



# pork industry handbook

COOPERATIVE EXTENSION SERVICE • MICHIGAN STATE UNIVERSITY

## Carcass Evaluation

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### Introduction

Carcass evaluation is an essential part of determining relative success in pork production. Following reproduction, feeding and marketing of the hog, the final step is its transformation to food for humans. Through these processes, swine producers can effectively evaluate their progress in selection and management. In addition to measuring efficiency in terms of producing large, healthy litters that gain rapidly using a minimum of feed, producers should also be concerned about how much lean, edible pork is produced, and how desirable it is to process and consume. It is the purpose of this fact sheet to describe quantitative and qualitative characteristics associated with pork carcass desirability, and to identify procedures that can be practically standardized and applied to measure these characteristics throughout the pork industry.

### Transforming the Pig to Pork

**Identification.** Each pig is tattooed with approved edible ink at two locations on each side of the pig. If pigs are skinned rather than dehaired, metal tags can be clipped to both ears. After bleeding and before the head is removed, the tags are removed, placed in a plastic bag and securely pinned to the foreshank.

**Inspection.** The veterinarian in charge of inspection at the slaughter plant can be asked to record information concerning any specific abnormalities that are observed during ante-mortem and post-mortem inspection. Even though carcasses may pass inspection, some abnormalities may exist (e.g., jowl abscesses, arthritis, and cryptorchidism). The producer should be informed if such conditions are present in his swine. It is recommended that such carcasses be eliminated from competition.

**Hot carcass weight and belly dimension.** The hot weight is observed and then written on the carcass with an

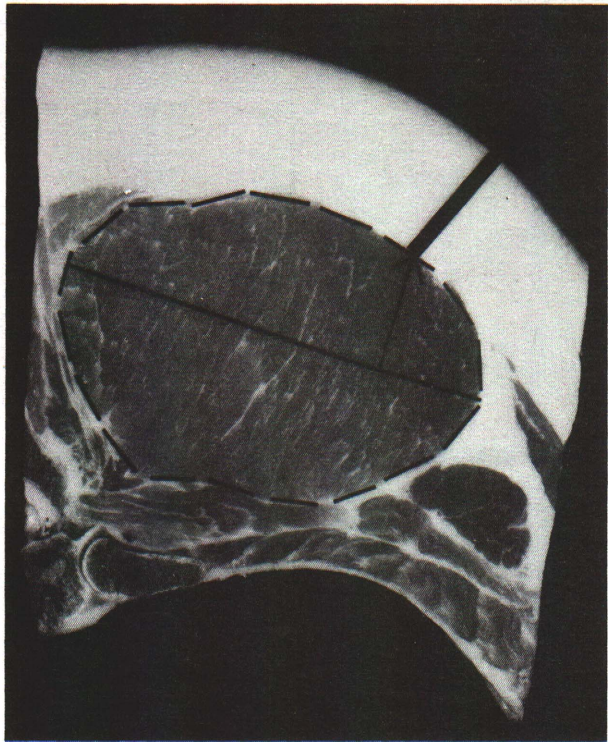
edible ink marker, or if time and space do not permit this, weight may be recorded sequentially on a weigh sheet. One advantage of writing on the carcass is that fewer are lost in the coolers. If chilled weights are recorded, convert to a hot weight basis by dividing by .985 (most carcasses shrink about 1.5% during drying and chilling). For skinned carcasses, adjust to a skin-on basis by dividing the hot weight by 0.94 (the skin accounts for about 6% of hot carcass weight).

If jowls are removed, or if muscle, fat or bone have been removed from locations where measurements need to be taken, or if excessive muscle, fat and/or bone have been removed because of bruises or localized infections, the carcass should not be considered for competition. If the trim loss is not excessive, the amount missing should be estimated and added to the hot carcass weight.

A minimum carcass weight of 140 lb. is recommended for competition. However, if there is a concern about thin bellies at this weight, then the minimum carcass weight requirement should be increased. To date, there is no objective definition of a belly that is too thin; such descriptions have not been standardized and there is no clearly interpreted and practical method for identifying such cuts. Most carcasses weighing 150 lb. or more will be free of the thin-belly problem. Once bellies meet minimal dimensions for subsequent processing, the major concern is desirable composition and quality.

**Ribbing the carcass.** To measure quantitative and qualitative characteristics, the vertebra of the untrimmed carcass is first cut with a saw perpendicular to the long axis of the loin between the 10th and 11th ribs or between the 6th and 7th ribs, depending upon which method described in the next section is used. Start adjacent to the 11th or 7th rib to permit a square cut across the loin muscle without cutting into the 10th or 6th rib. After the vertebra is sawed,





**Figure 1. Loin eye area and fat depth at 10th rib location.**

use a knife and extend the cut no more than 1 in. beyond the outer end of the loin eye surface. Extending the cut further will damage the belly. Ribbing should be done only on properly chilled carcasses (12 hours or more after slaughter), and it should be completed a minimum of 30 minutes prior to visual examination to allow for full expression of the qualitative characteristics.

#### **Quantitative Characteristics**

Quantity refers to the proportionate amount of lean or muscle that a carcass contains. Degree of fatness and extent of muscling (reflecting variation in muscle-bone ratio) are the two important factors associated with quantity. It is desirable to have as much muscle and as little fat, bone and skin as biologically possible without jeopardizing qualitative and production factors. When comparing carcasses or measuring the production efficiency of a pig, it would be ideal to determine the proportion of muscle by physical dissection and chemical analysis. However, these procedures are not practical under most circumstances. Simpler, though less accurate, methods are used to estimate composition. Use of one of the following four methods (listed in order of preference) is recommended, with the specific methods often depending on circumstances in the cooperating packing plant.

#### **Hot carcass weight, fat depth and loin eye area at 10th rib.**

- **Fat depth.** Divide the longest axis of the loin muscle into quarters. Measure the fat depth opposite a point that is  $\frac{3}{4}$  the distance along the long axis toward the belly. The measurement is taken in tenths of inches from the edge of the loin muscle to the outer edge of and perpendicular to the skin (see Fig. 1). For skinned carcasses, add 0.1 in. to the measurement. For greater accuracy, both sides of the carcass could be ribbed, measured and averaged. There is no minimum fat thickness that can be recommended because there is



**Figure 2. Carcass length and backfat thickness measures.**

little or no information to support a minimal acceptable fatness level. As long as selection against fatness does not result in muscle quality deficiencies, inadequacies in belly characteristics or live production efficiency, producers must continually attempt to reduce fatness.

- **Loin eye area.** This measurement is taken in square inches by using a clear plastic grid (Grid AS-235 is available from Iowa State University, Ames). Loin eye area is determined by measuring the cross-sectional area as illustrated in Figure 1. The area can also be measured by tracing the outer perimeter of the loin muscle on acetate paper and using a compensating



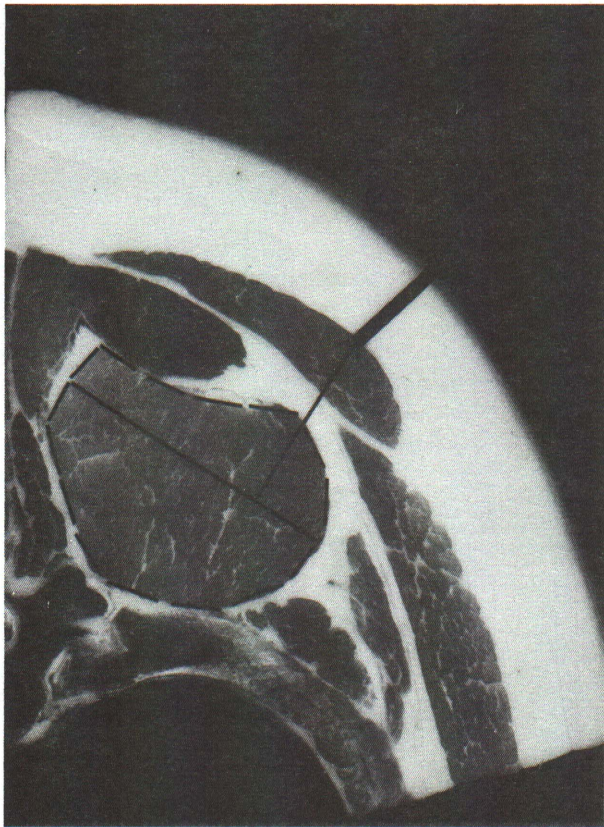


Figure 3. Loin eye area and fat depth at 6th rib location.

polar planimeter to measure the area on the tracing paper. For accuracy, both sides of the carcass could be ribbed and measured and the values averaged.

- **Combining hot carcass weight, fat depth and loin eye area to estimate pounds or percentage of muscle (containing 10% fat).** The following equation can be used to estimate pounds of muscle in a carcass.

$$\begin{aligned} \text{Pounds of muscle} &= 2 \\ &+ (\text{hot carcass weight, lb.} \times .45) \\ &+ (\text{loin eye area, in.}^2 \times 5) \\ &- (\text{fat depth, in.} \times 11) \end{aligned}$$

To determine percentage of muscle in the carcass, divide pounds of muscle by hot carcass weight and multiply by 100. This calculation also applies to the three subsequent methods.

A table of conversion values is published in "Procedures to Evaluate Market Hogs" (NPPC), published by the National Pork Producers Council, Des Moines, Iowa, and can be used as an alternative to solving the above equation.

For purposes of competition, it is recommended that carcasses grade U. S. No. 1 (U.S.D.A. specifications) and meet minimum breed certification standards as outlined in Table 1. Carcass length is measured in as straight a line as possible, from the anterior tip of the aitch bone to the anterior edge of the first rib and next to the vertebra (see Fig. 2). The longest side should be used to determine carcass length. The information included in this paragraph also applies to the following three methods.

**Hot carcass weight, fat depth, loin eye area and seam fat score at 6th rib.**

- **Fat depth.** Divide the longest axis of the loin muscle into quarters. Measure the fat depth opposite a point that is

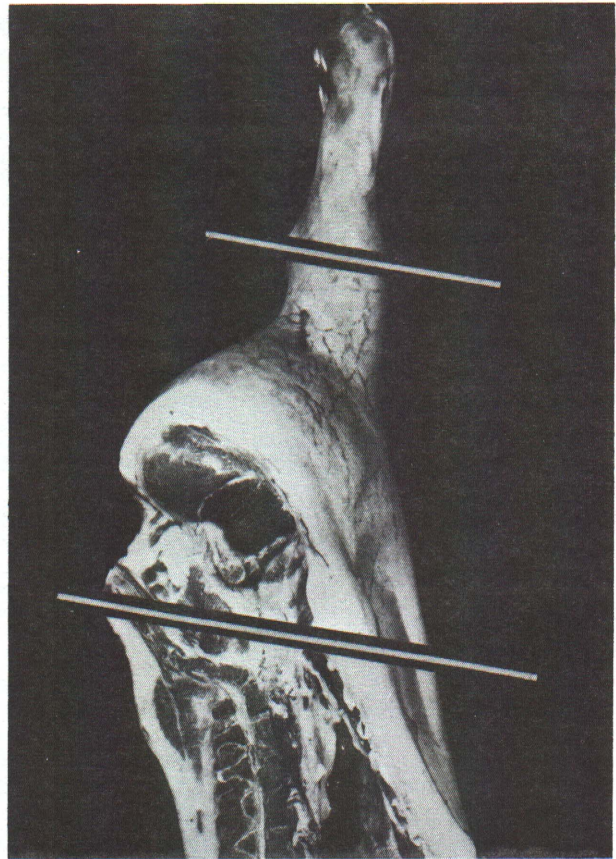


Figure 4. Skinned-defatted ham.

$\frac{3}{4}$  the distance along the long axis toward the belly. The measurement is taken in tenths of inches from the edge of the outer muscle (*trapezius*) to the outer edge of and perpendicular to the skin (see Fig.3). When in doubt, measure from the thickest portion of the *trapezius*. For skinned carcasses, add 0.1 in. to the measurement. For greater accuracy, both sides of the carcass could be ribbed, measured and the values averaged.

- **Loin eye area.** This measurement is taken similarly to that described previously and as illustrated in Figure 3.
- **Seam fat scores.** Scores range from 0 to 5, including 0 = very little, 1 = slight, 2 = small, 3 = moderate, 4 = abundant and 5 = very abundant. Photographs of these scores can be obtained by requesting the centerfold of "Procedures to Evaluate Market Hogs" (NPPC).



- **Combining hot carcass weight, fat depth, loin eye area and seam fat score to estimate pounds or percentage of muscle (containing 10% fat).**

$$\begin{aligned} \text{Pounds of muscle} &= 4.5 \\ &+ (\text{hot carcass weight, lb.} \times .47) \\ &+ (\text{loin eye area, in.}^2 \times 6.4) \\ &- (\text{fat depth, in.} \times 5.8) \\ &- (\text{seam fat score} \times 2.5) \end{aligned}$$

**Hot carcass weight, skinned-defatted ham weight and average backfat.**

- **Skinned-defatted ham weight.** The ham is removed from the carcass at a point half the distance between the anterior tip of the aitch bone and the last lumbar vertebra (see Fig. 4). The line of cutting is perpendicular to the long axis of the limb. The foot is removed by cutting parallel to the cut which separates the ham and loin and is made through the center of the tip of the hock. The tail (posterior to the last sacral vertebra), all skin and all external fat are removed. The ham is weighed to the nearest tenth of a pound.
- **Average backfat thickness.** This includes the average of three measurements of backfat taken at points opposite the first rib, last rib, and last lumbar vertebra (see Fig. 2). Each measurement is made to the nearest tenth of an inch, perpendicular to and including the skin, and includes only the middle and outer layers of fat exposed on the split surface of the backfat. Measurements from one side of the carcass are usually satisfactory for accuracy, but both sides should be measured if the carcass is split off-center. Subjective adjustments of the average thickness should be made only when there are mechanical disfigurements and/or very unusual fat distributions. If the skin has been removed, add 0.1 in. to adjust to a skin-on basis.
- **Combining hot carcass weight, skinned-defatted ham weight and average backfat thickness to estimate pounds or percentage of muscle (containing 10% fat).**

$$\begin{aligned} \text{Pounds of muscle} &= 15.3 \\ &+ (\text{hot carcass weight, lb.} \times .3) \\ &+ (\text{skinned-defatted ham weight, lb.} \times 2) \\ &- (\text{average backfat thickness, in.} \times 7.75) \end{aligned}$$

**Hot carcass weight and average backfat thickness.**

- **Combining hot carcass weight and average backfat thickness to estimate pounds or percentage of muscle (containing 10% fat).**

$$\begin{aligned} \text{Pounds of muscle} &= 21.3 \\ &+ (\text{hot carcass weight, lb.} \times .55) \\ &- (\text{average backfat thickness, in.} \times 17.75) \end{aligned}$$

**Qualitative Characteristics**

Desirable fresh pork quality is defined as a combination of physical traits that provides for an edible product that

loses a minimum of constituents, is wholesome after processing and storage, is attractive in appearance, and is appetizing, nutritious and palatable after cooking. Nutritive value is basic to pork quality; the primary merit of pork as a food is its nutrient content. Pork muscle contains the essential amino acids in biologically available form; the water-soluble vitamins, especially thiamine; some minerals, notably iron; and high-energy lipids, including the essential fatty acids.

Wholesomeness refers in large part to the freedom from undesirable microorganisms, which is influenced by the health of the live pig and by proper sanitation during handling and storage of pork. Together, nutritive value and wholesomeness satisfy the minimum requirements for pork to be used as food.

Suitability for processing relates to pork which sustains minimal shrinkage, and this is related to muscle acidity. Attractiveness of pork is an esthetic factor that is determined largely by its color and structural appearance, as well as its convenience (size of cut, amount of bone, etc.) for use as food. Palatability characteristics include flavor (taste and aroma), tenderness, texture, and juiciness. The following quality factors are related to shrinkage, appearance and palatability and should be useful predictors of pork quality.

**Muscle color.** Pork muscle should be bright grayish pink to pinkish red. Individual muscles are usually uniform in color, but muscle groups in close proximity often display considerable variability in color (such as in the ham). Darker color may result from increased quantities of color pigments, greater physiological activity, less surface oxygen, surface dehydration, bacterial contamination or minimal production of lactic acid during carcass chilling.

Muscles that are too pale or too dark are objectionable in appearance in retail trade. Abnormally pale muscles quickly turn gray in the retail display case and often incur considerable shrinkage, resulting in economic losses during processing and in dry-tasting products after cooking. Dark muscles will have a shorter shelf life because of their higher pH, and are considered by some consumers to originate from older animals (generally not a correct assumption). The five color scores (1 = pale, 2 = slightly pink, 3 = grayish pink, 4 = slightly dark red, and 5 = dark red) shown in "Procedures to Evaluate Market Hogs" (NPPC) represent normal variation of pork color. It is recommended that carcasses having either of the two extreme color scores be disqualified from competition.

**Muscle firmness and texture.** If the loin is soft and watery, displaying obvious fluid accumulations on its surface and exhibiting a loose, coarse texture, the carcass should be eliminated from competition. This condition is related to the pale color described above and such a product often sustains excessive shrinkage during processing and is dry when eaten.

**Intramuscular fat.** Marbling is visible fat within the boundaries of loin muscle. Slight to moderate amounts

**Table 1. Breed certification standards for 220-lb. live hogs.**

Breed	Carcass length (in.)	Average backfat thickness skin-on, (in.)	Loin eye area (10th rib, sq. in.)	Days to 220 lb.
Hampshire	29.5	1.5	4.50	175
Spotted swine	29.5	1.5	4.75	180
All other breeds & crossbreds	29.5	1.5	4.50	180



**Table 2. Recommended data collection form to facilitate processing by computer.**

Name of Program or Contest National Barrow Show, Austin, Minn. 9-17-78  
 Producer's Name E.E. Smith  
 Address (town, state, zip) B.P. 1 Mt. Moriah, Missouri  
 Telephone (area code and number) 217-238-7878

Data starts in card column

1 10  
1 4 3  
4 0 4

1. Class number  
 3. Live identification number  
 6. Carcass tattoo

1  
3  
3

9. Sex (barrow = 1, gilt = 2)  
 10. Breed of sire } 1 = Berk; 2 = CW; 3 = Duroc; 4 = Hamp; 5 = Land;  
 11. Breed of dam } 6 = P.C.; 7 = Spot; 8 = York; 9 = crossbred  
 12. Age in days, date farrowed 4-1-78, date slaughtered 9-13-78, or date acquired —, farm condition weight —

1 6 5

15. Liveweight, lb.  
 Hot carcass weight, lb. 158  
 18. Adjusted hot carcass weight, lb. (estimated lb. of trim to be added 2)

2 2 5

1 6 0

21. USDA Muscling Score 1 = very thick; 2 = thick; 3 = moderately thick; 4 = slightly thin; 5 = thin; 6 = very thin  
 22. Carcass length, in. (use longest side to meet minimum standard)  
 25. Average backfat thickness (including skin), in. First rib 1.4 Last rib 1.0 last lumbar 1.2

2

2 9 7

1 2 0

5 0

1 0 0

28. Average or single loin eye area, sq. in., (10th rib) or (6th rib) right 5.0 left —  
 30. Average or single fat depth over loin eye, in. (10th rib) or (6th rib) right 1.0 left —

1 0 0

X X

33. Average or single seam fat score (6th rib), 0 = very little; 1 = slight; 2 = small; 3 = moderate; 4 = abundant; 5 = very abundant. right — left —  
 35. Weight of skinned, defatted ham, lb.

X X X

3 0

38. Average or single muscle color score, 1 = pale; 2 = slightly pink; 3 = grayish pink; 4 = slightly dark; 5 = dark. right 3 left —

2 0

40. Average or single muscle marbling score, 1 = traces; 2 = slight; 3 = small; 4 = moderate; 5 = abundant. right 2 left —

3 0

42. Average or single muscle firmness-watery score, 1 = unacceptable; 2 = questionable; 3 = acceptable. right 3 left —

0 9 0 0

44. Carcass visual abnormalities; 1 = jowl abscess; 2 = excess trim; 3 = arthritis; 4 = cryptorchid; 5 = diseases; 6 = blood splashing; 7 = soft, oily fat; 8 = fatty infiltration; 9 = other —

0 9 0 0

1

48. Does carcass meet breed certification standards? 1 = yes, 2 = no

shown in "Procedures to Evaluate Market Hogs" (NPPC) are desired to provide a juicy and flavorful cooked product. Pork with traces or less marbling may be less flavorful and less juicy than desired. However, at the other extreme, abundant marbling does not make pork proportionately more palatable but does supply excess calories (thus

diluting the nutritive value) making these pork products objectionable to some consumers. It is recommended that carcasses possessing traces or abundant quantities of marbling be disqualified from competition.

**Abnormalities.** Pork fat should be firm and white. Soft, oily and slightly brownish colored fat is objectionable



because it is not attractive when displayed at the market place and is more susceptible to the onset of rancidity during processing and storage.

Other abnormalities affecting the acceptability of pork muscle include fatty infiltration and blood splashing. Such conditions are rare but if present should be grounds for disqualification.

### **Combining Quantitative and Qualitative Characteristics of the Carcass with Live Production Traits**

If carcasses are to be ranked on the basis of overall merit, then each carcass should (a) be free of all abnormalities and (b) meet minimum standards for muscle quality (slightly pink to slightly dark red, slight to moderate amounts of marbling, and free of the soft, watery, coarse-textured properties). Quantitatively, they should grade U.S. No. 1 and be eligible for breed certification (Table 1). Carcasses meeting these criteria can then be ranked on percentage muscle as calculated by one of the four

methods described, preferably the one using hot carcass weight, loin eye area and fat depth at the 10th rib.

Carcass excellence in itself is desirable but is not the ultimate answer to successful pork production. Factors indicative of carcass quality and composition should be combined with live visual traits and production records as described in "Procedures to Evaluate Market Hogs" (NPPC). Age units required to produce 85 lb. of acceptable quality pork muscle should be implemented to measure more realistically overall progress in pork production, rather than simply ranking entries on the basis of percent muscle.

### **Data Collection and Dissemination**

A completed form containing raw carcass data is presented as Table 2. These data can be transferred to data processing cards or tapes to make appropriate calculations for efficiently disseminating the results. For circumstances where computers are not available, a form shown in "Procedures to Evaluate Market Hogs" (NPPC) can be used.