Extensive record keeping will be required. And there will be certifiers out in the field. The federal role will be to assure that the standards are there, certifiers are audited, and some overall integrity is provided to the program.

There are still a lot of questions. Like with livestock, how far back do you take it? There will be a hearing on livestock standards next week in Washington. There are labeling issues with the Food Safety and Inspection Service. It also has international implications. The European Community has a directive that has diverse requirements for organic which make it difficult for us to get organic into the EC. There are international organic organizations that do their own certification activities.

Grading Systems in the Pork and Beef Industries

Marvin Hayenga and James Kliebenstein[1]

Government commodity grading systems have a long and sometimes controversial history in the livestock and meat industry. Historically, the only way to develop standard procedures for a very independent and fragmented group of producers and processors has been to utilize the auspices of government. Originally, the primary reason for government grading systems was to facilitate (1) more accurate identification of value-related differences in commodities being marketed for both buyers and sellers, (2) an improved competitive process, and (3) improved resource allocation (producing the "right" products) in the industry.

The government grading system in the beef industry has been a frequent subject of controversy and, infrequently, changed in the last 30 years, while the pork government grading system has fallen into disuse. In this paper, we focus primarily on the pork industry grading system, its history, alternative criteria and grading approaches, and offer some recommendations. Then we discuss some related issues regarding the beef grading system and consider possible changes.

Question: Why not let the beef industry develop private standards the way the pork industry did?

Response: That would be throwing the baby out with the bath. There's a lot of investment in the system, so it would be better to adjust the system rather than reinvent the wheel.

Question: Isn't there still a lot of consumer dissatisfaction with pork standards? Bacon, for example.

Response: The pork industry is moving rapidly toward being more responsive to consumer demand.

Grading System Objectives[2]

The objective of commodity grading systems is to sort a population with heterogeneous characteristics with some economic importance for commodity users, into lots with more uniform or homogeneous characteristics. A desirable grading system should increase product uniformity, reduce the perceived risk of commodity users in purchasing a particular grade of a product, and facilitate purchases on the basis of description rather than personal observation or testing. Grades can serve as the basis for determining product prices in line with product value. A more accurate and equitable pricing system can

[1]This paper draws extensively from "The Pork Grading System" in *A New Technological Era in Agriculture*, published by the Office of Technology Assessment. See that report for detailed references omitted in this paper. We received valuable comments from R. G. Kauffman on an earlier draft of this paper.

[2]For an excellent discussion of the economics of grades, see Nichols, Hill and Nelson (1983) and Bockstael (1987).

stimulate producers to use their resources to produce commodities with characteristics more aligned with customer demands. Further, effective market price reporting systems must use grades and other relevant differentiating characteristics of the product, if price reports are to accurately communicate changes in equilibrium market prices and prevailing product quality incentives to market participants.

A common set of descriptive criteria and class or grade labels, rather than a disparate group in an industry, can facilitate these functions in the same way that a common language facilitates communication. However, common grading systems may not be economically justified if customer groups put different values on various product characteristics, or processors differ in their evaluation technology or the market niches in which they participate.

Pork Grading Systems

Grading systems in the pork industry are used primarily at the producer-packer level of the marketing system. Nearly all packers employ their individually-designed market-hog carcass grading systems in: (1) their carcass merit (grade and yield) market hog purchasing from farmers and (2) their internal hog buyer evaluation systems. The latter may also affect prices offered to producers of hogs that vary in carcass characteristics and value. USDA grades for market hogs (based on their expected carcass characteristics) have been used in the Federal-State Market News reporting system for recording market hog prices. (The recommended procedure has recently been adopted in price reporting in several regions of the United States.). However, USDA grades are not used by the industry to establish wholesale pork prices, as the carcass characteristics of the market hog population have changed significantly, while the USDA grading system has not.

Grading systems in the pork industry soon may be subject to even more stress when some emerging technologies (porcine somatotropin, beta adrenergic agonists) become commercially available. These growth promotants used in market hog production have been shown to change pork carcass composition. If the relative mix of carcass lean and fat—the primary factor in current pork grading and pricing systems—changes, grading and evaluation systems of the USDA and individual pork processors and merchandisers may have to change to more accurately convey carcass value differences.

The changes in composition of the market hog population, the significant changes occurring in packer classification and pricing systems in the last two decades, the nonuse of federal grades, the potential technological changes affecting pork product composition and quality, and the emergence of new measurement technologies for pork carcass quality evaluation suggest a need for reexamination of the current grading and evaluation systems in the pork industry. Do the current systems provide effective carcass value information? What changes are worthwhile for the USDA, meat packers, and other pork industry participants?

Evolution of USDA Pork Carcass Grade Standards

Tentative standards for grades of pork carcasses and fresh pork cuts were issued by USDA in 1931 and revised slightly in 1933. New standards for grades of barrow and gilt carcasses were proposed by USDA in 1949 and became effective in 1952. These standards represented the first application of objective measurements as criteria for grades for pork carcasses.

The official standards were amended in July 1955, by changing the grade designations Choice No. 1, Choice No. 2, and Choice No. 3 to U.S. No. 1, U.S. No. 2, and U.S. No. 3, respectively. In addition, the

backfat thickness requirements were reduced for each grade, and the descriptive specifications were reworded slightly to reflect the reduced fat thickness requirements and to allow more uniform interpretation of the standards. In 1968, the official standards were again revised to reflect the improvements made since 1955 in pork carcass composition. The minimum backfat thickness requirement for the U.S. No. 1 grade was eliminated, and a new U.S. No. 1 grade was established to properly identify the superior pork carcasses. The former No. 1, No. 2, and No. 3 grades were renamed No. 2, No. 3 and No. 4, respectively. The former Medium and Cull grades were combined and renamed U.S. Utility. Also, the maximum allowable adjustment for variations-from-normal fat distribution and muscling were changed from one-half to one full grade to more adequately reflect the effect of these factors on yields of carcass cuts.

USDA grade surveys in 1980 and 1981-82 found that over 70 percent of pork carcasses were graded U.S. No. 1, and over 24 percent were No. 2. The studies also found that a large amount of variation in lean yield was not accounted for by the grading system, so the USDA standards were not effectively discriminating among hogs varying significantly in value.

As a result, the USDA changed the backfat standards for each grade in 1985 to reflect improvements in pork carcasses and changes in the pork slaughter industry since 1968. The grade of a barrow or gilt carcass with acceptable lean quality and belly thickness is placed in one of four grades, denoted by numbers 1 through 4. This is determined by considering two characteristics: (1) the backfat thickness over the last rib and (2) the degree of muscling (thickness of muscling in relation to skeletal size). These grades are based primarily on the expected carcass yields of the four lean cuts. The fat thickness range in each grade was narrowed from 0.3 inch to 0.25 inch, to more adequately sort the pork carcasses being produced according to value.

While there is an official Utility grade for any carcass with unacceptable quality of lean, soft or oily fat, or bellies that are too thin, only 0.1 percent of the 1980 USDA study of the market hog grade distribution were classified as Utility (Parham and Agnew 1982), and no mention of the Utility grade was made in an unpublished 1988-89 USDA pork carcass grade survey. Thus, while quality is supposed to be one factor in the USDA grades, the current system is almost entirely based on expected yield, which in turn is predominantly determined by the backfat thickness (relative to carcass weight). Thick or thin muscling is supposed to be a factor that could cause a one-grade shift from the preliminary grade based on backfat, but only 4.4 percent of the carcasses in the 1988-89 carcass study were classified as superior muscling, and 4.9 percent were inferior muscling, suggesting that muscling plays a very small role in affecting USDA grades. The bottom line is that USDA grades provide very little differentiation on quality. In addition, a 1989 study of the market hog characteristics from five plants in the South and Midwest found 98 percent of the pigs were in the U.S. No. 1 or 2 grades (Rothschild et al. 1990). Thus, the situation may be similar to what it was in the early 1980s: The USDA grades are again providing little differentiation on carcass yield and value.

Packer Grading System

A USDA study of pork slaughter firm grade and yield systems used by 12 packers in 1981 and 1982 found that the systems used for grade and yield purchases and internal buyer evaluation varied in their bases for packer grade standards (usually one or more from a list of backfat, muscling, percentage of carcass weight consisting of primal cuts, and conformation). One plant had no grading system. At that time, visual appraisal by packer employees was the

primary method used for grading. One packer used actual backfat measurement to establish the carcass grade. Each packer's grade and evaluation system was individually designed, with differences in grade criteria, descriptive terms used for grades, and evaluation methods among packers. The USDA grading system was not used by any of the packers.

Since the 1981-82 study, packer grading and evaluation systems have further changed. A 1990 Iowa State University survey of 12 of the largest pork slaughter firms found that their systems have changed so much they no longer have much in common with the USDA grading system. Four of the largest packers indicated that actual backfat measurements were the primary basis for their internal evaluation system and their carcass merit buying systems (though the grade could be modified by extremes in muscling noted by visual evaluation). Where backfat measurements were employed, the top grades often had much lower backfat thresholds than USDA grades currently do, with three individual packers reporting their top grades beginning at 0.6 inch, 0.75 inch , and 0.8 inch or less of backfat. Seven firms reported using or switching in the near term to the use of the Fat-O-Meater, an electronic probe measuring fat thickness and loin depth. With the Fat-O-Meater, the basis for the packers' carcass grades becomes the percent lean in the carcass rather than the estimated four lean cut yield that serves as the basis for USDA grades. This has one potential shortcoming—when the total lean yield from the carcass is the basis for carcass evaluation, that implicitly weights lean from all muscle groups equally, essentially disregarding any market price or value differentials that exist.

One packer reported using visual evaluation of carcass fat thickness and muscling, in conjunction with actual trimmed ham and loin weights from each carcass to determine value differences for carcasses. With this system value differences become the focus of the evaluation system rather than lean content or four lean cut yield.

These survey results appear quite consistent with a 1990 University of Wisconsin packer survey by Kauffman (1990) who reported 53 percent of pork carcasses were evaluated using a Fat-O-Meater, 41 percent by measuring backfat with a ruler, 4 percent by carcass cutout, and 2 percent by visual appraisal of the carcass. All packers were using carcass weights in their evaluation procedure.

Thus, the most prevalent methods of packer grading and evaluation have basic criteria, specific measures employed in grading, and terminology that differ from the current USDA system. Packers using a ruler measurement had their top grades begin at backfat levels significantly lower than the 1 inch or less standard for the current U.S. No. 1 grade. A 1988-89 USDA survey of pork carcasses found 8.3 percent with 0.8 inch of backfat or less, and 9 percent between 0.8 and 0.9 inch of backfat. Packers paying higher incentives for the leanest hogs would have more of their slaughter volume in those categories.

The Usefulness of Current Grading Systems

Several aspects of current grading systems influence their usefulness. The relevance of the criteria employed, the accuracy of measurement and value differentiation, and the technical feasibility and cost of the grading system are briefly considered below for the USDA grading system, with some comparisons to the grading and specification systems currently in use by packers and pork merchandisers.

Relevance of Criteria Used

The USDA emphasizes primal (lean) cut yield as the distinguishing characteristic of different grades, with backfat thickness as

the primary predictor, with a minor influence played by muscling. The quality of fat and lean is mentioned in the specifications, but they play practically no role. Though never explicitly mentioned in the grade standards, it seems clear that the four lean cuts serve as a proxy for carcass value. These cuts represent a significant portion of the carcass and are relatively high in price, resulting in a major proportion of total carcass value. The percentage of carcass lean recently adopted by many packers (Fat-O-Meater) as the basis for their evaluation procedures is also a proxy for carcass value, reflecting the fact that the relative price of fat is sharply lower than lean.

While the current USDA grading system employed for pork carcasses has relevance to packers, it has little or no usefulness to processors of pork products or consumers of meat. Criteria such as muscling in the grade standards are hardly ever a factor in grades. Furthermore, the PSE (pale, soft, exudative) pork quality problem in some pork carcasses is not easy to identify in pork carcasses at the time of grading. In addition, palatability traits important to consumers are not considered in the current grading system. Maximum fat thickness or fat content of pork products may be designated in a grocery chain or HRI[3] buyer's product purchasing specifications, in a packer's standard trim, or on branded package labels in the meat case, but not by government grades at the wholesale or retail level of the pork merchandising system.

Accuracy of Grading Methods

In 1984, Grisdale et al. (1984) estimated that carcass value was most highly correlated with the 10th rib backfat (r = -.79), followed by other backfat measures (r = -.78 to -.64). Also, the yield of four lean cuts used to establish USDA grades was a reasonably good proxy for carcass value (r = -.76).

The USDA backfat categories and muscling score used in the grading system at that time explained much less of the variation in carcass value—due to the lumping together of a range of 0.3 inch of backfat into a single grade, when 0.1 inch of backfat significantly changed carcass value. Subjective visual evaluation systems used in the actual grading would have even more error than the objective measurements in the Grisdale study, though good training programs can minimize that error.

Feasibility of Grading Methods

The simplest and least costly method to use in high chain speed packing plants is visual carcass evaluation, followed closely by measuring external fat thickness with a ruler at one location on the carcass. Combined with scale weights of carcasses, these procedures were the dominant ones employed by U.S. packers until the last few years when an electronic device called the Fat-O-Meater became better able to withstand the difficult working conditions and the demands imposed by chain speeds of 1000 or more carcasses per hour. Splitting the loin to make muscle area measurements was too time consuming and expensive in loss of high value product to warrant its use in grading procedures. While the electronic measurement system does not estimate loin muscle size, it does estimate loin muscle depth and backfat thickness in one simple procedure, and translation equations based on typical electronic measurement and carcass cutout relationships established in cutout tests can be used in today's microchip technology to estimate carcass lean percentage, or percent of four lean cuts, or even carcass value directly if appropriate prices are used in the evaluation system. Tracing the weight of each cut from each hog as it moves through the processing lines in a plant is more costly, though it could certainly add to evaluation precision. Presently, only one packer is using actual

[3]Hotel, restaurant, institutional.

weights of the ham and loin from each carcass in its routine evaluation procedure. The usefulness of magnetic scanning (TOBEC) to determine carcass lean composition is being explored in the lab and in one packing plant, but it has not been shown to be commercially feasible.

Factors Influencing Pork Value

In determining potential criteria for use in alternative grading systems, it seems logical to focus on those characteristics considered most important by the ultimate consumer of pork products, with some consideration of the factors that might be considered important by the intermediate merchandiser and the pork processor. The goal of an evaluation scheme as it pertains to pork quality is to predict from characteristics of fresh meat the general merit and value of the cooked product.

Consumers

Besides price, consumers usually consider certain product characteristics that they consider important when purchasing pork products, including the amount of lean versus fat and bone, cholesterol levels, flavor, tenderness, texture, firmness, degree of marbling, juiciness, color of the lean and fat, and aroma of the product. However, some of these factors are easier to discern than others, and their relative importance varies greatly among consumers.

The USDA grades of pork are influenced largely by subcutaneous (external) fat. In the pork carcass, external fat accounts for approximately 70 percent of total carcass fat. Backfat thickness is highly related to yield of lean cuts and total carcass lean. Until recently external fat was trimmed to approximately ¼ inch on pork cuts at the retail level. The Pork Market Basket Study completed in 1990 at the University of Wisconsin revealed that retail pork is currently trimmed to an average of only ⅛ inch of external fat.

Although trimming away undesirable external fat is one method of improving product quality and increasing consumer appeal, it is not appealing to the retailer who suffers the trim loss or to pork producers who suffer poor feed efficiency (producing fat requires more calories than lean). Furthermore, carcasses with excessive external fat are likely to contain more intermuscular or seam fat that is difficult to locate and remove, particularly in large roasts. Seam fat levels in excess of 20 percent of weight are common in some pork products; on average that type of fat represents 15 percent of carcass weight. Thus, the trimming away of external fat deposits is a less than satisfactory solution to the fatness issue, but it is a major cause of the improved leanness observed at the retail level in the Wisconsin Pork Market Basket Study.

An accurate method of determining directly the total fat percentage or lean/fat ratio of carcass products would be valuable in influencing consumer and packer acceptance of the product, and its value. Fat-free lean percentages are widely used (and widely accepted by consumers) in retail store meat merchandising of ground meats and branded lunch meat products.

The relative importance of marbling (intramuscular fat) and the degree necessary for minimum acceptability are not clearly established. There is a closer relationship between marbling and juiciness than between marbling and tenderness, although both exhibit a positive relationship. Further, marbling appears to be more important to palatability in fresh than cured pork and more important in chops than in roasts. However, marbling or intramuscular fat does affect palatability.

Although controversial, the fat component of meat also has been implicated as contributing to cardiovascular disease through saturated fatty acids and cholesterol content. Recently, red meat consumption has been linked to higher rates of some types of cancer.

Problems of poor muscle quality continue to plague the pork industry. Frequencies of pale, soft and exudative (PSE) and dark, firm and dry muscle ranging from 3-25 percent have been reported among carcasses in U.S. packing plants. PSE pork has the tendency to lose water.

Color, as a quality factor, is currently recognized in the USDA standards to be used for evaluating overall muscle quality. Color per se does not contribute to overall palatability; rather it is an easily observed indicator of physiological, chemical or microbiological changes in muscle that create palatability differences. Further, our largest export customer, Japan, is quite concerned with lean that is too pale in color.

Texture and firmness of meat are also factors influencing consumer acceptance. It is quite possible that the effect on consumer acceptance is relatively small (Stringer 1970). Extremes in texture would be important, but the small variations usually found in retail pork may have little direct influence on customer acceptance.

Objective tenderness measurements such as the Warner-Bratzler shear test have been positively correlated with palatability (tenderness) of cooked pork as well as other meats. To date, there is no practical direct method of evaluating tenderness in fresh meat or the carcass. Indirect indicators of meat tenderness such as color and texture of lean are inadequate indicators to use in commercial grading systems.

Nutrient content variation in pork cuts similar in lean/fat ratio is primarily due to the PSE condition and the resultant drip of nutrient-containing juices. Several nutritional components are water soluble and may be lost during retail storage or cooking. Losses, however, represent a very small portion of total nutrients present in pork; only extreme differences will appreciably change the nutritive value of fresh pork. Flavor is the most difficult trait to define of all the sensory traits. Fat is primarily responsible for the species-specific flavor. However, lean is also known to have important flavor components. Minimum quantities of fat necessary for "typical" flavor are not clearly defined because juiciness becomes a palatability factor at low fat levels before loss of flavor occurs. The lipid component of pork can lead to the development of off-flavors. The high degree of unsaturated fatty acids in pork fat is the major reason for the potentially greater rancidity of pork relative to beef. Vacuum packaging and the use of antioxidants increases the shelf life of pork.

Boar taint, or sex odor as it is more correctly termed, since it is not limited exclusively to boars, has been a problem for the pork industry. About 5-10 percent of young, slaughter-age, intact male pigs (5½ months or younger) are known to produce boar taint, a common cause of offensive odor and muscle toughness. Castration removes the taint. Determination of skatole or androsterone levels can aid in detecting boar taint.

Processors

Pork quality criteria desired by the processor are similar to those valued by the consumer. Processors are concerned first about price per unit of salable, high-value product and, second, about the potential of the product for value-added treatment to meet customer specifications. Like the consumer, the processor is very concerned about the lean content of the animals, carcasses or cuts purchased. Carcasses or cuts requiring an excessive amount of trimming of subcutaneous fat represent a direct loss and also may result in a product with excessive seam and intramuscular fat. Grading methods that discriminate between degrees of subcutaneous fatness, as well as fatness in other carcass locations, would be valuable to the immediate processor.

Water holding capacity is important to processors in curing and processing pork products, often with "water added." Water

retention of fresh pork is affected by the pH of the muscle and is associated with the PSE condition. The softness and tendency to lose water within the package as drip are effects of rapid postmortem pH drop in muscle. This characteristic, besides giving products an unattractive watery appearance, represents significant weight loss at all stages of distribution, thus becoming a basis for economic comparisons between normal and PSE products. It is generally agreed that the PSE condition is less than desirable for several reasons. Cured product color is poor, resulting in a two-toned appearance in ham. Loss of water results in considerably lower product yields when PSE pork is processed. PSE fresh pork has limited display life and discolors very quickly. The ability of PSE meat to emulsify fat, as in frankfurter and bologna processing, is also impaired. However, the PSE muscle may still be used if the condition is recognized and processing is modified.

Possible Developments in Pork Grading Systems

Of these characteristics that influence the value of pork, external fat thickness is the most easily measured at commercial slaughter plant line speeds. Characteristics such as cholesterol and fatty acid saturation, muscle quality, nutrient content and flavor are difficult to directly assess with present technology in modern pork slaughter plant operations. Muscle quality is related to the PSE condition and to muscle color, which may be influenced by genetics or handling conditions. However, the color may not present itself until 12-24 hours post mortem. Nutrient content of the final cooked product can be affected by the PSE problem. While these characteristics apparently can be indirectly measured, it would be necessary to maintain pig carcass identity up to 24 hours post mortem.

There is also some difficulty in directly measuring characteristics such as lean/fat ratios, intramuscular fat, and freedom from odors. Methods are currently available to measure lean and fat and provide a moderately accurate estimate of the lean/fat ratio. However, there are some problems with these technologies at rapid slaughter plant line speeds. Sex odor can be determined within one hour after slaughter (currently being done in all Danish slaughter houses, but at slow line speeds). Measurement of intramuscular fat appears to be more difficult.

Lean in the carcass is an important determinant of value. However, the distribution of lean between high and low value cuts is also important. Moreover, growth promotants may change the distribution of lean within the carcass and alter the relationship between high and low value cuts of meat. Thus, predictive equations based on current carcass characteristic relationships will not necessarily hold for those pigs having been administered growth promotants.

For pork processors, lean yield, water-holding capacity, shelf life and other processing capacities such as the meat's ability to emulsify fat are important characteristics. As discussed above, water-holding capacity, shelf life, and fat emulsification are adversely affected by PSE, so the ability to detect this condition is crucial to pork processors and pork exporters, with PSE-free pork having a higher value.

Technologies currently available for measuring pork carcass composition include visual assessment, direct manual measurements, carcass cutting and dissection, carcass grinding and chemical analysis, optical and mechanical fat-lean probes, and mechanical pneumatic assessment of muscling. Of these, the simplest is visual assessment, followed by direct manual measurement. However, these can be labor intensive, difficult to standardize and somewhat variable in accuracy. Carcass cutting and dissection along with carcass grinding and chemical

analysis are not practical with rapid line speeds. They also require added labor and lead to increased product loss in the testing process. Current use of optical and mechanical fat-lean probes is expanding and appears to provide information for reliable estimation of carcass lean. These probes may have potential for mass adoption by the industry for pork grading, though some uncertainty remains about their durability under stressful plant conditions. Fat-lean probes also offer the opportunity to take multiple carcass measurements, thus improving the ability to pay according to distribution of and quantity of lean cuts. However, the cost and practicality of taking multiple measurements at fast line speeds presents a problem. The Danish are using depths of backfat and lean taken at numerous positions on the carcass, but at line speeds less than 400 head per hour. Mechanical pneumatic assessment of muscling currently is not as accurate as fat/lean probes.

Technology not currently available on a commercial scale, but with potential in the future, includes magnetic resonance imaging, X-ray computed tomography, video image analysis of muscling and fat depth, bioimpedance analysis, and ultrasound. Magnetic resonance image measures are highly correlated with lipid, water, and protein content—three characteristics of value to processors and consumers. However, this technology is currently very expensive, so it is at best a longer-run technology for the industry. X-ray or CAT scan have been shown to provide very accurate predictions of pork carcass composition but are not practical for today's pork slaughter house. Ultrasound and bioimpedance analysis appear to be promising technologies which offer the opportunity for multiple carcass measurement and estimation of carcass lean.

Incremental Changes to Consider in Pork Grading

If factors considered important by consumers are not effectively incorporated into pork product grading or labeling systems, and visual evaluations by consumers do not discriminate among desirable and undesirable products, then the consumer's risk of getting an undesirable pork product is not reduced by the information provided by the grade of the product. Purchase volumes and relative prices of products with desirable and undesirable characteristics cannot reflect consumer desires if consumers don't know product characteristic differences. Value differences must be reflected back through the marketing system to producers to encourage "good" products and discourage "undesirable" products. The same is true for product characteristics influencing processor yields of high-value products.

What could improve the usefulness of grading systems? Should they be implemented in the private sector, the public sector, or both? Because the USDA grading system has only been used in price reporting in recent years and because packers have their own systems and would be unlikely to adopt a changed USDA system, one alternative is to do nothing. Although the current system is not uniform among packers, making comparisons of prices based on carcass classification difficult in some cases, there are enough packers using carcass lean percentages as the basis for pricing that there may not be a major problem.

The simplest change in the USDA grading system would be to shift the grade standards toward reduced backfat levels, making ranges for each grade more closely fit the range of leanness in market hogs and allowing less variability in carcass value within grades. Although many packers have already done this, such continuing change in packer technology and improvements in the market hog population's distribution of

fat thicknesses would eventually make the grading system obsolete.

A second possible change would involve the USDA shifting to carcass lean percentage (e.g., 54 percent lean) as the basis for grades, rather than the yield of the four lean cuts currently associated with the USDA numerical grading system. Simple lean percentages (or very narrow percentage lean classes) could replace the numbered grades used in the current system which continually become less discriminating in value as the distribution of carcass characteristics in the hog population continually changes over time. Many packers have shifted to probe measurement systems in which their grades and prices are based on estimates of carcass lean percentages. Since not all packers currently use the probe measurement system which calculates percentage lean in the carcass, the typical relationships between carcass lean percentage and other measurements used by packers not using the probe measurement system would have to be determined. These relationships would be used in price reporting, but they also would need to be made available to pork producers in education programs during the transition, to facilitate their comparisons of packer grading and pricing systems and their understanding of the new price reporting system.

In either packer or USDA systems, hogs produced using some new growth promotants may need to be segregated in handling, grading and reporting if there are significant differences in their carcass composition relationships with whatever fat and lean measurement system is employed by packers. New cutout tests would be necessary to accurately estimate the relationship of any external carcass measures to the lean content and value of the carcass.

For possible consumer grades, grading or labeling the quality of lean would appear desirable in pork products and carcasses. However, this is not yet practical due to the lack of commercially feasible measurement technology.

Nutrient composition or similar labeling of fat content, calories, fatty acid profiles or cholesterol content for pork products at the consumer level would provide information that could be useful in consumer decision-making, possibly enhancing demand, but more surely assisting in providing clearer signals to producers and processors regarding consumer preferences. Some branded pork processors are currently providing some of this information (e.g., 95 percent fat free). In addition, some industry consumer information programs are beginning to move in this direction. Unfortunately, the commercially available technology for fat content evaluation is primarily adaptable to ground meat. Adapting this approach to highly variable intact fresh and processed pork products could add relatively significant capital and labor costs, especially in small processing and merchandising operations. Measuring other nutrients is typically even more difficult.

Several promising technologies in the research and development stage might provide accurate estimates of lean/fat composition of carcasses or pork products, unaffected by the changes brought on by the new growth promotants. This research should be encouraged. The information, when commercially feasible, could be incorporated with a grading program focused on carcass percent lean. When a commercially feasible lean quality measurement becomes available, pork carcass yield and quality grades or classes could be used to segregate carcasses according to value. Reporting pork prices could then be similar to the current beef yield and quality designations (e.g., Choice, yield grade 2), or could be based more directly on carcass lean percentage and a quantitative measure of lean quality.

Beef Grading Systems

The beef grading system was the first meat grading system initiated by the USDA, beginning in 1924. Beef grades were initially designed to provide a basis for uniform price reporting of dressed beef prices. Significant changes have been made in the USDA standards 10 different times, with the most recent being the introduction of the Select grade to replace the Good grade in the quality hierarchy (Kline 1981). Also, since 1989 yield grades can be obtained without quality grades and vice versa.

The current USDA quality grades for beef (Prime, Choice, Select, etc.) are used in product descriptions at the wholesale level as well as retail merchandising levels of the beef market where Prime (seldom), Choice or Select quality grades are virtually the only grades observed on retail package labels or restaurant menus. The primary factors determining the quality grade are the amount and distribution of intramuscular fat (subjective evaluation of marbling) in the lean, evaluated between the 12th and 13th ribs, and the maturity or chronological age of the carcass (measured by visual evaluation of bone calcification and the color of lean).

The yield grades (1-5) are used in the wholesale beef distribution system, although specific fat trim specifications are often used in packer merchandising programs or customer purchase arrangements. The yield grade is determined by subjective evaluations of the fat thickness over the rib eye between the 12th and 13th rib, the area of the rib eye relative to the size of the carcass, and kidney, heart and pelvic fat deviations from a base of 3.5 percent of carcass weight. The resulting whole number yield grade is based on the estimated yield of trimmed retail cuts expected to be derived from the carcass. Each yield grade's expected range in retail cut yield is approximately 2 percent.

USDA beef grades are used extensively by most beef packers in carcass merit purchasing and internal buyer evaluation systems, and in wholesale beef merchandising. The Federal-State Market News reporting system also uses USDA beef grades in both live cattle and wholesale beef price reporting. Between September 1992 and September 1993, the Agricultural Marketing Service reports having graded 95.2 percent of federally inspected steer and heifer slaughter and 81.2 percent of federally inspected beef slaughter; 80.7 percent of total steer and heifer slaughter were quality graded and yield graded, while 14.5 percent were only yield graded. Almost all steers and heifers graded were in the Choice (55 percent) or Select (24 percent) quality grade, while 48 percent of those yield graded were in yield grade 2; 40 percent, in yield grade 3. Thus, the bulk of all fed cattle is concentrated in few grades. In 1989, over 36 percent of all cattle were purchased on a carcass basis (defined as grade, weight, yield, guaranteed yield or combination thereof by the Packers and Stockyards Administration).

Issues

Over the last two decades, the primary controversies (besides the name change from Good to Select) were about where the separation points ought to be between quality grades Choice and (now) Select, and recently whether the yield grades ought to be further subdivided to provide more differentiation in value. Is the quality grade basis for differentiation meaningful to consumers? Does it minimize the risk of unacceptable results? Does the yield grade adequately reflect value differences among carcasses?

Relevant Research

In 1981, a National Beef Grading Conference held at Iowa State University thoroughly explored the relevant research and issues. F.C. Parrish, Jr. summarized the research at that time on marbling and age affecting palatability and concluded that marbling is

positively and significantly related to palatability, but there is much variability in palatability not explained by marbling. Only the oldest animals exhibited less tenderness. However, the amount of cooking affected palatability significantly—e.g., well done is not desirable. At the same conference, R. G. Kauffman traced the changes in yield grading in the 1960s and 1970s, as the extent of yield grading increased from 3 percent of slaughter in 1965 to 100 percent in 1976 when yield grading became required if the carcass was quality graded. The price differential between yield grade 3 and 4 carcasses widened dramatically in the late 1970s, while the Choice and Good price spread narrowed. These trends were associated with the increasing consumer demand for beef with less external and intramuscular fat, as fat and cholesterol from red meats became associated with cardiovascular and other health concerns.

Recent research dealing with quality and yield grades usually confirms the earlier studies. Savell et al. (1989) studied consumer acceptance of Choice and Select quality grade steaks and roasts and found they were approximately equally rated by consumers, but for different reasons. Choice was better tasting, but also fatter. Despite similar external fat trim, select cuts were leaner but less acceptable in taste and texture. Smith et al. (1984) found that differences in marbling explained only a small proportion of the variation in overall palatability ratings and had limited value in taste panel acceptance. In contrast, Parrish et al. (1991) reported that untrained consumer panels did consider the palatability of Prime, Choice and Select steaks to be significantly different. Rouse et al. (1993) found that the marbling score determined by a USDA grader had a correlation of .75 with an objective measurement of intramuscular fat; this imprecision may contribute to the limited value of marbling scores in predicting palatability.

Reiling et al. (1992) evaluated the yield grading equation developed in 1960 and found that it still explained variations in retail cut yield fairly well. However, adding data on actual yields of one trimmed cut (the round) substantially reduced the errors in estimating retail cut yield.

Packer Perspectives

A brief survey of beef grading managers at a few large meat packers was conducted by the authors to elicit other possible issues or problems with the current beef grading system. One manager suggested that the errors in yield grading were primarily associated with the subjective rather than objective estimation of rib eye area, making in-plant accuracy much lower than the studies based on objective measures would suggest. The yield differences between sexes and the Holstein breed yield difference versus most other breeds were cited as smaller problems of the current yield grading system. The significant price discount associated with grading errors leading to lower grades, especially yield 4, is the primary economic concern raised about yield grading. The concern was expressed that splitting current yield grades into smaller classes would increase the incidence of grading errors. One packer indicated that yield 2 and 3 carcass value differentials are quite small, near $10 per carcass, though that differential would likely increase if more beef merchandisers shifted to ¼ inch or less trim in retail merchandising. Yield 3 and 4 value differences were perceived as much greater—over $40 per carcass—though highly variable in response to changes in the relative supply of fatter cattle.

On quality grades, the success of the Certified Angus Beef merchandising program, especially with restaurant operations, was cited as an example where the current Choice grade was being subdivided successfully (top ⅔ of Choice, predominantly black angus breeding) and

apparently satisfying one class of customers. While there are disagreements regarding the usefulness of current quality grades in accurately predicting eating quality (it is a relatively weak predictor), many customers demand them.[4] Other packer managers cited the more heavily marbled part of the Choice grade as being perceived as too fat by many customers. Therefore, they prefer lowering the marbling requirements for the Choice grade, in the belief that change would not adversely influence customer satisfaction. Thus, we may have a dichotomy in consumer reaction to more marbling in beef—it may be desirable for some food service customers and some retail customers but be viewed as undesirable by an increasingly large class of fat averse consumers who dislike excess marbling and other fat in the beef they buy.

USDA market reports do convey price differentials for steers and heifers and Choice versus Select quality grades, but they do not differentiate among yield grades in their price reporting (they report yield 1-3 as a group). USDA reporters indicate that there are typically no premiums paid by packers for yield grades 1 and 2 versus yield 3, that yield 3 and 4 price differentials typically are near $12 per cwt. carcass, but have been as great as $28 per cwt. carcass. Yield grade 4 carcasses are not very numerous (2 percent of all carcasses selected to be graded), which probably accounts for their prices not being reported. Choice and Select quality grade differences range from $3-6 per cwt. carcass.

Beef Grading Alternatives

The current beef grading system is clearly perceived as very useful by most market participants, as evidenced by the very high use of USDA grades in the beef merchandising system. However, there is an inconsistency emerging in the reaction to higher levels of intramuscular fat by some classes of consumers. This raises questions regarding the current adequacy of quality grades primarily as a function of marbling, which is not a very good indicator of product palatability. Further, the gradual shift of the beef merchandisers to more closely trimmed product, if continued, seems likely to create increasing value differences between and within current yield grades. This may call for more differentiation than the current system allows. The ideal yield grading system reflecting value differences not associated with lean quality would involve actual weights of the closely trimmed, boneless high value products per pound of total carcass weight, weighted by relative wholesale prices, as an index of relative value of a beef carcass. This involves identifying, tracking and weighing various cuts from a carcass at the end of the fabrication process; this would be quite costly. A less costly alternative is to slightly restructure the current yield grading system by eliminating five yield grades. Not only do two grades comprise most of the fed beef population, but each grade includes a range in value that is likely to increase over time if more fat removal becomes common in beef merchandising. Since the current yield grades are based on the likely yield of trimmed retail cuts, why not shift directly to that index of value or the percent lean content of the carcass (50 percent retail cuts or lean). This would still employ the same measures employed in the current yield grade equations (rib eye size, fat thickness, etc.).[5] By shifting to percent retail yield or

[4]Based on his experience and early results from an ongoing study, Savell indicates that the more heavily marbled beef may be more forgiving (acceptable) when beef is overcooked. Some restaurant managers may believe that they are reducing the probability of an unhappy customer with higher marbling purchase specifications.

[5]Packers indicate that there are yield differences associated with sex and breeding (heifers and Brahman breeding are lower yielding) that are not built into the current yield grade equation. Adding

lean as a continuous index, the gradations in value would be more precise than the fairly gross groupings now employed, and errors in grading, while probably more frequent, would be much smaller in their economic consequences. When the fat and lean characteristics of the fed cattle population change over time, or the measurement technology becomes commercially available to directly estimate carcass lean, the grading system would accommodate those changes easily. The ideal quality grading system would involve objective measurement of palatability, not yet commercially feasible. The current quality grade is based primarily on age, which does not vary much, and intramuscular fat, which is a poor indicator of palatability. If an animal is very young, palatability is likely to be acceptable with almost any amount of marbling. If age could be determined more accurately than with the current subjective method, one could classify all steers and heifers as young, for Choice or Select, or old for some other grade. This would probably significantly reduce the risk of unacceptable palatability.

Further, the presence of a high level of intramuscular fat is perceived negatively by a growing part of the consumer population, but positively by others. Yet the terms Choice and Select have some meaning for consumers, even though they may not be very discriminating aids to consumer decision making. This is a quandary without a straight forward, clear prescription. Marbling is loosely, but positively, associated with palatabiliy; yet, at the same time, some consumers perceive marbling as a negative. Therefore, perhaps the best solution would be simple descriptions of the degree of marbling, if feasible, in quatitative terms, such as grams per unit of weight, rather than the current subjective marbling score. Then, combining too much with too little marbling in a grouping called Choice could be avoided. Customers would simply indicate which range of marbling was acceptable in their purchase specifications. The tradeoff would be the loss of the terms Choice or Select in consumer merchandising, though marbling measures or scores could be on the label, or retail or packer brands could be employed to provide assurance of minimum quality levels. Currently, some of the marbling scores employed in the Choice grade mean different things to different people, potentially creating problems in consumer satisfaction.

Another alternative would involve surveying consumers to discover the threshold levels of intramuscular fat minimally or maximally acceptable to consumer classes with differing preferences. Then, the Choice grade could be used as the high marbling grade, Select could be the low marbling grade; but the actual borders for each grade would be based upon consumer preferences, not on beef industry subjective opinion. Since marbling is not the best forecaster of consumer satisfaction, other factors influencing palatability, such as length of time in feedlot, energy content of the ration, and extent of Brahman genetic influence ought to also be considered in determining the quality grade.

footnote 5 continued
these factors into the yield grading process would only slightly improve the yield forecast accuracy.

Phillips: I agree with Hayenga: Government grading programs are no longer needed in the pork industry, for the functions are being handled very well privately. However, I disagree with him about beef. I think that, over time, there will be less need to provide information via grades. For the same reasons as in the other commodity areas: structural change in the industry and technological change. There are some very high-tech genetic improvements on the horizon for beef. Soon, the industry will be able to produce a very uniform product, day in and day out. Over time, there will be much less product variation. Brand names

will become more important in communicating information than any grading system ever devised could be. Brand labeling in the meat area is coming soon. Many quality characteristics will be tied to various brand names at the retail level.

Hayenga: On the beef industry: Beef packers have not come up with branded products yet because they haven't figured out a way to assure the quality and get this conveyed to customers. Maybe 10 to 15 years from now, but it's not even close to reality.

Meyer: The problem in the pork industry with branded products is one of consistency. An argument could be made that sorting at the packer level and branding various products out of that process could be more manageable. But the beef industry has a bigger challenge than the pork industry. We deal with a number of product lines, maybe 20 to 30; whereas, the beef industry deals with several times that number, plus having a lot of backyard farmers with a few cows confounding the consistency problem.

Conclusions

The grading systems for pork and beef have some interesting similarities and differences. Both are yield based, but only beef has a quality classification system. The government grading system has failed to stay abreast of the changes in the pork population and advances in grading technology. The industry has changed much faster than the government grading system, so private firm grading (and related pricing systems) have totally displaced the USDA pork grading system. In beef, the USDA grading system has been frequently fine tuned; and it is extensively used in fed cattle purchasing, packing plants, and wholesale and retail beef merchandising. As a result, the recommendations for improvement will be quite different. With beef, further fine tuning of a relatively useful system is recommended. With pork, we conclude that the government grading system should not be revived, and price reporting in the pork sector should be based on industry practices, not government grades.

The current USDA pork grading system is not effectively differentiating between carcasses that vary widely in value. This will become accentuated to an even greater degree in an industry when animals are produced using new growth promotant technology such as porcine somatotropin or beta-agonists. The current USDA system of pork grades is not being used by the meat industry. The grading and classification systems used by packers have evolved much more quickly in response to the changing characteristics of the market hog population and market realities than the government system has. It seems likely that the same pattern would repeat itself in the future, if the government grades were updated, so we recommend that the government grading system be allowed to expire. Even if the government system were updated, packers who have developed their own grading and evaluation systems tailored to their individual situations would be unlikely to shift to a volunteer government system. Most packers are shifting to a percent lean classification and pricing system and periodically modify their standards to effectively discriminate among the leanest hogs. We recommend that the pork price reporting system be based on the same percent lean classification system. The packing industry has stayed abreast of the changing market hog population characteristics, and the pricing of market hogs has become more closely related to value received in the last decade. The lack of perfect comparability of grading and pricing systems among packers remains a problem—the producer decision regarding where to optimally sell particular hogs still has some uncertainty attached to it. However, the general shift toward carcass lean yield estimates as the basis for pricing has reduced much of that uncertainty.

When adequate measurement systems become available, the carcass lean

classification approach for carcasses can be modified to incorporate lean quality factors similar to what we propose for beef. Further, the growing use of percent lean labeling for processed, branded meat products could be expanded to other meat products when technically and economically feasible methods of measurement become available.

In our 1991 OTA report (Kliebenstein et al. 1992), we recommended that the government price reporting system should be modified to have market hog price reports based on percent lean classes that are quite narrow and cover the entire range of the pork population. These can be easily changed by the price reporting agencies as the market hog population characteristics change, without the bureaucratic wrangling involved in getting U.S. grades changed. For example, price quotations would be for a certain percent lean range and a particular weight class of barrows and gilts, e.g. 170-180 lb. carcass weight, 51-52 percent lean hogs in Iowa. Backfat thickness or other measures used by some packers could be converted to approximate carcass lean equivalents by reporters in the transition phase. This general approach has been gradually adopted by the Federal-State Market News over the last two years, initially in the Southeast on a trial basis, then expanded to the Western Corn Belt and Eastern Corn Belt.

The beef grading system has wide acceptance, but changing consumer preferences make the current marbling standards for Choice and Select worth reexamining. If the consumer population is becoming more dichotomous in its perceptions of the desirability of marbling, the current marbling thresholds for these grades should be reconsidered. Further, the low predictability of consumer satisfaction based on current grades suggests the need for new technology to directly measure palatability or for additional factors to be considered, to come up with a more accurate index of consumer acceptability than current quality grades represent. Otherwise, without an accurate indicator of palatability for the consumer, the quality grades for beef will lose their value in beef merchandising.

The beef yield grading system could be refined by using percent retail cuts or percent carcass lean as the yield index in place of the aggregated grouping into five yield grades (but only two are used). As the industry moves toward merchandising beef with much less exterior and seam fat, the value differences associated with the lean content of the carcass will increase. Having narrower classes will sharply reduce the economic magnitude of errors in grading and allow more precision in evaluation and pricing.

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Meyer:

This session is covering a wide variety of agricultural commodities, grains, fruits and vegetables, and meats. The common theme of all the presentations so far is that of changing grading systems to meet the needs of increasingly fragmented marketplaces. Consumers of the 1990s do not demand that products be lumped into broad categories; they want products that carry specific attributes. Therefore, agricultural producers, market systems and language (i.e., grading systems of the 1990s) must sort and price products in the same manner.

The National Pork Producers Council (NPPC) continues to grapple with this dilemma in its promotion of the Pork Quality Assurance program which seeks to educate producers about management strategies and control mechanisms to reduce the incidence of drug residues and damaged carcasses. Our conclusion has been that nearly 100 percent of production must be included before we can attempt to capitalize on the attributes created by the Pork Quality Assurance program. We know that such a participation level will be very difficult to achieve, but any suggestion of contamination may well undercut the advantage created by a supposedly "healthy" image.

It should be no surprise that my major interest lies in the paper by Hayenga and Kliebenstein. They cite overwhelming evidence in favor of scrapping the USDA system for grading market hogs, and I agree with their conclusion. The system simply isn't useful because it fails to reflect the value differences of animals and has

virtually been replaced by packers' own systems. The packer systems are, in most cases, based upon objective measurements and scientific-based predictions of value. And, while it is true that not all lean is worth the same amount and that packer systems, in general, treat all lean as such, these systems still provide far closer estimates of carcass value than do USDA 1, 2, 3, 4, and Utility. In addition, packer systems are sufficiently transparent to be understood by any producers who take the time to research and study them.

The NPPC and the American Meat Institute will soon initiate the Uniform Lean Information Project which addresses the main crux of Hayenga and Kliebenstein's recommendations. The project will utilize the Fat-Free Lean Index as a standardized lean measurement. This index will be comparable across packers, measurement systems, and time periods so the quality and improvement of a producer's hogs can be measured. The Fat-Free Lean Index will also provide a common language to classify pork products moving into international trade. And, a method of comparison will exist by which carcass prices can be more accurately reported by the USDA. This is not a government program. It is the result of 10 years of work by pork producers and pork packers. Such cooperation is likely to be the key determinant of the success of grading programs in the future.

Hayenga and Kliebenstein also discussed in some detail the challenges facing the beef grading system. While problems exist, I believe the beef industry must work to solve them instead of doing away with the system. Why? Simply because the terms "USDA Choice" and "USDA Prime" represent reputational capital of such great value. These terms are the standard of world's fed beef trade, and they carry strong connotations of quality in the United States. There is value in this system and its grades because they have always been used at the retail level and now carry "brand name" acceptance.

Contrast this "brand name" acceptance of beef grades to the lack of value that the live hog grading system currently possesses. The pork chain never carried its grading system to the retail level, so replacing it with a system that more accurately reflects the value of live hogs carries very little, if any, reputational cost to the industry.

Comment: In Denmark, the pork is run through much slower and there are many more processes. They do 17 probes to our one. They control genetics from the start. Because of their finely tuned system, they can do a lot more product differentiation.
Meyer: The difference in Denmark is that producers own the entire system. We can't internalize the decisions the way they can. It may happen over time as more integration takes place in the pork industry.