butcher hog carcasses according to index of lean.

the widest scatter of the indices of lean it was possible to obtain within each weight group was to be preferred to a representative selection of carcasses. In evaluating the relative accuracy with which carcasses can be classified into homogeneous groups by different grade standards, a curve such as this distribution, in which the peak is flatter and the tails are higher than would be characteristic of a normal curve, is to be preferred to a normal distribution.

# APPENDIX D
## Some Limitations to the Precise Determination of Carcass Value

Unfortunately, the process of arriving at carcass values by grade and weight groups is not as straightforward as it may appear from the previous discussion. Certain assumptions were made at various steps in the analysis and results based on these assumptions must be considered as approximate, even though they may not be seriously in error.

The first of these limitations concerns the use of the midvalue of the indicated indices of lean within a grade, instead of the actual mean of such indices, for purposes of evaluating the carcass grade. The data used in this study, however, were taken at only one plant and mostly during one season of the year. It is not believed that any representation of the entire population can be made from the means determined within this sample. The distribution of the universe is subject to both geographical and seasonal biases. The procedures used in this study should, therefore, be regarded as demonstrations of technique, rather than as final, conclusive analyses. Under the operation of a carcass buying and grading system within any given plant, the average index of lean by weight and grade groupings and at different seasons of the year should not be difficult to determine.

The use of the midvalue of carcass weight for each weight group as the basis of pricing certain of the wholesale cuts is subject to the same limitations. The actual distribution of weights within a grade and weight grouping is probably skewed in different directions during different seasons of the year. Again the determination of the distribution and the means should not be difficult under the operation of a carcass buying system. Such distributions are now regularly being determined by most packing plants on the basis of liveweight classifications.

Another limitation to the building up of carcass values from the component cuts and trimmings concerns the representativeness of the distribution of the wholesale cuts and trimmings according to the index of lean (table 12). Since there is no standard cutting procedure within the industry, there are probably as many cutting procedures as there are slaughterers who process hog carcasses. In addition to the variation between plants, there are also variations at different times within the same plant.

As price relationships between adjacent cuts are altered, the line of demarcation between the cuts may be changed. Within certain limits the separations between hams and loins, loins and butts, butts and picnics can be adjusted to add more weight to one cut at the expense of the other if the changing price relationships between cuts warrant such alterations. The relative distribution of such cuts in this study is, therefore, only representative of one plant at one particular time. Although this distribution cannot be expected to enable a precise determination of carcass value, nevertheless, it is believed to be adequate for determining differences in value, differences between grades, and differences between weights, with any given schedule of prices and within the range of cutting variations currently present in the packing industry.

The practice of altering the points of separation between cuts to take advantage of changing price relationships will probably widen the margin between grades beyond that shown in this analysis. This is expected because it would enhance the average price of the four lean cuts taken collectively, the aggregate value of the lean cuts, and would, therefore, make differences in the aggregate percentage of these cuts more important from the standpoint of value. To the extent that cutting procedures are varied from time to time, the price differences between grades are probably understated in this analysis.

Arriving at the appropriate carcass prices for Grades 11 and 12 poses certain problems. These are problems of determining the probable frequency with which discounted cuts are yielded from carcasses within these underfinished grades and of arriving at a proper price discount for the cuts discounted for quality. Little is known of the probable frequency of such cuts. Furthermore, little information is available to the researcher regarding the proper price discount for No. 2 grade wholesale cuts. Regular price information on discounted cuts has not been available since May, 1940, and at that time such quotations were restricted to cured cuts.[59] It is apparent that smaller numbers of discounted cuts have been moved into the wholesale trade in recent years. Most of these items are now being utilized by processing into prepared products such as luncheon meats, boned and canned hams, etc., but packers do have a discount which they impute to such cuts of inferior grades.

Further discounts for Grades 8 and 9, beyond those indicated by this increased yield of lard and fat, will probably be necessary because of the greater probability that bellies will be discounted for excessive fat within these grades. Some of the lean cuts in these carcass grades, particularly the hams and loins, also probably should be discounted because of the excess fat distributed within the cuts. A considerable frequency of such cuts can be expected within Grade 8, particularly in the heavier weight groups.

These limitations have been primarily concerned with the problem of pricing carcasses of different grades. They are problems which confront the researcher because of certain gaps in desired information. They do not necessarily limit the effectiveness of a grading system, nor the practical operation of a carcass buying method. Information needed to value carcasses more precisely is either already available to packers or could be obtained with little added effort.

# APPENDIX E
## Calculation of Value Variances in Measuring Pricing Accuracy

**The Problem**

The analytical procedures used to determine the relative pricing accuracy of the two marketing methods depended primarily upon a comparison of the variances of value at the several stages of the marketing process. The three value variances pertinent to this analysis are (1) the variance of individual animal values about their mean ($V_T$), (2) the variance of live values about live prices paid for lots ($V_L$), and (3) the variance of values about prices which would have been paid under the carcass weight and grade method ($V_C$). The relative accuracy of the liveweight method would be measured by the difference between the total individual value variance and the value variance about live prices paid ($V_{T-L}$). Any improvement in pricing accuracy of the carcass method over the live method would be measured by the difference between the variation of values about live prices paid and the variation of values about prices which would have been paid on the carcass basis. Thus, total variance could be broken down into its component parts, the reduction in value variance accomplished by live buying, the further reduction in value variance accomplished by carcass buying, and the residual variance of values remaining about the carcass prices (due to variations in value within carcass grades). In symbolic terms the equation would be:

$$V_T = V_{T-L} + V_{L-C} + V_C$$

If detailed cut-out information had been obtained on each of the 200 hogs included in this portion of the study, the actual value of each hog per 100 pounds liveweight could have been determined precisely and the several var-

[59] Prior to May, 1940, quotations by grade of cured cuts of hams and bacons were available in *Livestock, Meats, and Wool Market Statistics*, weekly mimeographed market news publication of the United States Department of Agriculture.

iances of value could have been readily calculated. In the collection of data, however, information was obtained only as far as the carcass rail, and detailed cut-out data were not obtained. Nevertheless, it was possible to approximate the distribution of values and then to estimate the extent of the error from this approximation. Because of the additive nature of the constituent portions of total variance, the total variance of individual values about their mean could be estimated by adding the variances of the two component elements.

### The Variance of Computed Values—A First Approximation

Lacking the detailed cut-out information, the closest approximation of the distribution of values would appear to be the variance of computed carcass values per 100 pounds liveweight. Each of the 200 carcasses was graded, and each of the grade and weight groups has its own price. Total carcass values were converted to liveweight values per 100 pounds. Of the 200 individual hogs, the mean liveweight value based on carcass prices was $28.39. The extreme values ranged from a low of $26.39 to a high of $30.23, a range of $3.84 per hundredweight. The standard deviation about the mean value was 0.723649, and the variance (the standard deviation squared) was 0.523668.

This variance of the computed values is not an adequate approximation of total value variance. This is because it inherently assumes that the price attached to each grade designation represents an accurate statement of the values of all carcasses within the grade. In other words, it ignores the variation in value among carcasses within the same grade. The next step in the analysis, therefore, was to estimate the variation of carcass values within carcass grades and to convert this variation to liveweight terms.

### The Variance About Computed Values—Within Grades

The earlier analysis of 695 carcasses provided information on which the expected physical variation within grades can be predicted. The standard deviation of indices of lean within grades was 1.8439. This standard deviation, expressed in terms of the index of lean, must be converted to value terms. On the basis of the prices of component cuts and trimmings used in this study, the average changes in carcass value associated with a one point change in the index of lean was 26.0 cents. The standard deviation of carcass value variations within grades contributed by the variability of the index of lean is now readily computed to be $0.4794 (1.8439 × $0.26).

The figure $0.4794 is a measure of the value variability within grades expressed on the carcass weight basis. The problem now is to convert this figure to a liveweight and value expression. This task is complicated somewhat by the fact that hogs vary considerably in their carcass yields. At a 65 per cent yield the standard deviation of value within grades would be $0.3116 ($0.4794 × 65) on the liveweight basis; at 70 per cent it would be $0.3356 ($0.4794 ×70), etc. The 200 hogs in the sample varied from 64 to 73 per cent in carcass yield.

The most appropriate method of arriving at value variability on the liveweight basis was to convert the standard deviation to liveweight terms at each of the yields from 64 to 73 and to compute the liveweight variance at each of the yields. Each of the variances was weighted by the number of hogs yielding the respective figures. The sum of the weighted variances ($\Sigma N\sigma^2$) divided by the number of animals (200) gives the variance of actual values about the computed value (liveweight value computed on the basis of carcass price) expressed in liveweight and value terms. Calculated in this manner, the variance of liveweight values about the computed values was 0.10826076. Extracting the square root gave $0.3290 as the standard deviation of values about the computed values.

Following the evaluation process through on one animal may clarify the meaning of this standard deviation of $0.3290. One of the 200 hogs processed in this study weighed 225 pounds alive and when slaughtered produced a carcass weighing 153 pounds, thus yielding 68 per cent. This particular carcass was classified as a Grade 10, worth $41.75 per 100 pounds of carcass hanging on the rail. The computed value of this hog on the liveweight basis was, therefore, $28.39 ($41.75 × 68.0 per cent) This value of $28.39 is only an approximate value, however. Although all of the carcasses grading No. 10 were priced at $41.75, a considerable dispersion of values around this grade price can be expected. This dispersion was converted to liveweight terms in the standard deviation of $0.3290. The value of this hog was not necessarily $28.39, but approximately two-thirds of the hogs of a similar description would have actual values within a range of 32.9 cents either above or below $28.39. The standard deviation and the variances that have been calculated are, therefore, measures of the dispersion of actual values about the computed values of live hogs, liveweight values computed on the basis of carcass prices for the different grades and weights.

## Total Variance of Individual Values

The two constituent portions of total value variance, the variance **of** the computed values and the variance **about** the computed values have now been determined. The relationship between the two is somewhat similar to the relationship between the variance of computed regression values and the variance about the regression line in the conventional bi-variate regression analyses. The two variances added together make up the total variance about the mean. The computed carcass values in our analysis are analogous to the predicted values which define the position of the regression line itself. The dispersion about these computed values comprises the errors of prediction, and hence is comparable to the standard error of estimate about the regression line. The additive nature of constituent variances enables the calculation of total variance and the standard deviation of actual values about the mean. This is done as shown below:

| | Standard deviation ($\sigma$) | Variance ($\sigma^2$) |
|---|---|---|
| Dispersion of computed values (On the basis of carcass weight and grade) | .7236 | .523668 |
| Dispersion about computed values (Due to variability within carcass grades) | .3290 | .108261 |
| Total dispersion of actual values of individual hogs | .7949 | .631929 |

The total variance of actual values of individual hogs about their mean value is, therefore, computed to be .631929. This is the value for $V_T$ in the variance equation. It will be noted that the standard deviation about the mean value of $28.39 was increased from 72.4 cents to 79.5 cents when the effect of value variations within grades was given due consideration.

## Successive Reductions of Total Variance

With total variance of values as a reference point, the logical approach to analyzing the relative accuracy of the various methods would be to determine the extent of the reduction in total variance accomplished by live buying and the further reduction accomplished by carcass buying. Remaining variance about prices which would have been paid under the carcass method is due to physical variation within grades.

**Table 18. Reduction in Value Variance by Live and Carcass Marketing Methods, 40 Lots of 5 Hogs Each**

| | Variances | | | | | | |
|---|---|---|---|---|---|---|---|
| | Total of individual animals ($V_T$) | | Reduction attributed to live buying ($V_{T-L}$) | Of computed carcass values | Reduction from live buying to carcass buying ($V_{L-C}$) | | About computed values (within grades) ($V_C$) |
| Total variance calculated | .631929 | = | | .523668 | | + | .108261 |
| Total variance distributed | .631929 | = | .284188 | + | .239480 | + | .108261 |
| Percentage distribution | 100.0 | = | 45.0 | + | 37.9 | + | 17.1 |

This more direct approach to the problem of determining the successive reduction in variance was also precluded by the failure to obtain detailed cut-out data on the 200 carcasses. Nevertheless, the problem may be approached by starting with the residual variances, working through the successive alterations in variance accomplished by the several buying methods to the total variance, exactly in reverse of the more logical order.

The residual variance, the variance **about** the computed values, is .108261. This is the variance due to the variation within carcass grades and is the variance about prices which would have been paid under the carcass method, the $V_C$ of the basic variance equation. This leaves the two reductions in variance, $V_{T-L}$ and $V_{L-C}$, as the missing elements in the equation. The variance of the computed values, which equals .523668, is now the remaining variance. It comprises the entire reduction in variance from the total value variance to the value variance about carcass prices, and, therefore, includes both $V_{T-L}$ and $V_{L-C}$ in the variance equation.

The improvement in accuracy of carcass buying over liveweight buying was measured as explained on page 61. The standard deviation of the differences between live price paid and liveweight value based on carcass prices for the 40 lots of hogs was $0.4894. This is a measure of the portion of the error in liveweight pricing that could be removed by the adoption of the carcass method. The variance of this error, .239480, therefore, comprises the reduction in variance from live buying to carcass buying, the $V_{L-C}$ in our basic variance equation. Since the variance of the computed values, .523668, is equivalent to $V_{T-L}$ and $V_{L-C}$ combined, the reduction in variance accomplished by live buying alone, $V_{T-L}$, must be the difference between these two, or, .284188, since it is the other component element of the variance of computed values.

This completes the calculation of the various members of the basic variance equation. The several relationships of the constituent elements of variance to the total have been schematically arranged (table 18).

The first line of this table is a recapitulation of the method by which total variance was determined. The second line breaks down total variance into terms appropriate for the purpose of our analysis. This table does not show the variance of values about liveweight prices paid ($V_L$). This variance is obtained by subtraction as follows:

$$V_T - V_{T-L} = V_L$$
$$.631929 - .284188 = .347741$$

The standard deviation calculated from this variance would be .5897. This would be an estimate of the variation of actual cut-out values about prices paid on the liveweight basis.

# APPENDIX F

## Factors Contributing to Variation of Live Hog Values

It has been stated that hogs differ in value because of variations in weight, carcass yield, and carcass type (see page 43). The question logically arises as to the relative importance of these factors in their individual or joint contributions to the total variation of live hog values.

At the time the data on live hogs were obtained for purposes of comparing the relative accuracy of the live and carcass methods, price discounts for weight, both on wholesale cuts and on live hogs, were probably at a minimum. None of the 40 lots of hogs included in this part of the study were discounted in price for excessive weight. Since discounts for the heavier weights of wholesale cuts were negligible, they were ignored in arriving at prices for the various carcass grades. For that reason these data were not considered to be suitable for analyzing the relative importance of the weight factor in contributing to the total value variability.

An attempt was made, however, to measure the relative importance of the yield factor and the carcass type factor, to the extent that variations in type are accounted for by differences in carcass grade. For each difference between lot value and the average value for all lots, the portion due to differences in yield and the portion due to differences in grade were determined.

The portion of the value deviation from the average attributed to a yield difference was determined by weighting the yield deviation from average yield by the average carcass value for the particular lot (since lots usually included two, sometimes three, and in one case four different carcass grades). The portion of the value deviation attributed to differences in carcass grade from one lot to another was determined by weighting the deviation of the average carcass price for the lot (since average carcass price is determined by the grades of the carcasses in the lot) from the average carcass price for all lots by the average yield for all lots. For each lot the relation is additive; that is, the portion of value deviation due to yield difference plus the portion of value deviation due to grade difference is equal to the total value deviation.

The standard deviations of these separate variations for the 40 lots of hogs were as follows:

Total lot value .......................... $\sigma_t = .4928$[60]
Due to yield differences $\sigma_y = .5508$
Due to grade differences $\sigma_g = .1778$

With no correlation between the yield and grade factors, the variance of each (the standard deviation squared) added together would be equal to the variance of the total. When correlation is present, however, an interaction factor must be added to the equation, in order to express completely the relationship. The expression would be as follows:

Total lot value variance = value variance due to yield + value variance due to grade + interaction

the symbolic expression is:

$$\sigma_t^2 = \sigma_y^2 + \sigma_g^2 + 2r_{yg}\sigma_y\sigma_g$$

[60] As used here, the total variation of lot values, which has been given the symbol $\sigma_t$, is not comparable either to the variance of individual values ($V_T$) or to the variance of lot values about liveweight prices paid ($V_L$) discussed on pages 47 to 49. It is a variation of lot values, not of individual values, but it is a variation about the mean lot value, rather than about liveweight prices paid. Furthermore, it differs from both of these expressions in that the variation within grades is not included.

If the correlation between the two component variances is positive, the effect of the addition of an interaction factor is to enlarge the total value variance beyond that which would be expected from a simple summation of the two component variances. If the positive correlation were complete ($r = +1.0$), the total variance would be exactly twice that of the sum of the two components. This would be the case if every value deviation due to a yield difference were matched by an equal value deviation due to a grade difference.

Conversely, if the correlation is negative, the effect of the inclusion of the interaction factor is to reduce the total value variance below what would be expected from a simple summation of the two component variances. If the negative correlation were complete ($r = -1.0$), the total variance would be reduced to zero. Such would be the case if every value deviation due to a yield difference were matched by an opposite value deviation of equal magnitude due to a grade difference.

The carcass yield of hogs is positively related to degree of finish. In this study relative finish, as specified by backfat thickness and carcass weight, was the primary determinant of carcass grade. Because more carcasses were discounted for overfinish than for underfinish, however, the contribution of carcass yield to the total variability of lot values can be expected to be negatively correlated with the contribution of carcass grade. And because the correlation is negative, the interaction factor will take on a negative sign.

The relative influence of carcass yield, carcass grade, and the interaction factor on the value variance for the 40 lots of hogs is shown as follows:

| Total lot value variance | | value variance due to yield | | value variance due to grade | | interaction |
|---|---|---|---|---|---|---|
| .2429 | = | .3033 | + | .0316 | − | .0920 |

Several tendencies are apparent in these data. The first of these is the predominant influence of yield variations in contributing to lot value variations. On the basis of this test and these price relationships, differences in yield appear to be more than nine times as important as differences in carcass grade in their influence on value variations. Because price differentials between grades are not constant but are constantly changing as the price relationships between the several wholesale cuts and lard are altered, these results should be interpreted with considerable caution. At the time this study was made, the price of lard was about 55 per cent of the price of hams. Grade variations would have been more important if prices for the last week in February, 1949, when lard prices were about 27 per cent of the price of 12- to 16-pound hams, had been used as the basis of comparison. Nevertheless, it is apparent that yield differences are considerably more important than grade differences in contributing to the variation of values of hogs sold in lots.

Another important tendency indicated in these data is the presence of a negative association of grade and yield and the resultant negative interaction factor. The correlation between the value difference due to yield and the value difference due to grade was −.47. Hogs which have overfinished carcasses tend to have a higher dressing percentage or carcass yield. The value-decreasing effect of one factor tends to be partially offset by the value-increasing effect of the other. Hogs that produce overfinished carcasses are generally worth less per pound alive than those with somewhat less finish, even though they tend to have higher yields.

In order to improve the accuracy of the present live buying method, it would be necessary for buyers to estimate the carcass yield as well as the carcass grade in arriving at the price to be paid. Whether or not any improvement in pricing accuracy over the present method could be effected, or how closely the pricing accuracy of the carcass grade and weight method could be approached, depends on how accurately buyers would be able to estimate the carcass grade and yield on live hogs.

# APPENDIX G

**Table 19. Correlation Coefficients of Average Backfat Thickness to Four Criteria of Carcass Merit, by Weight Groups**

| | | Correlation Coefficient of Average Backfat to: | | | |
|---|---|---|---|---|---|
| Group number | Carcass weight, pounds | Percentage of four lean cuts | Percentage of four lean cuts plus lean trimmings | Percentage of four lean cuts plus lean trimmings and bellies | Percentage of four lean cuts plus bellies |
| I | Under 125 | —.8901 | —.9076 | —.8797 | —.7399 |
| II | 125-135 | —.7773 | —.7925 | —.8036 | —.7155 |
| III | 135-145 | —.9254 | —.9116 | —.8940 | —.9147 |
| IV | 145-155 | —.9038 | —.8694 | —.9083 | —.8825 |
| V | 155-165 | —.8850 | —.8941 | —.8613 | —.7536 |
| VI | 165-175 | —.8956 | —.8767 | —.8934 | —.6667 |
| VII | 175-185 | —.8627 | —.8577 | —.8740 | —.8584 |
| VIII | 185-195 | —.7707 | —.7863 | —.7728 | —.7473 |
| IX | 195-205 | —.7011 | —.7099 | —.7953 | —.7705 |
| X | 205 and over | —.8138 | —.8023 | —.7419 | —.7389 |
| | $\rho$ (rho)* | —.8639 | —.8581 | —.8589 | —.7925 |
| | $\zeta$ (zeta)* | 1.3087 | 1.2863 | 1.2892 | 1.0784 |

* Method of calculating $\rho$ (rho) and $\zeta$ (zeta) was as follows:

$$\zeta = Z_r - \frac{r}{2(N-1)}$$

$$\bar{\zeta} = \frac{\Sigma\zeta(N-3)}{(N-3)}$$

$\rho = \bar{\zeta}$ as transformed from a table of $Z_r$

Standard deviation of zeta = 0.03801

Standard deviation of difference of two zetas = 0.0538

**Table 20. Correlation and Regression Coefficients of Average Backfat Thickness and Body Length to the Index of Lean (Per Cent of Four Lean Cuts Plus Lean Trimmings and Bellies)**

| | Group I | Group II | Group III | Group IV | Group V | Group VI | Group VII | Group VIII | Group IX | Group X | Average correlation $\rho$ | Zeta* $\zeta$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Carcass weight, pounds | Under 125 | 125-135 | 135-145 | 145-155 | 155-165 | 165-175 | 175-185 | 185-195 | 195-205 | 205 and over | | |
| Number of carcasses | 79 | 85 | 75 | 75 | 95 | 82 | 72 | 50 | 45 | 37 | | |
| Simple correlations | | | | | | | | | | | | |
| $r_{12}$ | −.8797 | −.8036 | −.8940 | −.9089 | −.8613 | −.8934 | −.8740 | −.7728 | −.7953 | −.7419 | −.8589 | 1.2892 |
| $r_{13}$ | +.5989 | +.5373 | +.7091 | +.7415 | +.6024 | +.6614 | +.6928 | +.6012 | +.6074 | +.5133 | +.6350 | 0.7497 |
| $r_{23}$ | −.5921 | −.6586 | −.7239 | −.7804 | −.6073 | −.6508 | −.7634 | −.5553 | −.5628 | −.5335 | −.6648 | 0.8015 |
| Multiple correlations | | | | | | | | | | | | |
| $R_{1.23}$ | .8850 | .8037 | .8985 | .9104 | .8700 | .8996 | .8749 | .8000 | .8184 | .7548 | .8656 | 1.3153 |
| Partial correlations | | | | | | | | | | | | |
| $r_{12.3}$ | −.8137 | −.7087 | −.7825 | −.7871 | −.7776 | −.8129 | −.7418 | −.6605 | −.6905 | −.6448 | −.7741 | 1.0306 |
| $r_{13.2}$ | +.2037 | +.0180 | +.2004 | +.1236 | +.2411 | +.2341 | +.0818 | +.3260 | +.3189 | +.2072 | +.1828 | 0.1849 |
| Simple regressions | | | | | | | | | | | | |
| $b_{12}$ | −.3708 | −.3499 | −.3798 | −.3817 | −.3696 | −.3735 | −.3739 | −.3183 | −.3367 | −.3387 | ...... | ...... |
| $b_{13}$ | +.0601 | +.0510 | +.0670 | +.0750 | +.0620 | +.0607 | +.6057 | +.0365 | +.0529 | +.0532 | ...... | ...... |
| Partial regressions | | | | | | | | | | | | |
| $b_{12.3}$ | −.3408 | −.3458 | −.3398 | −.3548 | −.3295 | −.3358 | −.3537 | −.2614 | −.2809 | −.2987 | ...... | ...... |
| $b_{13.2}$ | +.0120 | +.0013 | +.0123 | +.0083 | +.0145 | +.0127 | +.0058 | +.0151 | +.0204 | +.0171 | ...... | ...... |

$X_1$ = Index of lean (per cent of four lean cuts plus lean trimmings and bellies).
$X_2$ = Average backfat thickness.
$X_3$ = Body length.
* Standard deviation of $\zeta = 0.03801$. Standard deviation of the difference between any two zetas = 0.0538.

**Table 21. Calculation of Standard Error of Estimate and Correlation Ratio from Expected Regression Lines**

| Nearest carcass weight, pounds | Number | $\Sigma d^2$ | Sy |
|---|---|---|---|
| 115 | 45 | 115.86 | 1.6046 |
| 125 | 89 | 290.45 | 1.8065 |
| 135 | 74 | 177.45 | 1.5485 |
| 145 | 66 | 116.66 | 1.3295 |
| 155 | 90 | 191.64 | 1.4592 |
| 165 | 79 | 226.80 | 1.6944 |
| 175 | 89 | 213.98 | 1.5506 |
| 185 | 57 | 161.15 | 1.6814 |
| 195 | 51 | 141.50 | 1.6657 |
| 205 | 28 | 84.94 | 1.7417 |
| 215 | 27 | 147.22 | 2.3351 |
| Totals | 695 | 1,867.65 | |

$$Sy = \sqrt{\frac{\Sigma d^2}{N}} = 1.6393$$

$$\sigma \text{ (from table 2)} = \quad = 3.3172$$

$$\eta \text{ (correlation ratio)} = \sqrt{1 - \frac{Sy^2}{\sigma^2}} = 0.8694$$

**Table 22. Comparison of Three Different Correlations of Average Backfat Thickness to the Index of Lean (Per Cent of Four Lean Cuts Plus Lean Trimmings and Bellies)**

| Type of correlation expression | | Correlation coefficient | Z* | Coefficient of determination |
|---|---|---|---|---|
| | | | | per cent |
| Simple correlation of entire sample of 695 carcasses (from table 2) | r | 0.8475 | 1.2474 | 71.83 |
| Theoretical average of 10 correlation coefficients from 10 weight groups (from table 20) | $\rho$ | 0.8589 | 1.2892 | 73.77 |
| Correlation ratio computed from deviations from 11 expected regression lines separated by 10-pound weight intervals (from table 21) | $\eta$ | 0.8694 | 1.3307 | 75.59 |

* Standard deviation of Z = 0.03801
Standard deviation of the difference between two Z's = 0.0538

## Table 23. Alternative Hog Carcass Grade Standard C, Based on Backfat Thickness and Carcass Weight Modified 0.3 Inch of Backfat per Grade, with Grade 10 Centered at Index of Lean of 71.0*

| Carcass weights, pounds | Equivalent liveweight (approximate), pounds | | Carcass grades | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 8 | | 9 | | 10 | | 11 | | 12 | |
| | | | margins | midpoints | margins | midpoints | margins | midpoints | margins | midpoints | margins | midpoints | margins |
| 110-145 | 165-210 | Backfat thickness, inches | 2.2 | | 1.9 | | 1.6 | | 1.3 | | 1.0 | | 0.7 |
| (127.5 av.) | | Index of lean | 63.7 | 65.2 | 66.7 | 68.1 | 69.6 | 71.0 | 72.5 | 73.9 | 75.4 | 76.8 | 78.3 |
| 145-185 | 210-265 | Backfat thickness, inches | 2.4 | | 2.0 | | 1.7 | | 1.4 | | 1.1 | | 0.8 |
| (165 av.) | | Index of lean | 63.3 | 65.1 | 66.9 | 68.3 | 69.7 | 71.0 | 72.4 | 73.8 | 75.1 | 76.5 | 77.8 |
| 185-230 | 265-325 | Backfat thickness, inches | 2.5 | | 2.1 | | 1.8 | | 1.5 | | 1.2 | | 0.8 |
| (207.5 av.) | | Index of lean | 63.7 | 65.4 | 67.2 | 68.4 | 69.7 | 71.0 | 72.3 | 73.6 | 74.9 | 76.6 | 78.3 |
| 230-290 | 325-405 | Backfat thickness, inches | 2.6 | | 2.3 | | 1.9 | | 1.6 | | 1.2 | | 0.9 |
| (260 av.) | | Index of lean | 64.2 | 65.4 | 66.6 | 68.2 | 69.8 | 71.0 | 72.2 | 73.8 | 75.4 | 76.6 | 77.8 |
| 290-350 | 405-485 | Backfat thickness, inches | 2.8 | | 2.4 | | 2.0 | | 1.7 | | 1.3 | | 0.9 |
| (320 av.) | | Index of lean | 63.8 | 65.3 | 66.8 | 68.3 | 69.9 | 71.0 | 72.2 | 73.7 | 75.2 | 76.7 | 78.2 |

* This standard may be used if it is found that an index of lean of 71.0 is more nearly the optimum magnitude than an index of lean of 70.0, as in Grade Standard B (table 7). It may also be used if graders are subjectively eliminating those carcasses from the Grade 10 category which have obviously discounted cuts.

## Table 24. Calculation of Distribution of Designated Cuts within Grades for Grade Standard B: All Distributions Expressed as Percentages of the Total Carcass Weight

| Wholesale cuts | Standard error of designated cut about the regression line | Variance about the regression line | Dispersion of index of lean within grades | Regression coefficient | Dispersion of average weight of cut at varying indices of lean within grades | Variance of average weight of cut within grades | Total variance of designated cut within grades | Dispersion of designated cut within grades |
|---|---|---|---|---|---|---|---|---|
| | Sy | $Sy^2$ | $\sigma_I$ | b | $b \cdot \sigma_I$ | $(b \cdot \sigma_I)^2$ | $Sy^2 + (b \cdot \sigma_I)^2$ | $\sqrt{Sy^2 + (b \cdot \sigma_I)^2}$ |
| Hams | .7783 | .6058 | 1.8439 | +.405 | .7468 | .5577 | 1.1634 | 1.0786 |
| Loins | .9019 | .8134 | 1.8439 | +.296 | .5458 | .2979 | 1.1113 | 1.0542 |
| Picnics | .5768 | .3327 | 1.8439 | +.181 | .3337 | .1114 | .4441 | .6664 |
| Bellies | 1.2821 | 1.6437 | 1.8439 | —.216 | .3983 | .1586 | 1.8024 | 1.3425 |
| Fatbacks | 1.0321 | 1.0652 | 1.8439 | —.714 | 1.3165 | 1.7333 | 2.7985 | 1.6702 |

**Table 25. Standard Deviations (within Grades of Grade Standard B) of Selected Wholesale Cuts for Designated Carcass Weights Expressed in Pounds***

| Carcass weight, pounds | Wholesale cuts | | | | |
|---|---|---|---|---|---|
| | Hams | Loins | Picnics | Bellies | Fatbacks |
| 115 | 0.6202 | 0.6062 | 0.3832 | 0.7719 | 0.9604 |
| 125 | 0.6741 | 0.6589 | 0.4165 | 0.8391 | 1.0439 |
| 135 | 0.7281 | 0.7116 | 0.4498 | 0.9062 | 1.1274 |
| 145 | 0.7820 | 0.7623 | 0.4831 | 0.9733 | 1.2109 |
| 155 | 0.8359 | 0.8170 | 0.5165 | 1.0404 | 1.2944 |
| 165 | 0.8898 | 0.8697 | 0.5498 | 1.1076 | 1.3779 |
| 175 | 0.9438 | 0.9224 | 0.5831 | 1.1747 | 1.4614 |
| 185 | 0.9977 | 0.9751 | 0.6164 | 1.2418 | 1.5449 |
| 195 | 1.0516 | 1.0278 | 0.6497 | 1.3089 | 1.6284 |
| 205 | 1.1057 | 1.0805 | 0.6681 | 1.3761 | 1.7120 |
| 215 | 1.1595 | 1.1333 | 0.7167 | 1.4432 | 1.7955 |

* These standard deviations were not calculated separately by weight groups. They were obtained by taking the standard deviations expressed in percentage terms in the last column of table 24 and converting to pounds at the designated carcass weights.

**Table 26. Average Wholesale Prices: Pork Cuts and Trimmings, Chicago, September 29–October 11, 1947***

| Wholesale cuts | Weight, pounds | price per cwt. |
|---|---|---|
| Green skinned hams | 10-12 | $50.80 |
| | 12-14 | 50.80 |
| | 14-16 | 50.80 |
| | 16-18 | 50.80 |
| | 18-20 | 50.50 |
| | 20-22 | 50.50 |
| | 22-24 | 50.00 |
| Loins | 8-10 | 57.60 |
| | 10-12 | 57.60 |
| | 12-16 | 56.00 |
| | 16-20 | 51.50 |
| Green bellies | 6- 8 | 53.90 |
| | 8-10 | 53.90 |
| | 10-12 | 53.90 |
| | 12-14 | 53.90 |
| | 14-16 | 53.90 |
| | 16-18 | 53.20 |
| Dry salt fatbacks | 6- 8 | 20.00 |
| | 8-10 | 20.00 |
| | 10-12 | 20.00 |
| | 12-14 | 21.00 |
| | 14-16 | 21.00 |
| | 16-18 | 21.00 |

| Wholesale cuts | Weight, pounds | price per cwt. |
|---|---|---|
| Green picnics | 4- 6 | $39.20 |
| | 6- 8 | 38.90 |
| | 8-10 | 38.00 |
| | 10-12 | 37.50 |
| Boston butts | | 53.60 |
| Regular pork lean trimmings | | 40.60 |
| Dry salt jowl butts | | 29.80 |
| Refined lard | | 27.90 |
| Spareribs | | 47.00 |
| Neck bones | | 18.50 |
| Front feet | | 12.50 |
| Tails | | 12.50 |

Conversion of Fat to Lard
(27.9 × conversion factor)

| Cut or trimmings | Weight | Factor | Price |
|---|---|---|---|
| Fatbacks | 6- 8 | 81.50% | 22.74 |
| | 8-10 | 82.25% | 22.95 |
| | 10-12 | 83.50% | 23.30 |
| | 12-14 | 84.50% | 23.57 |
| | 14-16 | 85.50% | 23.85 |
| | 16-18 | 86.25% | 24.06 |
| Fatbacks under 6 pounds and fat trimmings | | 80.00% | 22.30 |

* Average prices for loins and Boston butts were obtained from *The Livestock Market News* October 8 and 15, 1947, published by the United States Department of Agriculture. Prices for other cuts and trimmings were obtained from *The National Provisioner*, October 4 and 11, 1947.

**Table 27. Distribution of Wholesale Cuts and Trimmings by Carcass Grade, 115 Pounds Carcass Weight**

| | Carcass Grades | | | | |
|---|---|---|---|---|---|
| | 8 | 9 | 10 | 11 | 12 |
| Median index of lean | 63.6 | 66.6 | 69.6 | 72.6 | 75.6 |
| Distribution of cuts and trimmings | Per cent | Per cent | Per cent | Per cent | Per cent |
| Hams | 15.97 | 17.18 | 18.40 | 19.61 | 20.82 |
| Loins | 12.21 | 13.10 | 13.99 | 14.88 | 15.76 |
| Picnics | 8.45 | 9.00 | 9.54 | 10.08 | 10.63 |
| Boston butts | 6.50 | 7.05 | 7.60 | 8.15 | 8.70 |
| Bellies | 16.78 | 16.13 | 15.48 | 14.83 | 14.19 |
| Regular lean trimmings | 3.69 | 4.14 | 4.59 | 5.05 | 5.50 |
| Fatbacks | 13.85 | 11.71 | 9.56 | 7.42 | 5.28 |
| Fat trimmings | 12.19 | 10.91 | 9.63 | 8.35 | 7.06 |
| Dry salt jowls | 4.34 | 4.04 | 3.74 | 3.44 | 3.14 |
| Spareribs | 1.92 | 2.16 | 2.40 | 2.64 | 2.88 |
| Neck bones | 1.46 | 1.71 | 1.95 | 2.19 | 2.44 |
| Front feet | 1.03 | 1.13 | 1.24 | 1.35 | 1.46 |
| Hind feet | 1.37 | 1.49 | 1.62 | 1.74 | 1.86 |
| Tail | .24 | .25 | .26 | .27 | .28 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 28. Distribution of Wholesale Cuts and Trimmings by Carcass Grade, 125 Pounds Carcass Weight**

| | Carcass Grades | | | | |
|---|---|---|---|---|---|
| | 8 | 9 | 10 | 11 | 12 |
| Median index of lean | 64.1 | 67.0 | 70.0 | 72.9 | 75.8 |
| Distribution of cuts and trimmings | Per cent | Per cent | Per cent | Per cent | Per cent |
| Hams | 16.17 | 17.34 | 18.56 | 19.73 | 20.90 |
| Loins | 12.36 | 13.22 | 14.11 | 14.97 | 15.82 |
| Picnics | 8.54 | 9.07 | 9.61 | 10.13 | 10.66 |
| Boston butts | 6.60 | 7.13 | 7.67 | 8.20 | 8.74 |
| Bellies | 16.67 | 16.04 | 15.40 | 14.77 | 14.15 |
| Regular lean trimmings | 3.76 | 4.20 | 4.65 | 5.10 | 5.53 |
| Fatbacks | 13.50 | 11.43 | 9.28 | 7.21 | 5.14 |
| Fat trimmings | 11.98 | 10.74 | 9.46 | 8.23 | 6.99 |
| Dry salt jowls | 4.29 | 4.00 | 3.70 | 3.41 | 3.12 |
| Spareribs | 1.96 | 2.19 | 2.43 | 2.66 | 2.89 |
| Neck bones | 1.51 | 1.74 | 1.98 | 2.21 | 2.45 |
| Front feet | 1.04 | 1.15 | 1.26 | 1.36 | 1.47 |
| Hind feet | 1.39 | 1.51 | 1.64 | 1.76 | 1.87 |
| Tail | .23 | .24 | .25 | .26 | .27 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 29. Distribution of Wholesale Cuts and Trimmings by Carcass Grade, 135 Pounds Carcass Weight**

| | Carcass Grades | | | | |
|---|---|---|---|---|---|
| | 8 | 9 | 10 | 11 | 12 |
| Median index of lean | 64.5 | 67.4 | 70.3 | 73.1 | 76.0 |
| Distribution of cuts and trimmings | Per cent | Per cent | Per cent | Per cent | Per cent |
| Hams | 16.33 | 17.51 | 18.68 | 19.82 | 20.99 |
| Loins | 12.48 | 13.34 | 14.21 | 15.02 | 15.88 |
| Picnics | 8.61 | 9.14 | 9.66 | 10.17 | 10.70 |
| Boston butts | 6.67 | 7.20 | 7.73 | 8.24 | 8.77 |
| Bellies | 16.58 | 15.95 | 15.33 | 14.73 | 14.10 |
| Regular lean trimmings | 3.83 | 4.26 | 4.70 | 5.13 | 5.56 |
| Fatbacks | 13.21 | 11.14 | 9.07 | 7.07 | 5.00 |
| Fat trimmings | 11.81 | 10.58 | 9.33 | 8.14 | 6.90 |
| Dry salt jowls | 4.25 | 3.96 | 3.67 | 3.39 | 3.10 |
| Spareribs | 1.99 | 2.22 | 2.45 | 2.67 | 2.91 |
| Neck bones | 1.54 | 1.77 | 2.00 | 2.23 | 2.47 |
| Front feet | 1.06 | 1.16 | 1.27 | 1.37 | 1.47 |
| Hind feet | 1.41 | 1.53 | 1.65 | 1.76 | 1.88 |
| Tail | .23 | .24 | .25 | .26 | .27 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 30. Distribution of Wholesale Cuts and Trimmings by Carcass Grade, 145 Pounds Carcass Weight**

| | Carcass Grades | | | | |
|---|---|---|---|---|---|
| | 8 | 9 | 10 | 11 | 12 |
| Median index of lean | 63.5 | 66.8 | 69.6 | 72.4 | 75.2 |
| Distribution of cuts and trimmings | Per cent | Per cent | Per cent | Per cent | Per cent |
| Hams | 15.93 | 17.26 | 18.40 | 19.53 | 20.65 |
| Loins | 12.18 | 13.16 | 13.99 | 14.82 | 15.63 |
| Picnics | 8.43 | 9.05 | 9.54 | 10.04 | 10.56 |
| Boston butts | 6.48 | 7.10 | 7.60 | 8.11 | 8.63 |
| Bellies | 16.80 | 16.09 | 15.48 | 14.88 | 14.28 |
| Regular lean trimmings | 3.68 | 4.17 | 4.59 | 5.02 | 5.44 |
| Fatbacks | 13.92 | 11.57 | 9.56 | 7.57 | 5.57 |
| Fat trimmings | 12.24 | 10.83 | 9.63 | 8.44 | 7.23 |
| Dry salt jowls | 4.35 | 4.02 | 3.74 | 3.46 | 3.18 |
| Spareribs | 1.91 | 2.16 | 2.40 | 2.62 | 2.85 |
| Neck bones | 1.45 | 1.71 | 1.95 | 2.17 | 2.41 |
| Front feet | 1.03 | 1.14 | 1.24 | 1.34 | 1.45 |
| Hind feet | 1.37 | 1.50 | 1.62 | 1.74 | 1.85 |
| Tail | .23 | .24 | .26 | .26 | .27 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 31. Distribution of Wholesale Cuts and Trimmings by Carcass Grade, 155 Pounds Carcass Weight**

| | Carcass Grades | | | | |
|---|---|---|---|---|---|
| | 8 | 9 | 10 | 11 | 12 |
| Median index of lean | 63.9 | 67.1 | 69.9 | 72.6 | 75.4 |
| Distribution of cuts and trimmings | Per cent | Per cent | Per cent | Per cent | Per cent |
| Hams | 16.09 | 17.38 | 18.52 | 19.61 | 20.74 |
| Loins | 12.29 | 13.25 | 14.08 | 14.88 | 15.70 |
| Picnics | 8.50 | 9.09 | 9.59 | 10.08 | 10.59 |
| Boston butts | 6.56 | 7.15 | 7.65 | 8.15 | 8.66 |
| Bellies | 16.72 | 16.02 | 15.43 | 14.83 | 14.24 |
| Regular lean trimmings | 3.74 | 4.21 | 4.64 | 5.05 | 5.47 |
| Fatbacks | 13.64 | 11.36 | 9.35 | 7.42 | 5.43 |
| Fat trimmings | 12.07 | 10.70 | 9.52 | 8.35 | 7.15 |
| Dry salt jowls | 4.31 | 3.99 | 3.71 | 3.44 | 3.16 |
| Spareribs | 1.94 | 2.20 | 2.42 | 2.64 | 2.86 |
| Neck bones | 1.50 | 1.75 | 1.97 | 2.19 | 2.42 |
| Front feet | 1.03 | 1.15 | 1.24 | 1.35 | 1.45 |
| Hind feet | 1.38 | 1.51 | 1.63 | 1.74 | 1.86 |
| Tail | .23 | .24 | .25 | .27 | .27 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 32. Distribution of Wholesale Cuts and Trimmings by Carcass Grade, 165 Pounds Carcass Weight**

| | Carcass Grades | | | | |
|---|---|---|---|---|---|
| | 8 | 9 | 10 | 11 | 12 |
| Median index of mean | 64.2 | 67.4 | 70.1 | 72.8 | 75.6 |
| Distribution of cuts and trimmings | Per cent | Per cent | Per cent | Per cent | Per cent |
| Hams | 16.21 | 17.51 | 18.61 | 19.69 | 20.82 |
| Loins | 12.39 | 13.34 | 14.14 | 14.94 | 15.76 |
| Picnics | 8.56 | 9.14 | 9.63 | 10.11 | 10.63 |
| Boston butts | 6.62 | 7.20 | 7.69 | 8.19 | 8.70 |
| Bellies | 16.65 | 15.95 | 15.37 | 14.79 | 14.19 |
| Regular lean trimmings | 3.78 | 4.26 | 4.67 | 5.08 | 5.50 |
| Fatbacks | 13.43 | 11.14 | 9.21 | 7.28 | 5.28 |
| Fat trimmings | 11.93 | 10.58 | 9.42 | 8.27 | 7.06 |
| Dry salt jowls | 4.28 | 3.96 | 3.69 | 3.42 | 3.14 |
| Spareribs | 1.97 | 2.22 | 2.43 | 2.65 | 2.88 |
| Neck bones | 1.52 | 1.77 | 1.99 | 2.21 | 2.44 |
| Front feet | 1.04 | 1.16 | 1.26 | 1.36 | 1.46 |
| Hind feet | 1.39 | 1.53 | 1.64 | 1.75 | 1.86 |
| Tail | .23 | .24 | .25 | .26 | .28 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 33. Distribution of Wholesale Cuts and Trimmings by Carcass Grade, 175 Pounds Carcass Weight**

| | Carcass Grades | | | | |
|---|---|---|---|---|---|
| | 8 | 9 | 10 | 11 | 12 |
| Median index of lean | 64.5 | 67.7 | 70.4 | 73.0 | 75.7 |
| Distribution of cuts and trimmings | Per cent | Per cent | Per cent | Per cent | Per cent |
| Hams | 16.33 | 17.62 | 18.72 | 19.78 | 20.86 |
| Loins | 12.48 | 13.43 | 14.23 | 14.99 | 15.79 |
| Picnics | 8.61 | 9.20 | 9.68 | 10.15 | 10.65 |
| Boston butts | 6.67 | 7.26 | 7.75 | 8.22 | 8.72 |
| Bellies | 16.58 | 15.89 | 15.31 | 14.75 | 14.17 |
| Regular lean trimmings | 3.83 | 4.31 | 4.72 | 5.11 | 5.52 |
| Fatbacks | 13.21 | 10.93 | 9.00 | 7.14 | 5.21 |
| Fat trimmings | 11.81 | 10.44 | 9.29 | 8.18 | 7.02 |
| Dry salt jowls | 4.25 | 3.93 | 3.66 | 3.40 | 3.13 |
| Spareribs | 1.99 | 2.25 | 2.46 | 2.67 | 2.89 |
| Neck bones | 1.54 | 1.80 | 2.00 | 2.22 | 2.44 |
| Front feet | 1.06 | 1.17 | 1.28 | 1.37 | 1.46 |
| Hind feet | 1.41 | 1.53 | 1.65 | 1.76 | 1.87 |
| Tail | .23 | .24 | .25 | .26 | .27 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 34. Distribution of Wholesale Cuts and Trimmings by Carcass Grade, 185 Pounds Carcass Weight**

| | Carcass Grades | | | | |
|---|---|---|---|---|---|
| | 8 | 9 | 10 | 11 | 12 |
| Median index of lean | 64.0 | 67.1 | 69.7 | 72.3 | 75.4 |
| Distribution of cuts and trimmings | Per cent | Per cent | Per cent | Per cent | Per cent |
| Hams | 16.13 | 17.38 | 18.44 | 19.49 | 20.74 |
| Loins | 12.33 | 13.25 | 14.02 | 14.79 | 15.70 |
| Picnics | 8.52 | 9.09 | 9.56 | 10.02 | 10.59 |
| Boston butts | 6.58 | 7.15 | 7.62 | 8.09 | 8.66 |
| Bellies | 16.69 | 16.02 | 15.46 | 14.90 | 14.24 |
| Regular lean trimmings | 3.75 | 4.21 | 4.61 | 5.01 | 5.47 |
| Fatbacks | 13.57 | 11.36 | 9.49 | 7.64 | 5.43 |
| Fat trimmings | 12.02 | 10.70 | 9.59 | 8.48 | 7.15 |
| Dry salt jowls | 4.30 | 3.99 | 3.73 | 3.47 | 3.16 |
| Spareribs | 1.95 | 2.20 | 2.39 | 2.61 | 2.86 |
| Neck bones | 1.50 | 1.75 | 1.96 | 2.17 | 2.42 |
| Front feet | 1.04 | 1.15 | 1.25 | 1.34 | 1.45 |
| Hind feet | 1.39 | 1.51 | 1.63 | 1.73 | 1.86 |
| Tail | .23 | .24 | .25 | .26 | .27 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 35. Distribution of Wholesale Cuts and Trimmings by Carcass Grade, 195 Pounds Carcass Weight**

| | Carcass Grades | | | | |
|---|---|---|---|---|---|
| | 8 | 9 | 10 | 11 | 12 |
| Median index of lean | 64.3 | 67.3 | 69.9 | 72.5 | 75.5 |
| Distribution of cuts and trimmings | Per cent | Per cent | Per cent | Per cent | Per cent |
| Hams | 16.25 | 17.47 | 18.52 | 19.57 | 20.78 |
| Loins | 12.42 | 13.32 | 14.08 | 14.85 | 15.73 |
| Picnics | 8.58 | 9.12 | 9.59 | 10.06 | 10.61 |
| Boston butts | 6.63 | 7.18 | 7.65 | 8.13 | 8.68 |
| Bellies | 16.63 | 15.97 | 15.43 | 14.86 | 14.22 |
| Regular lean trimmings | 3.80 | 4.25 | 4.64 | 5.03 | 5.48 |
| Fatbacks | 13.36 | 11.22 | 9.35 | 7.49 | 5.35 |
| Fat trimmings | 11.89 | 10.61 | 9.52 | 8.40 | 7.11 |
| Dry salt jowls | 4.27 | 3.97 | 3.71 | 3.45 | 3.15 |
| Spareribs | 1.97 | 2.21 | 2.42 | 2.63 | 2.87 |
| Neck bones | 1.52 | 1.76 | 1.97 | 2.18 | 2.43 |
| Front feet | 1.05 | 1.16 | 1.24 | 1.35 | 1.46 |
| Hind feet | 1.40 | 1.52 | 1.63 | 1.74 | 1.86 |
| Tail | .23 | .24 | .25 | .26 | .27 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 36. Distribution of Wholesale Cuts and Trimmings by Carcass Grade, 205 Pounds Carcass Weight**

| | Carcass Grades | | | | |
|---|---|---|---|---|---|
| | 8 | 9 | 10 | 11 | 12 |
| Median index of lean | 64.5 | 67.5 | 70.1 | 72.7 | 75.7 |
| Distribution of cuts and trimmings | Per cent | Per cent | Per cent | Per cent | Per cent |
| Hams | 16.33 | 17.55 | 18.61 | 19.65 | 20.86 |
| Loins | 12.48 | 13.37 | 14.14 | 14.91 | 15.79 |
| Picnics | 8.61 | 9.16 | 9.63 | 10.10 | 10.65 |
| Boston butts | 6.67 | 7.22 | 7.69 | 8.17 | 8.72 |
| Bellies | 16.58 | 15.93 | 15.37 | 14.81 | 14.17 |
| Regular lean trimmings | 3.83 | 4.27 | 4.67 | 5.06 | 5.52 |
| Fatbacks | 13.21 | 11.07 | 9.21 | 7.35 | 5.21 |
| Fat trimmings | 11.81 | 10.53 | 9.42 | 8.31 | 7.02 |
| Dry salt jowls | 4.25 | 3.95 | 3.69 | 3.43 | 3.13 |
| Spareribs | 1.99 | 2.23 | 2.43 | 2.65 | 2.89 |
| Neck bones | 1.54 | 1.78 | 1.99 | 2.20 | 2.44 |
| Front feet | 1.06 | 1.17 | 1.26 | 1.35 | 1.46 |
| Hind feet | 1.41 | 1.53 | 1.64 | 1.75 | 1.87 |
| Tail | .23 | .24 | .25 | .26 | .27 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 37. Distribution of Wholesale Cuts and Trimmings by Carcass Grade, 215 Pounds Carcass Weight**

| | Carcass Grades | | | | |
|---|---|---|---|---|---|
| | 8 | 9 | 10 | 11 | 12 |
| Median index of lean | 64.8 | 67.7 | 70.3 | 72.8 | 75.8 |
| Distribution of cuts and trimmings | Per cent | Per cent | Per cent | Per cent | Per cent |
| Hams | 16.45 | 17.62 | 18.68 | 19.69 | 20.90 |
| Loins | 12.57 | 13.43 | 14.21 | 14.94 | 15.82 |
| Boston butts | 6.72 | 7.26 | 7.73 | 8.19 | 8.74 |
| Picnics | 8.67 | 9.20 | 9.66 | 10.11 | 10.66 |
| Boston butts | 6.72 | 7.26 | 7.73 | 8.19 | 8.74 |
| Bellies | 16.52 | 15.89 | 15.33 | 14.79 | 14.15 |
| Regular lean trimmings | 3.87 | 4.31 | 4.70 | 5.08 | 5.53 |
| Fatbacks | 13.00 | 10.93 | 9.07 | 7.28 | 5.14 |
| Fat trimmings | 11.69 | 10.44 | 9.33 | 8.27 | 6.99 |
| Dry salt jowls | 4.22 | 3.93 | 3.67 | 3.42 | 3.12 |
| Spareribs | 2.01 | 2.25 | 2.45 | 2.65 | 2.89 |
| Neck bones | 1.56 | 1.80 | 2.00 | 2.21 | 2.45 |
| Front feet | 1.07 | 1.17 | 1.27 | 1.36 | 1.47 |
| Hind feet | 1.42 | 1.53 | 1.65 | 1.75 | 1.87 |
| Tail | .23 | .24 | .25 | .26 | .27 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 38. Distribution of Ham Weights by Carcass Weight and Grade***

| Carcass weight, pounds | | Carcass Grades | | | | |
|---|---|---|---|---|---|---|
| | | 8 | 9 | 10 | 11 | 12 |
| 115 | Median index of lean | 63.6 | 66.6 | 69.6 | 72.6 | 75.6 |
| | Mean weight of ham, pounds | 9.18 | 9.88 | 10.58 | 11.28 | 11.98 |
| | Distribution of ham weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 6-8 pounds | 2.9 | 0.1 | | | |
| | 8-10 pounds | 87.8 | 57.4 | 17.5 | 2.0 | 0.1 |
| | 10-12 pounds | 9.3 | 42.5 | 81.4 | 85.7 | 51.1 |
| | 12-14 pounds | | | 1.1 | 12.3 | 48.8 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 125 | Median index of lean | 64.1 | 67.0 | 70.0 | 72.9 | 75.8 |
| | Mean weight of ham, pounds | 10.11 | 10.84 | 11.60 | 12.33 | 13.06 |
| | Distribution of ham weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 6-8 pounds | 0.1 | | | | |
| | 8-10 pounds | 43.5 | 10.6 | 0.9 | | |
| | 10-12 pounds | 56.1 | 85.1 | 71.3 | 31.2 | 5.8 |
| | 12-14 pounds | 0.3 | 4.3 | 27.8 | 68.1 | 86.0 |
| | 14-16 pounds | | | | 0.7 | 8.2 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 135 | Median index of lean | 64.5 | 67.4 | 70.3 | 73.1 | 76.0 |
| | Mean weight of ham, pounds | 11.02 | 11.82 | 12.61 | 13.38 | 14.17 |
| | Distribution of ham weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 8-10 pounds | 8.1 | 0.6 | | | |
| | 10-12 pounds | 83.1 | 59.3 | 20.0 | 2.9 | 0.1 |
| | 12-14 pounds | 8.8 | 50.0 | 77.2 | 77.3 | 40.8 |
| | 14-16 pounds | | 0.1 | 2.8 | 19.8 | 58.5 |
| | 16-18 pounds | | | | | 0.6 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

* Mean weights of the several cuts shown in tables 38 to 42 were calculated by converting percentages shown in tables 27 to 37 to pounds at the respective carcass weights. The distribution of weights of cuts about their mean weight in tables 38 to 42 was determined from a normal curve area table using the standard deviations shown in table 25.

**Table 38. Distribution of Ham Weights by Carcass Weight and Grade—Continued**

| Carcass weight, pounds | | Carcass Grades 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| 145 | Median index of lean | 63.5 | 66.8 | 69.6 | 72.4 | 75.2 |
| | Mean weight of ham, pounds | 11.55 | 12.51 | 13.34 | 14.16 | 14.97 |
| | Distribution of ham weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 8-10 pounds | 2.4 | | | | |
| | 10-12 pounds | 69.5 | 25.8 | 4.4 | 0.3 | |
| | 12-14 pounds | 28.0 | 71.4 | 75.6 | 41.8 | 10.7 |
| | 14-16 pounds | 0.1 | 2.8 | 20.0 | 57.0 | 80.0 |
| | 16-18 pounds | | | | 0.9 | 9.3 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 155 | Median index of lean | 63.9 | 67.1 | 69.9 | 72.6 | 75.4 |
| | Mean weight of ham, pounds | 12.47 | 13.47 | 14.35 | 15.20 | 16.07 |
| | Distribution of ham weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 8-10 pounds | 0.2 | | | | |
| | 10-12 pounds | 28.5 | 3.9 | 0.2 | | |
| | 12-14 pounds | 67.9 | 69.7 | 33.5 | 7.5 | 0.7 |
| | 14-16 pounds | 3.4 | 26.3 | 63.9 | 75.7 | 46.1 |
| | 16-18 pounds | | 0.1 | 2.4 | 16.8 | 52.2 |
| | 18-20 pounds | | | | | 1.0 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 165 | Median index of lean | 64.2 | 67.4 | 70.1 | 72.8 | 75.6 |
| | Mean weight of ham, pounds | 13.37 | 14.45 | 15.35 | 16.24 | 17.18 |
| | Distribution of ham weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 10-12 pounds | 6.2 | 0.3 | | | |
| | 12-14 pounds | 69.8 | 30.3 | 6.4 | 0.6 | |
| | 14-16 pounds | 23.8 | 65.3 | 70.3 | 38.8 | 9.2 |
| | 16-18 pounds | 0.2 | 4.1 | 23.2 | 58.2 | 72.9 |
| | 18-20 pounds | | | 0.1 | 2.4 | 17.8 |
| | 20-22 pounds | | | | | 0.1 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 175 | Median index of lean | 64.5 | 67.7 | 70.4 | 73.0 | 75.7 |
| | Mean weight of ham, pounds | 14.29 | 15.43 | 16.38 | 17.30 | 18.26 |
| | Distribution of ham weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 10-12 pounds | 0.7 | | | | |
| | 12-14 pounds | 37.1 | 6.4 | 0.6 | | |
| | 14-16 pounds | 58.7 | 66.2 | 33.9 | 8.4 | 0.8 |
| | 16-18 pounds | 3.5 | 27.1 | 61.2 | 68.6 | 38.2 |
| | 18-20 pounds | | 0.3 | 4.3 | 22.8 | 57.7 |
| | 20-22 pounds | | | | 0.2 | 3.3 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 185 | Median index of lean | 64.0 | 67.1 | 69.7 | 72.3 | 75.4 |
| | Mean weight of ham, pounds | 14.92 | 16.09 | 17.06 | 18.03 | 19.19 |
| | Distribution of ham weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 10-12 pounds | 0.2 | | | | |
| | 12-14 pounds | 17.7 | 1.8 | 0.1 | | |
| | 14-16 pounds | 68.1 | 44.6 | 14.4 | 2.1 | |
| | 16-18 pounds | 13.9 | 50.8 | 68.1 | 46.7 | 11.7 |
| | 18-20 pounds | 0.1 | 2.8 | 17.2 | 48.8 | 67.4 |
| | 20-22 pounds | | | 0.2 | 2.4 | 20.7 |
| | 22-24 pounds | | | | | 0.2 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 38. Distribution of Ham Weights by Carcass Weight and Grade—Continued**

| Carcass weight, pounds | | Carcass Grades 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| 195 | Median index of lean | 64.3 | 67.3 | 69.9 | 72.5 | 75.5 |
| | Mean weight of ham, pounds | 15.85 | 17.03 | 18.06 | 19.09 | 20.27 |
| | Distribution of ham weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 12-14 pounds | 5.9 | 0.2 | | | |
| | 14-16 pounds | 51.7 | 16.1 | 2.5 | 0.2 | |
| | 16-18 pounds | 42.3 | 65.8 | 45.1 | 14.7 | 1.5 |
| | 18-20 pounds | 2.1 | 17.7 | 49.1 | 65.9 | 38.2 |
| | 20-22 pounds | | 0.2 | 3.3 | 18.9 | 55.4 |
| | 22-24 pounds | | | | 0.3 | 4.9 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 205 | Median index of lean | 64.5 | 67.5 | 70.1 | 72.7 | 75.7 |
| | Mean weight of ham, pounds | 16.74 | 17.99 | 19.08 | 20.14 | 21.39 |
| | Distribution of ham weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 12-14 pounds | 0.7 | | | | |
| | 14-16 pounds | 24.4 | 3.6 | 0.3 | | |
| | 16-18 pounds | 62.2 | 46.8 | 16.2 | 2.6 | 0.1 |
| | 18-20 pounds | 12.5 | 46.2 | 63.3 | 42.2 | 10.3 |
| | 20-22 pounds | 0.2 | 3.4 | 19.8 | 50.6 | 60.5 |
| | 22-24 pounds | | | 0.4 | 4.6 | 28.2 |
| | 24-26 pounds | | | | | 0.9 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 215 | Median index of lean | 64.8 | 67.7 | 70.3 | 72.8 | 75.8 |
| | Mean weight of ham, pounds | 17.69 | 18.95 | 20.08 | 21.17 | 22.47 |
| | Distribution of ham weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 12-14 pounds | 0.1 | | | | |
| | 14-16 pounds | 7.1 | 0.5 | | | |
| | 16-18 pounds | 53.4 | 20.1 | 3.7 | 0.3 | |
| | 18-20 pounds | 37.1 | 61.3 | 43.5 | 15.3 | 1.7 |
| | 20-22 pounds | 2.3 | 17.7 | 48.0 | 60.8 | 32.4 |
| | 22-24 pounds | | 0.4 | 4.8 | 22.9 | 56.6 |
| | 24-26 pounds | | | | 0.7 | 9.2 |
| | 26-28 pounds | | | | | 0.1 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 39. Distribution of Loin Weights by Carcass Weight and Grade**

| Carcass weight, pounds | | Carcass Grades 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| 115 | Median index of lean | 63.6 | 66.6 | 69.6 | 69.6 | 72.6 |
| | Mean weight of loin, pounds | 7.01 | 7.53 | 8.04 | 8.56 | 9.06 |
| | Distribution of loin weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 4-6 pounds | 4.7 | 0.6 | | | |
| | 6-8 pounds | 90.2 | 77.6 | 47.3 | 17.8 | 4.0 |
| | 8-10 pounds | 5.1 | 21.8 | 52.6 | 81.3 | 89.9 |
| | 10-12 pounds | | | 0.1 | 0.9 | 6.1 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 39. Distribution of Loin Weights by Carcass Weight and Grade—Continued**

| Carcass weight, pounds | | Carcass Grades 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| 125 | Median index of lean | 64.1 | 67.0 | 70.0 | 72.9 | 75.8 |
| | Mean weight of loin, pounds | 7.73 | 8.26 | 8.82 | 9.35 | 9.89 |
| | Distribution of loin weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 4-6 pounds | 0.4 | | | | |
| | 6-8 pounds | 65.5 | 34.8 | 10.7 | 2.0 | 0.2 |
| | 8-10 pounds | 34.1 | 64.8 | 85.6 | 81.9 | 56.6 |
| | 10-12 pounds | | 0.4 | 3.7 | 16.1 | 43.2 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 135 | Median index of lean | 64.5 | 67.4 | 70.3 | 73.1 | 76.0 |
| | Mean weight of loin, pounds | 8.42 | 9.00 | 9.59 | 10.14 | 10.72 |
| | Distribution of loin weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 4-6 pounds | | | | | |
| | 6-8 pounds | 27.8 | 7.9 | 1.3 | 0.1 | |
| | 8-10 pounds | 70.9 | 84.2 | 70.6 | 42.0 | 15.6 |
| | 10-12 pounds | 1.3 | 7.9 | 28.1 | 57.5 | 80.8 |
| | 12-14 pounds | | | | 0.4 | 3.6 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 145 | Median index of lean | 63.5 | 66.8 | 69.6 | 72.4 | 75.2 |
| | Mean weight of loin, pounds | 8.83 | 9.54 | 10.14 | 10.74 | 11.33 |
| | Distribution of loin weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 4-6 pounds | | | | | |
| | 6-8 pounds | 13.8 | 2.2 | 0.3 | | |
| | 8-10 pounds | 80.0 | 70.5 | 42.4 | 16.6 | 4.0 |
| | 10-12 pounds | 6.2 | 27.3 | 56.6 | 78.5 | 77.0 |
| | 12-14 pounds | | | 0.7 | 4.9 | 19.0 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 155 | Median index of lean | 63.9 | 67.1 | 69.9 | 72.6 | 75.4 |
| | Mean weight of loin, pounds | 9.52 | 10.27 | 10.91 | 11.53 | 12.17 |
| | Distribution of loin weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 4-6 pounds | | | | | |
| | 6-8 pounds | 3.1 | 0.3 | | | |
| | 8-10 pounds | 69.1 | 36.8 | 13.3 | 3.1 | 0.4 |
| | 10-12 pounds | 27.7 | 61.2 | 77.4 | 68.8 | 41.3 |
| | 12-14 pounds | 0.1 | 1.7 | 9.3 | 28.0 | 57.1 |
| | 14-16 pounds | | | | 0.1 | 1.2 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 165 | Median index of lean | 64.2 | 67.4 | 70.1 | 72.8 | 75.6 |
| | Mean weight of loin, pounds | 10.22 | 11.00 | 11.67 | 12.33 | 13.00 |
| | Distribution of loin weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 6-8 pounds | 0.5 | | | | |
| | 8-10 pounds | 39.5 | 12.5 | 2.7 | 0.4 | |
| | 10-12 pounds | 57.9 | 75.0 | 62.1 | 34.8 | 12.5 |
| | 12-14 pounds | 2.0 | 12.5 | 34.8 | 62.1 | 75.0 |
| | 14-16 pounds | | | 0.4 | 2.7 | 12.5 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 39. Distribution of Loin Weights by Carcass Weight and Grade—Continued**

| Carcass weight, pounds | | Carcass Grades 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| 175 | Median index of lean | 64.5 | 67.7 | 70.4 | 73.0 | 75.7 |
| | Mean weight of loin, pounds | 10.92 | 11.75 | 12.44 | 13.12 | 13.82 |
| | Distribution of loin weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 6-8 pounds | 0.1 | | | | |
| | 8-10 pounds | 15.8 | 2.9 | 0.4 | | |
| | 10-12 pounds | 72.0 | 57.7 | 31.2 | 11.3 | 2.4 |
| | 12-14 pounds | 12.1 | 38.7 | 63.9 | 71.6 | 55.5 |
| | 14-16 pounds | | 0.7 | 4.5 | 17.0 | 41.2 |
| | 16-18 pounds | | | | 0.1 | 0.9 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 185 | Median index of lean | 64.0 | 67.1 | 69.7 | 72.3 | 75.4 |
| | Mean weight of loin, pounds | 11.41 | 12.26 | 12.97 | 13.68 | 14.53 |
| | Distribution of loin weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 8-10 pounds | 7.3 | 1.0 | 0.1 | | |
| | 10-12 pounds | 65.6 | 38.4 | 16.0 | 4.3 | 0.5 |
| | 12-14 pounds | 26.7 | 56.9 | 69.4 | 58.6 | 29.0 |
| | 14-16 pounds | 0.4 | 3.7 | 14.4 | 36.2 | 64.0 |
| | 16-18 pounds | | | 0.1 | 0.9 | 6.5 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 195 | Median index of lean | 64.3 | 67.3 | 69.9 | 72.5 | 75.5 |
| | Mean weight of loin, pounds | 12.11 | 12.98 | 13.72 | 14.48 | 15.34 |
| | Distribution of loin weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 8-10 pounds | 2.0 | 0.2 | | | |
| | 10-12 pounds | 43.6 | 16.9 | 4.7 | 0.8 | |
| | 12-14 pounds | 51.1 | 66.8 | 55.9 | 31.1 | 9.7 |
| | 14-16 pounds | 3.3 | 15.9 | 38.1 | 61.2 | 64.2 |
| | 16-18 pounds | | 0.2 | 1.3 | 6.9 | 25.6 |
| | 18-20 pounds | | | | | 0.5 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 205 | Median index of lean | 64.5 | 67.5 | 70.1 | 72.7 | 75.7 |
| | Mean weight of loin, pounds | 12.79 | 13.70 | 14.49 | 15.28 | 16.19 |
| | Distribution of loin weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 8-10 pounds | 0.5 | | | | |
| | 10-12 pounds | 22.8 | 5.8 | 1.1 | 0.1 | |
| | 12-14 pounds | 63.6 | 55.2 | 31.5 | 11.8 | 2.1 |
| | 14-16 pounds | 13.0 | 37.3 | 59.3 | 63.0 | 40.8 |
| | 16-18 pounds | 0.1 | 1.7 | 8.1 | 24.5 | 52.5 |
| | 18-20 pounds | | | | 0.6 | 4.6 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 215 | Median index of lean | 64.8 | 67.7 | 70.3 | 72.8 | 75.8 |
| | Mean weight of loin, pounds | 13.51 | 14.44 | 15.28 | 16.06 | 17.01 |
| | Distribution of loin weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 8-10 pounds | 0.1 | | | | |
| | 10-12 pounds | 9.1 | 1.6 | 0.2 | | |
| | 12-14 pounds | 57.4 | 33.3 | 12.8 | 3.4 | 0.4 |
| | 14-16 pounds | 32.1 | 56.6 | 60.7 | 44.6 | 18.3 |
| | 16-18 pounds | 1.3 | 8.4 | 25.5 | 47.6 | 62.1 |
| | 18-20 pounds | | 0.1 | 0.8 | 4.4 | 18.8 |
| | 20-22 pounds | | | | | 0.4 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 40. Distribution of Belly Weights by Carcass Weight and Grade**

| Carcass weight, pounds | | Carcass Grades 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| 115 | Median index of lean | 63.6 | 66.6 | 69.6 | 72.6 | 75.6 |
| | Mean weight of belly, pounds | 9.65 | 9.28 | 8.90 | 8.53 | 8.16 |
| | Distribution of belly weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 4-6 pounds | | | | | 0.3 |
| | 6-8 pounds | 1.6 | 4.8 | 12.1 | 24.8 | 41.5 |
| | 8-10 pounds | 65.8 | 77.6 | 80.3 | 72.3 | 57.3 |
| | 10-12 pounds | 32.5 | 17.6 | 7.6 | 2.9 | 0.9 |
| | 12-14 pounds | 0.1 | | | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 125 | Median index of lean | 64.1 | 67.0 | 70.0 | 72.9 | 75.8 |
| | Mean weight of belly, pounds | 10.41 | 10.03 | 9.63 | 9.23 | 8.83 |
| | Distribution of belly weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 4-6 pounds | | | | | |
| | 6-8 pounds | 0.2 | 0.8 | 2.6 | 7.1 | 15.9 |
| | 8-10 pounds | 31.1 | 47.8 | 64.4 | 75.0 | 75.7 |
| | 10-12 pounds | 65.8 | 50.5 | 32.7 | 17.9 | 8.4 |
| | 12-14 pounds | 2.9 | 0.9 | 0.3 | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 135 | Median index of lean | 64.5 | 67.4 | 70.3 | 73.1 | 76.0 |
| | Mean weight of belly, pounds | 11.19 | 10.77 | 10.35 | 9.94 | 9.52 |
| | Distribution of belly weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 6-8 pounds | | 0.1 | 0.5 | 1.6 | 4.6 |
| | 8-10 pounds | 9.5 | 19.7 | 34.3 | 51.2 | 65.6 |
| | 10-12 pounds | 71.8 | 71.5 | 61.8 | 46.0 | 29.5 |
| | 12-14 pounds | 0.1 | | | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 145 | Median index of lean | 63.5 | 66.8 | 69.6 | 72.4 | 75.2 |
| | Mean weight of belly, pounds | 12.18 | 11.67 | 11.22 | 10.79 | 10.35 |
| | Distribution of belly weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 6-8 pounds | | | | 0.2 | 0.8 |
| | 8-10 pounds | 1.2 | 4.3 | 10.6 | 20.7 | 35.1 |
| | 10-12 pounds | 41.7 | 59.0 | 68.2 | 68.4 | 59.6 |
| | 12-14 pounds | 54.0 | 35.9 | 21.0 | 10.7 | 4.5 |
| | 14-16 pounds | 3.1 | 0.8 | 0.2 | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 155 | Median index of lean | 63.9 | 67.1 | 69.9 | 72.6 | 75.4 |
| | Mean weight of belly, pounds | 12.96 | 12.42 | 11.96 | 11.49 | 11.04 |
| | Distribution of belly weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 6-8 pounds | | | | | 0.2 |
| | 8-10 pounds | 0.2 | 1.0 | 3.0 | 7.6 | 15.7 |
| | 10-12 pounds | 17.7 | 33.5 | 48.6 | 61.2 | 66.2 |
| | 12-14 pounds | 66.2 | 59.1 | 45.9 | 30.4 | 17.7 |
| | 14-16 pounds | 15.7 | 6.4 | 2.5 | 0.8 | 0.2 |
| | 16-18 pounds | 0.2 | | | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 40. Distribution of Belly Weights by Carcass Weight and Grade—Continued**

| Carcass weight, pounds | | Carcass Grades 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| 165 | Median index of lean | 64.2 | 67.4 | 70.1 | 72.8 | 75.6 |
| | Mean weight of belly, pounds | 13.74 | 13.16 | 12.68 | 12.20 | 11.71 |
| | Distribution of belly weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 8-10 pounds | | 0.2 | 0.8 | 2.3 | 6.2 |
| | 10-12 pounds | 25.8 | 14.5 | 26.3 | 40.6 | 54.1 |
| | 12-14 pounds | 53.5 | 62.9 | 61.2 | 52.0 | 37.8 |
| | 14-16 pounds | 38.6 | 21.9 | 11.6 | 5.1 | 1.9 |
| | 16-18 pounds | 2.1 | 0.5 | 0.1 | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 175 | Median index of lean | 64.5 | 67.7 | 70.4 | 73.0 | 75.7 |
| | Mean weight of belly, pounds | 14.51 | 13.90 | 13.39 | 12.90 | 12.40 |
| | Distribution of belly weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 8-10 pounds | | | 0.2 | 0.7 | 2.1 |
| | 10-12 pounds | 1.6 | 5.3 | 11.7 | 21.4 | 34.6 |
| | 12-14 pounds | 31.8 | 48.3 | 58.0 | 60.5 | 54.6 |
| | 14-16 pounds | 56.4 | 42.7 | 28.8 | 17.0 | 8.6 |
| | 16-18 pounds | 10.1 | 3.7 | 1.3 | 0.4 | 0.1 |
| | 18-20 pounds | 0.1 | | | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 185 | Median index of lean | 64.0 | 67.1 | 69.7 | 72.3 | 75.4 |
| | Mean weight of belly, pounds | 15.44 | 14.82 | 14.30 | 13.78 | 13.16 |
| | Distribution of belly weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 8-10 pounds | | | | 0.1 | 0.5 |
| | 10-12 pounds | 0.3 | 1.2 | 3.2 | 7.5 | 17.1 |
| | 12-14 pounds | 12.0 | 24.3 | 37.3 | 49.5 | 57.6 |
| | 14-16 pounds | 55.1 | 57.4 | 51.0 | 39.2 | 23.7 |
| | 16-18 pounds | 30.6 | 16.6 | 8.4 | 3.7 | 1.1 |
| | 18-20 pounds | 2.0 | 0.5 | 0.1 | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 195 | Median index of lean | 64.3 | 67.3 | 69.9 | 72.5 | 75.5 |
| | Mean weight of belly, pounds | 16.21 | 15.58 | 15.03 | 14.48 | 13.86 |
| | Distribution of belly weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 8-10 pounds | | | | | 0.2 |
| | 10-12 pounds | | 0.3 | 1.0 | 2.9 | 7.6 |
| | 12-14 pounds | 4.5 | 11.0 | 20.5 | 32.7 | 46.6 |
| | 14-16 pounds | 39.1 | 51.3 | 55.8 | 52.1 | 40.5 |
| | 16-18 pounds | 47.9 | 34.2 | 21.5 | 11.9 | 5.0 |
| | 18-20 pounds | 8.3 | 3.2 | 1.2 | 0.4 | 0.1 |
| | 20-22 pounds | 0.2 | | | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 205 | Median index of lean | 64.5 | 67.5 | 70.1 | 72.7 | 75.7 |
| | Mean weight of belly, pounds | 16.99 | 16.33 | 15.76 | 15.19 | 14.52 |
| | Distribution of belly weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 10-12 pounds | | 0.1 | 0.3 | 1.0 | 3.4 |
| | 12-14 pounds | 1.5 | 4.4 | 9.7 | 18.5 | 31.8 |
| | 14-16 pounds | 22.1 | 36.0 | 46.8 | 52.7 | 50.8 |
| | 16-18 pounds | 53.2 | 48.2 | 16.8 | 25.7 | 13.4 |
| | 18-20 pounds | 21.7 | 10.9 | 26.3 | 2.1 | 0.6 |
| | 20-22 pounds | 1.5 | 0.4 | 0.1 | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 40. Distribution of Belly Weights by Carcass Weight and Grade—Continued**

| Carcass weight, pounds | | Carcass Grades 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| 215 | Median index of lean | 64.8 | 67.7 | 70.3 | 72.8 | 75.8 |
| | Mean weight of belly, pounds | 17.76 | 17.09 | 16.48 | 15.90 | 15.21 |
| | Distribution of belly weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 10-12 pounds | | | 0.1 | 0.3 | 1.3 |
| | 12-14 pounds | 0.4 | 1.6 | 4.2 | 9.0 | 18.7 |
| | 14-16 pounds | 10.7 | 20.8 | 32.8 | 43.5 | 50.9 |
| | 16-18 pounds | 45.7 | 51.2 | 48.2 | 40.0 | 26.4 |
| | 18-20 pounds | 37.1 | 24.2 | 14.0 | 7.0 | 2.7 |
| | 20-22 pounds | 5.9 | 2.2 | 0.7 | 0.2 | |
| | 22-24 pounds | 0.2 | | | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 41. Distribution of Picnic Weights by Carcass Weight and Grade**

| Carcass weight, pounds | | Carcass Grades 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| 115 | Median index of lean | 63.6 | 66.6 | 69.6 | 72.6 | 75.6 |
| | Mean weight of picnic, pounds | 4.86 | 5.17 | 5.49 | 5.79 | 6.11 |
| | Distribution of picnic weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 2-4 pounds | 1.2 | 0.1 | | | |
| | 4-6 pounds | 98.7 | 98.4 | 90.8 | 70.8 | 38.6 |
| | 6-8 pounds | 0.1 | 1.5 | 9.2 | 29.2 | 61.4 |
| | 8-10 pounds | | | | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 125 | Median index of lean | 64.1 | 67.0 | 70.0 | 72.9 | 75.8 |
| | Mean weight of picnic, pounds | 5.34 | 5.67 | 6.01 | 6.33 | 6.66 |
| | Distribution of picnic weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 4-6 pounds | 94.3 | 78.5 | 49.2 | 21.5 | 5.7 |
| | 6-8 pounds | 5.7 | 21.5 | 50.8 | 78.5 | 94.3 |
| | 8-10 pounds | | | | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 135 | Median index of lean | 64.5 | 67.4 | 70.3 | 73.1 | 76.0 |
| | Mean weight of picnic, pounds | 5.81 | 6.17 | 6.52 | 6.86 | 7.22 |
| | Distribution of picnic weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 4-6 pounds | 66.3 | 35.2 | 12.3 | 2.8 | 0.3 |
| | 6-8 pounds | 33.7 | 64.8 | 87.7 | 96.6 | 95.5 |
| | 8-10 pounds | | | | 0.6 | 4.2 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 145 | Median index of lean | 63.5 | 66.8 | 69.6 | 72.4 | 75.2 |
| | Mean weight of picnic, pounds | 6.11 | 6.56 | 6.92 | 7.28 | 7.66 |
| | Distribution of picnic weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 4-6 pounds | 40.9 | 12.3 | 2.9 | 0.4 | 0.1 |
| | 6-8 pounds | 59.0 | 87.6 | 95.9 | 92.8 | 75.7 |
| | 8-10 pounds | 0.1 | 0.1 | 1.2 | 6.8 | 24.2 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

Table 41. Distribution of Picnic Weights by Carcass Weight and Grade—Continued

| Carcass weight, pounds | | Carcass Grades 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| 155 | Median index of lean | 63.9 | 67.1 | 69.9 | 72.6 | 75.4 |
| | Mean weight of picnic, pounds | 6.59 | 7.04 | 7.43 | 7.81 | 8.21 |
| | Distribution of picnic weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 4-6 pounds | 12.7 | 2.2 | 0.3 | | |
| | 6-8 pounds | 87.0 | 94.7 | 86.1 | 64.4 | 34.1 |
| | 8-10 pounds | 0.3 | 3.1 | 13.6 | 35.6 | 65.9 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 165 | Median index of lean | 64.2 | 67.4 | 70.1 | 72.8 | 75.6 |
| | Mean weight of picnic, pounds | 7.06 | 7.54 | 7.94 | 8.34 | 8.77 |
| | Distribution of picnic weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 4-6 pounds | 2.7 | 0.3 | | | |
| | 6-8 pounds | 92.9 | 79.7 | 54.4 | 26.8 | 8.1 |
| | 8-10 pounds | 4.4 | 20.0 | 45.6 | 73.1 | 90.7 |
| | 10-12 pounds | | | | 0.1 | 1.2 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 175 | Median index of lean | 64.5 | 67.7 | 70.4 | 73.0 | 75.7 |
| | Mean weight of picnic, pounds | 7.54 | 8.04 | 8.47 | 8.88 | 9.31 |
| | Distribution of picnic weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 4-6 pounds | 0.4 | | | | |
| | 6-8 pounds | 78.1 | 47.2 | 20.9 | 6.5 | 1.2 |
| | 8-10 pounds | 21.5 | 52.8 | 78.7 | 90.8 | 86.9 |
| | 10-12 pounds | | | 0.4 | 2.7 | 11.9 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 185 | Median index of lean | 64.0 | 67.1 | 69.7 | 72.3 | 75.4 |
| | Mean weight of picnic, pounds | 7.88 | 8.41 | 8.84 | 9.27 | 9.79 |
| | Distribution of picnic weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 4-6 pounds | 0.1 | | | | |
| | 6-8 pounds | 57.4 | 25.1 | 8.7 | 2.0 | 0.2 |
| | 8-10 pounds | 42.5 | 74.4 | 88.3 | 86.1 | 63.1 |
| | 10-12 pounds | | 0.5 | 3.0 | 11.9 | 36.7 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 195 | Median index of lean | 64.3 | 67.3 | 69.9 | 72.5 | 75.5 |
| | Mean weight of picnic, pounds | 8.36 | 8.89 | 9.35 | 9.81 | 10.34 |
| | Distribution of picnic weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 6-8 pounds | 29.1 | 8.5 | 1.9 | 0.3 | |
| | 8-10 pounds | 70.3 | 87.1 | 82.2 | 61.1 | 30.1 |
| | 10-12 pounds | 0.6 | 4.4 | 15.9 | 38.6 | 69.4 |
| | 12-14 pounds | | | | | 0.5 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 205 | Median index of lean | 64.5 | 67.5 | 70.1 | 72.7 | 75.7 |
| | Mean weight of picnic, pounds | 8.83 | 9.39 | 9.87 | 10.35 | 10.91 |
| | Distribution of picnic weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 6-8 pounds | 10.7 | 1.9 | 0.3 | | |
| | 8-10 pounds | 85.3 | 80.0 | 57.2 | 30.0 | 8.7 |
| | 10-12 pounds | 4.0 | 18.1 | 42.4 | 69.3 | 86.2 |
| | 12-14 pounds | | | 0.1 | 0.7 | 5.1 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 41. Distribution of Picnic Weights by Carcass Weight and Grade—Continued**

| Carcass weight, pounds | | Carcass Grades 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| 215 | Median index of lean | 64.8 | 67.7 | 70.3 | 72.8 | 75.8 |
| | Mean weight of picnic, pounds | 9.32 | 9.88 | 10.39 | 10.88 | 11.46 |
| | Distribution of picnic weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | 6-8 pounds | 3.3 | 0.4 | | | |
| | 8-10 pounds | 79.5 | 56.4 | 29.5 | 10.9 | 2.1 |
| | 10-12 pounds | 17.2 | 43.1 | 69.3 | 83.2 | 75.2 |
| | 12-14 pounds | | 0.1 | 1.2 | 5.9 | 22.7 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 42. Distribution of Fatback Weights by Carcass Weight and Grade**

| Carcass weight, pounds | | Carcass Grades 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| 115 | Median index of lean | 63.6 | 66.6 | 69.6 | 72.6 | 75.6 |
| | Mean weight of fatback, pounds | 7.96 | 6.73 | 5.50 | 4.27 | 3.03 |
| | Distribution of fatback weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | Under 6 pounds | 2.1 | 22.4 | 69.9 | 96.4 | 99.9 |
| | 6-8 pounds | 49.5 | 68.3 | 29.6 | 3.6 | 0.1 |
| | 8-10 pounds | 46.7 | 9.3 | 0.5 | | |
| | 10-12 pounds | 1.7 | | | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 125 | Median index of lean | 64.1 | 67.0 | 70.0 | 72.9 | 75.8 |
| | Mean weight of fatback, pounds | 8.44 | 7.14 | 5.80 | 4.50 | 3.21 |
| | Distribution of fatback weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | Under 6 pounds | 1.0 | 13.8 | 57.5 | 92.5 | 99.6 |
| | 6-8 pounds | 32.7 | 65.6 | 40.8 | 7.5 | 0.4 |
| | 8-10 pounds | 59.5 | 20.3 | 1.7 | | |
| | 10-12 pounds | 6.8 | 0.3 | | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 135 | Median index of lean | 64.5 | 67.4 | 70.3 | 73.1 | 76.0 |
| | Mean weight of fatback, pounds | 8.92 | 7.52 | 6.12 | 4.77 | 3.37 |
| | Distribution of fatback weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | Under 6 pounds | 0.5 | 8.8 | 45.6 | 86.2 | 99.0 |
| | 6-8 pounds | 20.1 | 57.8 | 49.7 | 13.6 | 1.0 |
| | 8-10 pounds | 62.6 | 32.0 | 4.7 | 0.2 | |
| | 10-12 pounds | 16.5 | 1.4 | | | |
| | 12-14 pounds | 0.3 | | | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 145 | Median index of lean | 63.5 | 66.8 | 69.6 | 72.4 | 75.2 |
| | Mean weight of fatback, pounds | 10.09 | 8.38 | 6.93 | 5.49 | 4.04 |
| | Distribution of fatback weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | Under 6 pounds | | 2.4 | 22.1 | 66.3 | 94.7 |
| | 6-8 pounds | 4.3 | 35.4 | 59.0 | 31.8 | 5.3 |
| | 8-10 pounds | 42.9 | 53.2 | 18.3 | 1.9 | |
| | 10-12 pounds | 47.1 | 8.9 | 0.6 | | |
| | 12-14 pounds | 5.7 | 0.1 | | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 42. Distribution of Fatback Weights by Carcass Weight and Grade—Continued**

| Carcass weight, pounds | | Carcass Grades | | | | |
|---|---|---|---|---|---|---|
| | | 8 | 9 | 10 | 11 | 12 |
| 155 | Median index of lean | 63.9 | 67.1 | 69.9 | 72.6 | 75.4 |
| | Mean weight of fatback, pounds | 10.57 | 8.80 | 7.25 | 5.75 | 4.21 |
| | Distribution of fatback weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | Under 6 pounds | | 1.5 | 16.6 | 57.5 | 91.6 |
| | 6-8 pounds | 2.4 | 25.3 | 55.3 | 38.4 | 8.2 |
| | 8-10 pounds | 30.6 | 55.6 | 26.4 | 4.1 | 0.2 |
| | 10-12 pounds | 53.5 | 16.9 | 1.7 | | |
| | 12-14 pounds | 13.1 | 0.7 | | | |
| | 14-16 pounds | 0.4 | | | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 165 | Median index of lean | 64.2 | 67.4 | 70.1 | 72.8 | 75.6 |
| | Mean weight of fatback, pounds | 11.07 | 9.19 | 7.60 | 6.01 | 4.37 |
| | Distribution of fatback weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | Under 6 pounds | | 1.0 | 12.3 | 49.6 | 88.1 |
| | 6-8 pounds | 1.3 | 18.5 | 49.1 | 42.9 | 11.5 |
| | 8-10 pounds | 20.5 | 52.7 | 34.5 | 7.3 | 0.4 |
| | 10-12 pounds | 53.1 | 25.7 | 4.0 | 0.2 | |
| | 12-14 pounds | 23.4 | 2.1 | 0.1 | | |
| | 14-16 pounds | 1.7 | | | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 175 | Median index of lean | 64.5 | 67.7 | 70.4 | 73.0 | 75.7 |
| | Mean weight of fatback, pounds | 11.56 | 9.56 | 7.87 | 6.25 | 4.56 |
| | Distribution of fatback weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | Under 6 pounds | | 0.7 | 10.0 | 43.2 | 83.9 |
| | 6-8 pounds | 0.7 | 13.5 | 43.6 | 45.3 | 15.2 |
| | 8-10 pounds | 13.5 | 47.6 | 39.2 | 11.0 | 0.9 |
| | 10-12 pounds | 47.6 | 33.5 | 7.0 | 0.5 | |
| | 12-14 pounds | 33.5 | 4.6 | 0.2 | | |
| | 14-16 pounds | 4.6 | 0.1 | | | |
| | 16-18 pounds | 0.1 | | | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 185 | Median index of lean | 64.0 | 67.1 | 69.7 | 72.3 | 75.4 |
| | Mean weight of fatback, pounds | 12.55 | 10.50 | 8.75 | 7.06 | 5.02 |
| | Distribution of fatback weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | Under 6 pounds | | 0.2 | 3.7 | 24.5 | 73.6 |
| | 6-8 pounds | 0.2 | 5.1 | 27.6 | 48.4 | 23.7 |
| | 8-10 pounds | 4.7 | 32.1 | 47.7 | 24.2 | 2.7 |
| | 10-12 pounds | 31.0 | 46.0 | 19.2 | 2.9 | |
| | 12-14 pounds | 46.7 | 15.4 | 1.8 | | |
| | 14-16 pounds | 16.1 | 1.2 | | | |
| | 16-18 pounds | 1.3 | | | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 42. Distribution of Fatback Weights by Carcass Weight and Grade—Continued**

| Carcass weight, pounds | | Carcass Grades 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| 195 | Median index of lean | 64.3 | 67.3 | 69.9 | 72.5 | 75.5 |
| | Mean weight of fatback, pounds | 13.02 | 10.93 | 9.12 | 7.31 | 5.22 |
| | Distribution of fatback weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | Under 6 pounds | | 0.1 | 2.7 | 21.2 | 68.4 |
| | 6-8 pounds | 0.1 | 3.5 | 21.8 | 45.1 | 27.2 |
| | 8-10 pounds | 3.1 | 24.8 | 46.0 | 28.8 | 4.2 |
| | 10-12 pounds | 23.2 | 46.0 | 25.7 | 4.7 | 0.2 |
| | 12-14 pounds | 46.2 | 22.6 | 3.7 | 0.2 | |
| | 14-16 pounds | 24.0 | 2.9 | 0.1 | | |
| | 16-18 pounds | 3.3 | 0.1 | | | |
| | 18-20 pounds | 0.1 | | | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 205 | Median index of lean | 64.5 | 67.5 | 70.1 | 72.7 | 75.7 |
| | Mean weight of fatback, pounds | 13.54 | 11.34 | 9.45 | 7.54 | 5.34 |
| | Distribution of fatback weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | Under 6 pounds | | 0.1 | 2.2 | 18.4 | 65.2 |
| | 6-8 pounds | | 2.5 | 17.6 | 42.2 | 28.7 |
| | 8-10 pounds | 1.9 | 19.2 | 42.8 | 31.9 | 5.8 |
| | 10-12 pounds | 16.5 | 43.4 | 30.6 | 7.1 | 0.3 |
| | 12-14 pounds | 42.2 | 28.7 | 6.4 | 0.4 | |
| | 14-16 pounds | 31.9 | 5.8 | 0.4 | | |
| | 16-18 pounds | 7.1 | 0.3 | | | |
| | 18-20 pounds | 0.4 | | | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 215 | Median index of lean | 64.8 | 67.7 | 70.3 | 72.8 | 75.8 |
| | Mean weight of fatback, pounds | 13.97 | 11.75 | 9.75 | 7.83 | 5.52 |
| | Distribution of fatback weights | Per cent | Per cent | Per cent | Per cent | Per cent |
| | Under 6 pounds | | | 1.8 | 15.4 | 60.6 |
| | 6-8 pounds | | 1.8 | 14.8 | 38.2 | 31.9 |
| | 8-10 pounds | 1.3 | 14.8 | 39.0 | 35.1 | 7.1 |
| | 10-12 pounds | 12.3 | 39.0 | 33.8 | 10.3 | 0.4 |
| | 12-14 pounds | 37.2 | 33.8 | 9.7 | 1.0 | |
| | 14-16 pounds | 36.4 | 9.6 | 0.9 | | |
| | 16-18 pounds | 11.6 | 0.9 | | | |
| | 18-20 pounds | 1.2 | | | | |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |