

Valuing Market Hogs: *Information and Pricing Issues*



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Executive Summary

Rapid and dramatic changes in hog industry structure have led to substantial changes in the way hogs are marketed and valued. Once common, live-hog negotiated cash markets have been largely replaced with marketing contracts. Under marketing contracts, each hog carcass value is comprised of a base price augmented with a premium or discount reflecting carcass quality attributes. These changes have created several issues that deserve industry consideration.

Most marketing contracts rely on prices negotiated in cash markets to establish base hog price. However, declining trade in cash hog markets (representing less than 20 percent of hog marketings) makes using these markets as a base problematic. In particular, concerns regarding how representative cash prices are of market conditions make their future use questionable. We evaluate several alternative base price methods and find that all alternatives have benefits and drawbacks. Given continued thinning of negotiated cash hog markets, however, moving toward formulas reliant on wholesale carlot pork price to establish base price is recommended. This means carlot pork price reporting, which is not included in mandatory price reporting, needs to be more comprehensive. In addition, variability in packer margins over time means that base prices linked to wholesale market values will be greater than cash hog prices at times and lower than cash hog prices at other times.

The USDA has attempted to keep up with these rapid changes by instituting mandatory price reporting for slaughter hogs, which facili-

tates base price reporting, and by publishing packer premium/discount schedules. However, the price and premium/discount schedule information reported by USDA is aggregated across such a varied set of carcass attributes that it is of limited value to producers. Further, additional contract details provided in the Swine Contract Library have not resolved the problems in interpreting the information contained in USDA price reports. We recommend additional work be done with USDA to improve price reports so they become easier to interpret and use.

As carcass merit pricing systems have become the norm, accurate pork yield and quality measurement have become more important to the industry. A variety of technologies have been, and are being, developed to objectively measure yield and quality attributes. The pork industry successfully increased lean meat yield over time. However, at the same time pork quality concerns associated with pale, soft, and exudative pork increased. On-line technology currently evaluates individual pork carcasses for lean meat yield. Ideally, technology could also be used to assess pork carcass quality. Functional pork quality can be determined by laboratory methods evaluating various physicochemical aspects of the lean tissue, yet rapid, on-line methods of evaluation have yet to exhibit a high degree of accuracy. Until technology is developed that predicts fresh pork quality accurately and quickly, every level of the pork production chain should strive to use existing production and processing techniques to develop a system that assures every pig will possess excellent pork quality.

Introduction

Hog production and marketing have changed dramatically. An industry once characterized by a large number of diversified operations rapidly evolved to one where specialization is the norm. Average operation size has been increasing for decades, but the pace of change accelerated during the 1990s. By 2000, 80 percent of the nation's hogs were produced by farms marketing 5,000 or more hogs per year and the top 156 firms produced 52 percent of U.S. hogs.

The way hogs are valued began to change at the same time specialization in hog production increased and industry structure became more concentrated. A little over two decades ago, less than 10 percent of U.S. hogs were marketed via carcass merit pricing systems. Now more than 75 percent of U.S. produced hogs are sold via carcass merit pricing systems. Carcass merit pricing values each hog carcass separately, thereby allowing processors to send clear signals regarding desirable or undesirable carcass characteristics.

Concurrent with the shift toward carcass merit pricing was a major shift away from use of daily cash markets (terminal markets and negotiated sales) to marketing contracts. Net price received for hogs sold via marketing contracts is a function of a base price and premiums/discounts associated with hog carcass characteristics. Base price, the premium/discount schedule, and hog carcass characteristics are all important determinants of price received for hogs marketed via a carcass merit pricing system. Most marketing contracts use a negotiated cash market price to establish the base price. Daily cash market volume has declined dramatically to where it represents a small share of total hog marketings raising concerns of how representative cash prices are of market conditions.

Several aspects of carcass merit valuation and marketing hogs via contract need additional consider-

ation. This report focuses on four major issues in changing slaughter hog market structure and pricing:

- 1) Rapidly changing hog market structure has created dramatic changes in the way hogs are sold and valued. New technology, size economies, and the need to provide consumers consistent pork products at competitive prices motivated the structural change. Economics will continue to drive change in this dynamic industry. This is important to keep in mind as policy positions are established.
- 2) Current USDA hog price reports do not provide a transparent view of market prices and may even mask whether observed price changes are attributable to changes in hog market fundamentals or simply a shift among firms purchasing hogs on a given day. Recommendations for changes are identified.
- 3) Declining negotiated cash market hog volume creates concerns about levels of competition in cash markets and whether the quality of hogs sold via negotiated trade is representative of the industry. We review alternative methodologies for base price establishment, highlighting pros and cons of each method.
- 4) Rewarding producers for production of leaner, heavier muscled pigs has resulted in an inadvertent deterioration of fresh pork quality. Electronic carcass grading equipment was developed to determine carcass lean meat yield and subsequently solve the industry's former problem with over-fat carcasses. Currently, the industry is struggling to identify electronic techniques capable of accurately evaluating pork quality. We review current and evolving technology used for evaluation of various factors associated with pork quality.

More than 75 percent of market hogs are sold via carcass merit pricing systems.

Daily negotiated cash hog marketings have declined dramatically and now represent a small share of total sales.

Operations marketing 5,000 head or more produce 80 percent of all hogs.

Ten years ago, 87 percent of slaughter hogs were sold in cash markets. Today, less than 15 percent of hogs are sold in cash markets.

Rapidly Changing Hog Market Structure

The structure of the U.S. pork industry has changed dramatically over the last decade. Periodic surveys conducted jointly by the University of Missouri and Iowa State University document much of the change (Lawrence and Grimes). The two most recent surveys covered the 1997 and 2000 marketing years. Changes that took place during that short time frame are revealing. For example, the industry's largest 145 farms produced 37 percent of hogs marketed and farms that marketed 5,000 head or more per year produced 63 percent of hogs sold in the United States during 1997. But the picture changed by 2000.

Farms that produced at least 5,000 hogs per year produced 80 percent of all the hogs marketed in the United States during 2000 (Table 1). The 20 largest firms alone marketed 33.3 million hogs during 2000, approximately 35 percent of the total. Combined hog marketings of the largest 156 operations marketing 50,000 or more head per year accounted for 52 percent of all the hogs sold in the United States during 2000 (Lawrence and Grimes). Clearly, during the 1990s, large hog production operations were realizing significant economies of size.

Not surprisingly, given the increasing prevalence of very large hog operations, the way hogs are marketed changed dramatically. A decade ago (1993), Hayenga *et al.* estimated that 87 percent of all market hogs were sold in cash markets. The remaining 13 percent of U.S. hog marketings were contracted for sale to packers or owned by packers. As hog production firms increased in size, securing a market for slaughter hogs became increasingly important, and operation size could be used as leverage for negotiations with packers. As a result, contracting and packer ownership both became more prevalent during the ensuing decade, to the point where percentages sold via cash markets and contracts have nearly reversed.

Survey results compiled by University of Missouri and Iowa State University revealed that marketing contract usage grew dramatically in just four years. According to Lawrence and Grimes, 57 percent of all hogs marketed in the United States during 1997 were sold via contract or owned by a packer, and the remaining 43 percent of hogs were sold via the cash market. Contract usage continued to grow during the late 1990s. Survey data summarizing marketing patterns during 2000 suggest that 71 percent of all hogs marketed that year were sold via contract, although this figure might overstate marketing contract usage since it likely included some packer-owned hogs (Lawrence and Grimes). The remaining 29 percent of hogs marketed during 2000 were sold in the cash market.

More recent research indicates negotiated cash market sales of hogs continue to shrink. A review of hog sales data published by the U.S. Department of Agriculture (USDA) Agricultural Marketing Service (AMS) indicates that just 13.5 percent of hogs sold during January 2003 were sold in negotiated cash markets compared with 16.7 percent one year earlier (Grimes, Plain,

Table 1. *Estimated Number of Operations and Share of U.S Slaughter 2000, by Size Category Based on Annual Marketings*.*

Annual Marketings 1,000 head.	Number of Operations	Market Share %
<1	54,513	2
1-2	10,034	7
2-3	4,118	5
3-5	3,312	7
5-10	2,627	10
10-50	2,501	18
50-500	136	17
500+	20	35
Total	77,260	100

*Source: Lawrence, J. and G. Grimes. *Production and Marketing Characteristics of U.S. Pork Producers, 2000. Staff Paper No. 343, Department of Economics, Iowa State University, August 2001.*

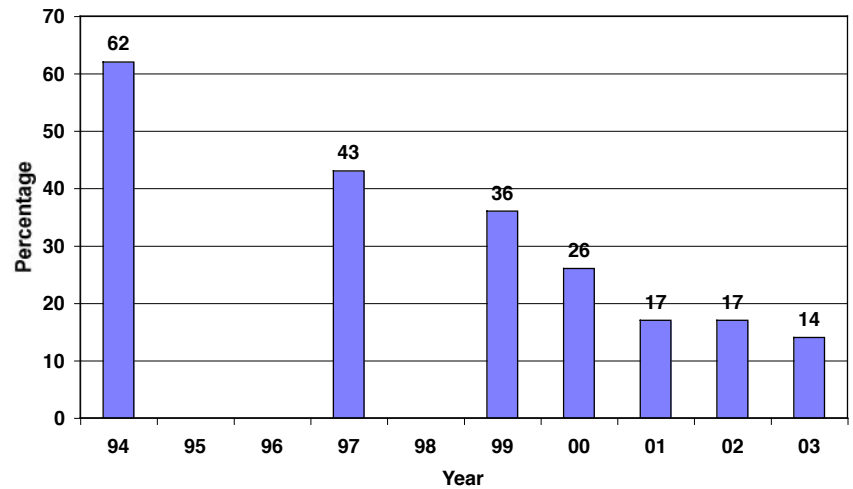
and Meyer). Surveys conducted by the same researchers in January of 1999, 2000, and 2001 indicate cash market usage fell from 35.8 percent of slaughter hogs marketed in 1999 to 17.3 percent in 2001, with further declines in subsequent years summarized from USDA mandatory price reports that were launched during 2001 (Figure 1).

Carcass Merit Pricing Escalates

Until recently, most hogs in the United States were sold via a live weight pricing system that did not explicitly provide premiums for hogs possessing desirable carcass traits, or discounts for undesirable carcass traits. Consider that, in 1980, just 8 percent of U.S. hogs were marketed via a carcass merit system. But by 1999, approximately 75 percent of hogs sold in the United States were marketed via a carcass merit pricing system (Plain). Larger farms are more likely to market hogs based upon carcass merit. Survey data covering hogs marketed during 2000 indicate that large operations, marketing more than 50,000 head per year, sold nearly all (over 97 percent) of their production via carcass merit pricing methods (Lawrence and Grimes). And even smaller operations sold the majority of their hogs via carcass merit pricing systems. During 2000 farms marketing 1,000 to 3,000 head per year sold more than 60 percent of their hogs via carcass merit pricing systems and farms marketing 3,000 to 10,000 thousand hogs sold 80 percent of their hogs via carcass merit (Lawrence and Grimes).

Carcass merit pricing systems value each hog carcass individually and thereby provide the opportunity for packers to signal producers regarding carcass attributes they find desirable or undesirable. In general, carcass merit pricing systems start off with a base carcass price and carcass quality premiums and discounts are added to the base price to calculate net price received for each carcass. The

Figure 1. *Percent of Hogs Sold on the Negotiated Market.*



Source: U.S. Hog Marketing Contract Study, January 2003. G. Grimes, R. Plain and S. Meyer.

base carcass price is associated with a standard set of carcass characteristics, but individual packers have different base carcass characteristics and different premium/discount schedules. As a result, comparing base and net prices across packers for the same quality hogs requires knowing both the base price and the particular premium/discount schedule each packer is using.

Controversy regarding prices being paid for livestock, both in negotiated and marketing contract trade, was one of the motivations behind passage of the Livestock Mandatory Reporting Act in 1999. As a result, hog price reporting changed dramatically in 2001 when all major packers began providing hog pricing data to USDA electronically twice daily, reporting all of their purchases. The transition from the old voluntary to the mandatory price reporting system has created a number of challenges for hog producers as they attempt to interpret and assess marketing opportunities.

Difficulty in Determining Hog Market Price and Associated Premiums and Discounts

Understanding and interpreting the plethora of hog price information reported by USDA is a substantial challenge. The USDA's Agricultural Marketing Service (AMS) began mandatory

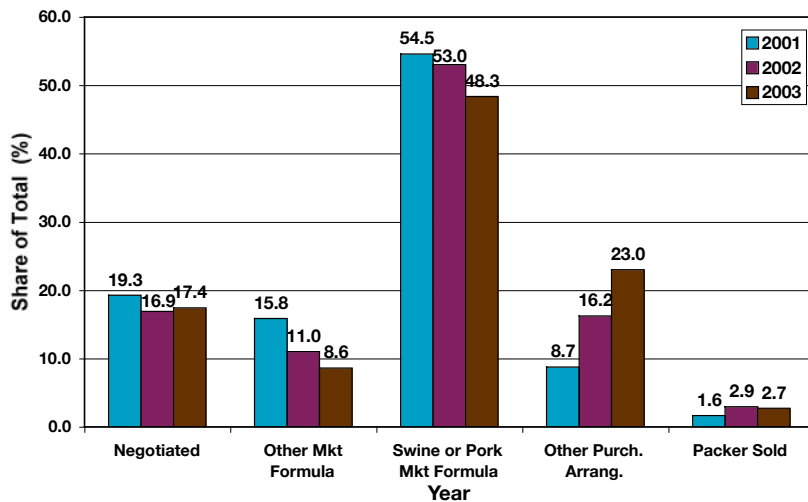
Valuing each carcass based on its merit enhances the information flow from packers to producers.

Table 2. Summary of Types of Daily AMS Hog Price Reports.

Purchase Type	Description
Negotiated Cash Trade	Carcass-based negotiated cash market trade ^a
Swine or Pork Market Formula	Formula based upon a USDA quoted hog or pork price
Other Market Formula	Formula typically based off of lean-hog futures price
Other Purchase Agreement	Other agreements like feed cost, breed programs, etc.
Packer Sold	Packer-owned hogs sold to other packers

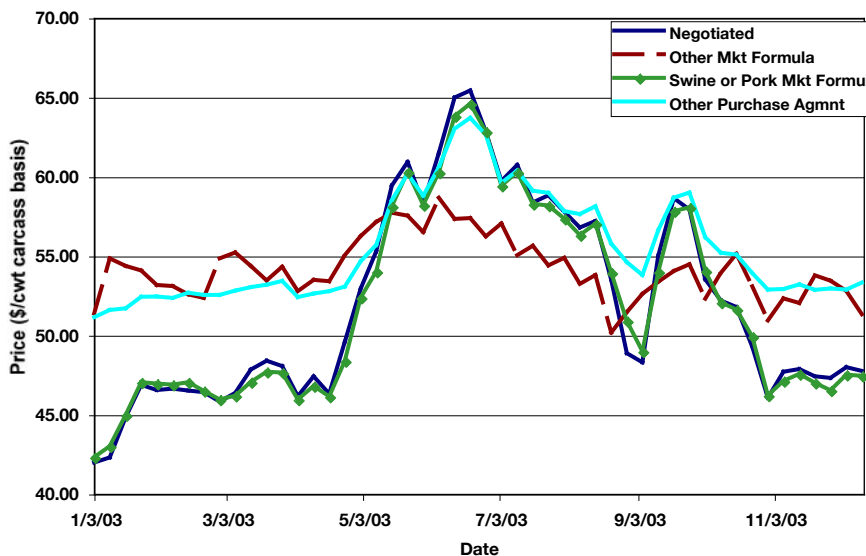
^aIn January 2004 AMS will add price reporting for live-based negotiated cash market trade.

Figure 2. Shares of Live and Carcass-Based Hog Purchase Methods, 2001 (starting May) - 2003 (through Dec. 12).



Source: USDA-AMS LM_HG 200, Summarized by Livestock Marketing Information Center

Figure 3. Weekly Average National Base Prices by Purchase Method, Jan. - Dec. 12, 2003.



Source: USDA-AMS LM_HG 200, Summarized by Livestock Marketing Information Center

hog price reporting in April 2001 under the Livestock Mandatory Reporting Act of 1999. AMS reports daily price summaries for purchased hogs and slaughtered hogs. In particular, AMS reports base prices (and head counts) for hogs purchased via five different carcass basis purchase-type categories (Table 2).

Distributions of hog volume sold under each of these categories from May 2001 through mid-December 2003 are reported in Figure 2. Negotiated purchases (live and carcass basis) comprised about 17 to 19 percent of hog market volume from May 2001 through December 2003, while other market formula purchases declined from about 16 percent in 2001 to less than 9 percent in 2003. Likewise, swine and pork market formula purchases declined from 55 percent during 2001 to 48 percent in 2003. In contrast, the other purchase arrangement category has been increasing, rising from 9 percent during 2001 to 23 percent of hog purchases during 2003. If the other purchase arrangements continue to expand, information-identifying types of arrangements represented in this category would enhance our understanding of hog marketing techniques.

Daily weighted-average base prices during 2003, sorted by purchase type, are summarized in Figure 3. Clearly, different marketing arrangements result in markedly different base prices over time. Interpretation and comparison of these base prices is difficult because USDA does not provide any information about the nature of these marketing arrangements or base price characteristics.

USDA reports base prices twice daily for three regions (Western Cornbelt, Eastern Cornbelt, and Iowa/Minnesota) in addition to providing a national report. For each region and purchase category listed in Table 2, USDA reports a weighted-average base price. The weighted-average base price is calculated from all hogs purchased by packers during the specified reporting period. One

significant challenge in interpreting and using base prices reported by USDA is the considerable range in reported values. The wide price range is partly attributable to the fact that reported prices often represent different types of hogs (i.e., different lean percentages, carcass weights, back fat measures, loin depths, etc.). For example, USDA reports a price range for negotiated carcass-based purchases each day. The range from the lowest to the highest base price is generally greater than \$10 per hundredweight carcass basis. Figure 4 illustrates the weighted-average and range in daily USDA quotes during 2003. Note that the volume-weighted average negotiated base price tends to be nearer the upper end of the range most days. This means relatively few hogs traded at the lower base prices, relative to the higher prices.

Lack of additional information about these marketing arrangements makes USDA's base price reporting of limited value to producers. Currently, USDA assimilates base prices representing different hog carcass qualities, and that have markedly different premium/discount schedules associated with them, when calculating reported base prices. The problem with reporting base prices in the format adopted by USDA is that it is not possible to discern how much of day-to-day base price variation is attributable to hog quality variation versus differences in prices paid for similar quality hogs. As a result, knowledge of the range in reported base prices is of very limited value to hog producers. To make this information useful to producers, more details about marketing arrangements associated with each base price are needed. Recent efforts by Grain Inspection and Packers and Stockyards Administration to provide more information regarding these base prices (discussed further below) have not resolved this problem.

In addition to the weighted-average base price, USDA also reports average

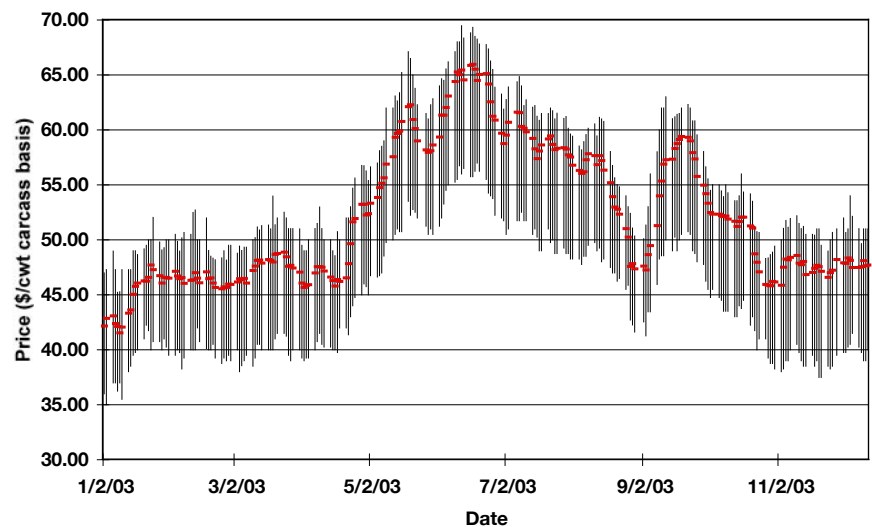
net price for slaughtered hogs daily. Average net price is the volume-weighted-average price of hogs slaughtered that day, net of premiums and discounts for quality and carcass weight. USDA reports this price for the five hog purchase methods outlined in Table 2. Again, the difficulty in interpreting these prices is they measure price for an average quality hog each day, where the average quality level is allowed to vary from one day to the next. As a result, shifts in price from one day to the next might be attributable to a shift in hog quality, a shift in hog market fundamentals, or a mixture of changes in both quality and hog market fundamentals. Consequently, using average net prices reported by USDA as a daily barometer of hog market fundamentals is problematic.

To provide information on premiums and discounts being offered by pork packers, USDA reports a daily purchase price matrix for a 185-pound carcass with varying loin area/depth and back fat measures. An example of this report is presented in Figure 5. These prices are derived by taking each reporting packer's base price and adding to it the carcass premium and discount matrix reported by individual packers. As is apparent, wide variation exists for each type of hog. For example, on December 17,

USDA market hog price reports changed substantially following enactment of Mandatory Price Reporting in 2001.

USDA reports indicate "Other Purchase Arrangements" total 23 percent of sales, suggesting the need for more details regarding this sales category.

Figure 4. Daily Negotiated Base Prices (Carcass Basis), Low, High, and Weighted Average, Jan. - Dec. 12, 2003



Source: USDA-AMS LM_HG 200, Livestock Marketing Information Center

Figure 5. Example USDA Hog Purchase Matrix, taken from December 17, 2003 National Daily Direct Prior Day Hog Report Based on Plant Location Purchased Data (LM_HG200).

NATIONAL DAILY DIRECT NEGOTIATED HOG PURCHASES MATRIX LOIN AREA/DEPTH (INCHES)185 lb Carcass Basis (Defined by Muscle and Fat)					
BACK-FAT	4.0/1.4	5.0/1.7	6.0/2.0	7.0/2.3	8.0/2.7
0.4	42.25 55.00	43.75 55.00	45.25 56.00	46.25 56.00	46.25 56.23
0.5	39.75 54.50	42.25 54.50	45.25 55.00	46.25 55.00	46.25 56.00
0.6	39.75 53.50	42.25 54.50	43.75 54.50	45.25 55.00	46.25 55.00
0.7	39.75 52.25	39.75 53.50	42.25 53.50	45.25 54.50	46.25 54.50
0.8	37.75 52.25	39.75 52.25	42.25 53.50	43.75 53.50	46.25 54.50
0.9	37.75 50.00	39.75 50.00	39.75 52.25	42.25 52.25	45.25 53.50
1.0	36.75 49.18	37.75 50.00	39.75 50.00	42.25 50.16	43.75 52.25
1.1	35.75 47.78	37.75 48.75	39.75 48.96	39.75 50.00	43.75 50.33
1.2	35.75 47.20	36.75 47.78	37.75 48.37	39.75 48.96	42.25 49.78
1.4	32.25 46.07	35.75 46.66	36.75 47.25	37.75 47.83	39.01 48.62

Base prices reported by USDA have such a wide range because of quality and other variations, that their usefulness to producers is limited.

Improvements are needed in the way USDA reports base hog prices to make these price reports useful.

2003 a 0.8 inch back fat hog, with a loin area of 6.0 and depth of 2.0 inches, had calculated prices ranging from \$42.25 to \$53.50 per hundredweight (carcass weight). These bounds, though useful for obtaining a sense for the extreme values paid, are of limited value when attempting to gain a perspective on market price premiums or discounts.

In December 2003, USDA Grain Inspection Packers and Stockyards Administration (GIPSA), as mandated by Congress, launched the Swine Contract Library. An amendment to the Packers and Stockyards Act mandated the Secretary of Agriculture to establish and maintain a library of types of contracts offered by pork packers to producers. The library is intended to enhance the price discovery process by providing increased market information to all participants. Information available in the Library (on the Web at <http://scl.gipsa.usda.gov/>) includes a listing of the variety of base prices currently being used by pork packers (not identified by packer). These are useful for gaining a perspective of the vast number of different base prices being used. In addition, the Library contains a variety of hog carcass price premium and discount matrices (again not identified by packer).

This list likewise illustrates the diversity of matrix formats (quality of hogs receiving, or not receiving, premiums or discounts under various packer programs) and variation in premium/discount magnitudes. The challenge to producers attempting to use information contained in the Library is that there is no way to link the base price and the matrix together (because they are reported separately and anonymously). The inability to link base

prices and matrices together makes it impossible to compare net prices offered across different programs. So, understanding the price paid for hogs remains elusive, despite USDA efforts to increase transparency. Industry efforts should focus on working with USDA (AMS and GIPSA) to make hog price reports easier to interpret and more useful for hog producers.

Base Price Challenges

At first glance, research documenting the decline in the volume of hogs marketed via negotiated cash markets seems to imply cash market sales are losing their relevance in the hog market. But that is clearly not the case. Negotiated cash market sales still play an important role in pricing for most hogs sold in the United States. Base prices in carcass merit pricing systems are determined by tying the base price to an external reference price. The most common type of external reference price is a negotiated cash sale price reported by USDA. In fact, during January 2003, prices paid for at least 54.9 percent of the hogs sold in the United States were linked to negotiated cash market hog prices (Grimes, Plain, and Meyer). And

to the extent that packer-owned and packer-sold hog prices were also linked to negotiated prices, the percentage of U.S. hog production valued based upon negotiated prices was likely even higher.

The decline in negotiated cash market hog trade volume gives rise to concerns that current hog pricing systems are not sustainable. In particular, concerns center around whether current negotiated trade volume is large enough to ensure that prices are competitively determined and whether hogs sold via negotiated trade are of similar quality to those marketed via carcass merit contracts. For example, Grimes, Plain, and Meyer report that during January 2003, the average lean percentage of hogs marketed via negotiated trade was 53.54 percent, whereas hogs sold via swine-pork market formula averaged 54.32 percent lean. Similarly, hogs sold via negotiation had average carcass weights that were nearly 3 pounds lighter than hogs sold via swine-pork market formulas.

Given that more than 80 percent of market hogs are purchased via some marketing arrangement other than negotiated cash trade, understanding trade-offs associated with the various methods used to establish price for these hogs is important. A variety of methods are used to value market hogs purchased using some marketing arrangement. For example, as illustrated in Figure 2, base prices of over 50 percent of market hogs are linked to USDA reported prices; about 8 percent of market hogs have a base established using lean-hog futures; and 23 percent of market hogs have base prices established in other ways. Here we summarize some benefits and drawbacks of using various methods to establish hog base prices.

For several of the base price methods discussed below, a variety of price floors and ceilings are incorporated into the base price establishment formula. These price windows essentially limit downside price risk for the hog producer and generally limit upside poten-

tial. They also can shift a considerable amount of market risk from producer to packer, or packer to producer, depending upon how the floor and ceiling prices are set. Whether a producer wishes to be involved in such an arrangement depends upon the price risk absorbing ability of the producer. Therefore, evaluating window-pricing strategies is beyond the scope of this report.

Cash Market Formula

The GIPSA data library lists nearly 80 different base prices established from a variety of cash hog market prices, including various regional and national USDA reported weighted-average prices, plant average prices, or terminal market prices. Thus, this method of establishing base prices is common and a variety of formulas exist.

Advantages of this type of pricing method include:

- 1) Formula pricing in this manner is an easy and low cost way for the parties to determine the base price.
- 2) When the local cash market price is used as a base, the price is reported by a third independent party (e.g., the USDA). In this way the base price is visible to both parties.

However, concerns with base prices tied to cash market or plant averages are formidable:

- 1) Producers are tying the price for their hogs to a price packers have a natural, normal, economic incentive to keep as low as possible because hog prices represent a large component of total input costs to packers.
- 2) Less than 20 percent of total hog trade is in the negotiated cash market. Therefore, whether packers do or do not have sufficient market power to influence the base price (plant average or cash market quote), the perception that they *might*, especially at times when cash market trade

Despite declining negotiated cash market volume, cash markets remain the most common source for establishing base prices.

Use of cash market prices to establish base prices raises concerns because they may not be representative of overall market conditions.

Large basis risk makes base price establishment via lean-hog futures prices problematic.

- is thin, may be sufficient concern to try to avoid using these prices as a base in formula trade.
- 3) Declining trade volume in cash hog markets raises legitimate concerns about how representative these prices are of overall market fundamentals. Many of these markets are becoming thinly traded. Likewise, if plant averages are used to establish a base, a mechanism for verifying the base-price calculation is generally not made available to the producer.
 - 4) Shifts in USDA reported weighted-average base and net market prices from day-to-day might not be attributable to changes in market fundamentals. For example, a formula price established using a weighted-average regional market price to establish the base can change simply because a particular packer bought relatively more, or fewer, hogs on a particular day, even if the overall market price remained constant.

Lean-Hog Futures Market Formula

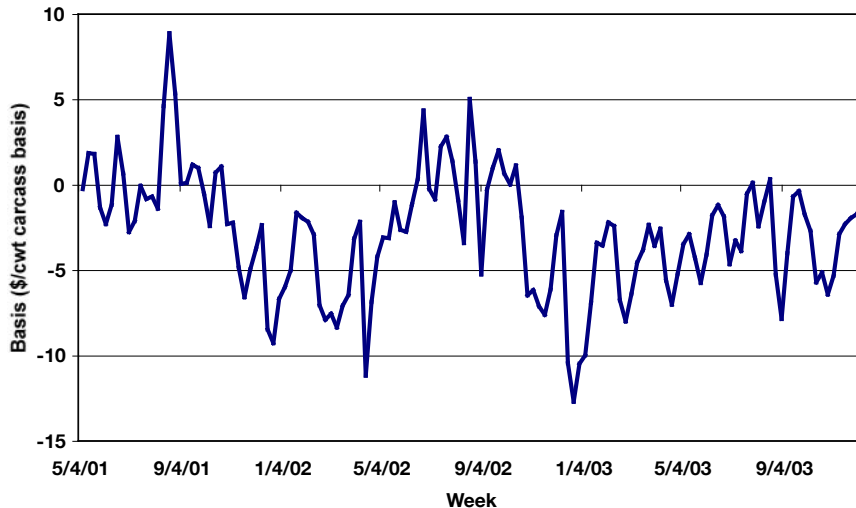
An alternative to using regional cash markets, or plant averages, as a base price is to use lean-hog futures. Advantages of using lean-hog futures include:

- 1) This method of formula pricing to set the base price is easy and low cost.
- 2) The futures market arena is a national market in which individual firms do not have market power to appreciably influence price.
- 3) Futures price quotes are readily available on a continuous basis during trading hours and interested parties have easy access to public price quotes.
- 4) Tying base prices to futures price quotes reduces basis risk (for the base price) and thereby enhances producer and packer opportunities for price risk management.

Disadvantages of using lean-hog futures market to establish base price include:

- 1) Basis risk in lean hog markets is substantial. For example, Figure 6 illustrates the weekly average nearby contract basis for the USDA reported national weighted-average negotiated base purchase price. Basis often swings \$5 to \$10 per hundred-weight (carcass weight) in a short time frame. Some of this is seasonal variation, and therefore, somewhat predictable. But, a lot of basis variability over time is not predictable, at least based on seasonality. What this means is that a base price formulated using lean-hog futures will have a lot of variability attributable to basis variation over time.
- 2) When a futures market base price is employed, packers absorb basis risk and most likely incorporate the costs of that risk into the futures price formula. In other words, the producer ultimately pays for the basis risk reduction through a lower base price.
- 3) Any material change in futures market contract specifications potentially requires renegotiation of the base price formula.

Figure 6. National Lean Hog Basis (National Weighted-Average Negotiated Base Purchase Price minus Nearby Lean-hog futures Price), May 2001 - Dec. 12, 2003.



Source: USDA-AMS LM HG 200 & CME Lean Hog Futures

Negotiated Base Prices

Relatively little interest has been expressed in negotiating base prices by hog producers. This is in sharp contrast to cattle feeders, some of whom have vociferously advocated using negotiated base prices that are discovered in much the same way as negotiated live animal cash market trade. Advantages to this method of price discovery are:

- 1) Producers and packers are each actively involved in the negotiation process contributing to overall price discovery in the market.
- 2) Many problems associated with using local cash market or plant average formulas to set base price are alleviated.
- 3) Producers retain the opportunity to reject a base price bid.
- 4) Producers know the base price prior to agreeing to deliver hogs to a particular packer.

Disadvantages to negotiated base prices include:

- 1) The absolute small number of packers with which to negotiate can make negotiation a challenge.
- 2) All costs associated with price discovery are present with base price negotiation. That is, costs of information collection and synthesis, costs of contacting potential buyers, and the time costs associated with the negotiation process are potentially expensive. An uninformed negotiator will be at a severe disadvantage.
- 3) If the targeted buyer is determined well in advance of the sale date, the seller has little leverage in the negotiation process. Different packers offer a matrix with quite different premium/discount schedules. For example, one grid may offer greater incentives for lean percentage, whereas another provides aggressive premiums for

a certain carcass weight range. In this context, the grid premiums and discounts may determine which packer a particular seller targets. This can severely limit producers' ability to negotiate base prices.

- 4) Many packers are reluctant to negotiate base prices, day-to-day, with individual producers.

Wholesale Pork Cutout Base Prices

The GIPSA Swine Contract Library lists seven base price determination methods that use the *National Carlot Pork Report* (i.e., wholesale pork cutout price) to establish base prices. The advantages of such a method are:

- 1) Compared to using cash-market or plant-average prices, this base moves pricing one step closer to consumers. As such, it sends a clearer consumer demand signal to producers.
- 2) Packers and producers both have incentives for the pork cutout price to be high.
- 3) Composite wholesale pork cutout price reports are readily available and reported by an independent party (USDA).

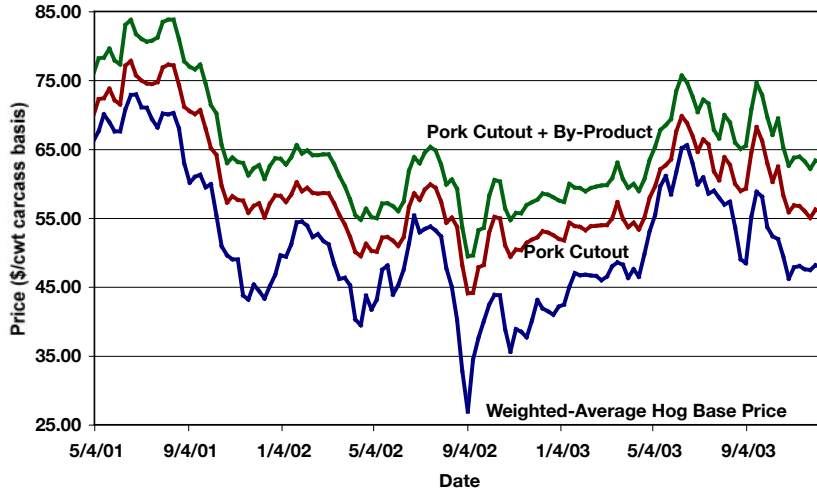
However, there are problems here as well.

- 1) How representative USDA reported wholesale pork prices are of overall wholesale pork trade during a particular week is questionable. The pork cutout price is calculated by weighting prices of individual pork wholesale cut trades based upon the percentage of pork carcass weight they typically represent. But on any given day, the volume of trade captured by USDA for particular wholesale pork cuts is small. As such, it is not clear how accurately USDA's wholesale pork cutout measure reflects actual wholesale pork cutout market value.

Inadequate leverage and high costs inhibit base price negotiation for each transaction.

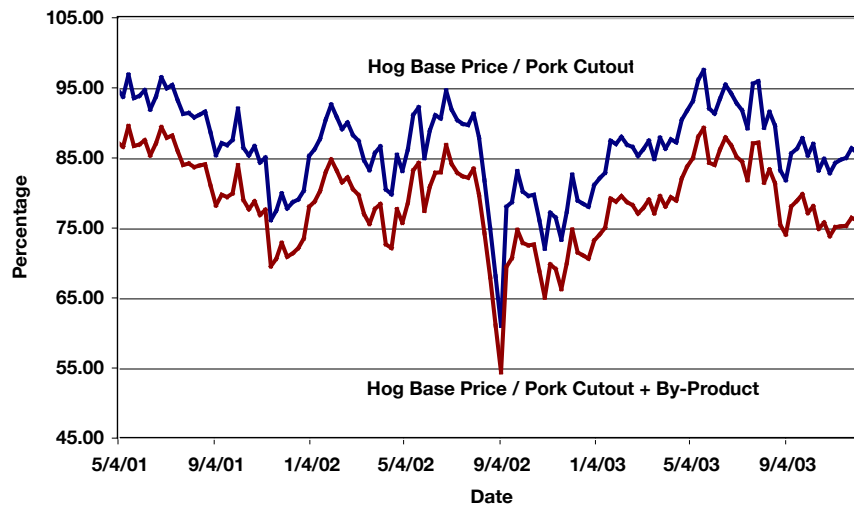
Wholesale carlot pork prices have promise for use in establishing base prices, but adequacy of USDA's carlot pork price reporting and volatility of packer margins must be considered.

Figure 7. Weekly Weighted-Average Negotiated National Hog Base Price (carcass basis) and National Wholesale Pork Cutout Value (plus by-product value), May 2001 - Dec. 12, 2003.



Source: USDA-AMS LM_HG 200, NW_LS 500, NW_LS 446, Summarized by Livestock Marketing Information Center

Figure 8. Weekly Weighted-Average Negotiated National Hog Base Price (carcass basis) as Percentage of National Wholesale Pork Cutout Value (plus by-product value), May 2001 - Dec. 12, 2003.



Source: Calculated using price data from USDA-AMS LM_HG 200, NW_LS 500, NW_LS 446

- 2) The difference between wholesale value and hog price is the packer gross margin. This margin fluctuates over time and is perhaps the most difficult obstacle to deal with in using a wholesale pork cutout price as a base.

Examining the relationship between negotiated base hog prices and wholesale carlot pork cutout price (keep in mind limitations of both these price series) demonstrates the amount of variability

in this relationship. Figure 7 illustrates the two weekly price series from 2001 through 2003, in addition to the carlot pork cutout price plus the pork by-product value. The price series generally follow similar trends, although the relationship between them varies a lot over time. For example, the difference between the carlot pork cutout price and the weighted-average hog price averaged \$7.73 per hundredweight (standard deviation of \$2.91 per hundredweight) and ranged from \$1.62 per hundredweight to \$17.16 per hundredweight. This suggests that a simple formula of carlot price less some constant amount would result in a base hog price that, at times, is substantially different than the weighted-average negotiated cash market hog price.

Another way to look at this relationship is the ratio of the weighted-average negotiated hog base price to the pork cutout value. This ratio is illustrated in Figure 8. Similar to conclusions drawn from Figure 7, substantial variability exists in the ratio of these price series. Cash hog price averaged about 86 percent of carlot pork cutout price, but ranged from 61 percent to 97 percent. Adding by-product price to the carlot pork cutout value shifts the average ratio to 79 percent although it ranged from 55 percent to 89 percent. Clearly, the relationship between wholesale pork cutout price (including and excluding by-product value) and negotiated weighted-average cash hog price varies substantially.

The conclusion of this analysis is that if base price is established using a formula incorporating wholesale carlot pork cutout values (including or excluding by-product value), both producers and packers must realize that, at times, this base price will vary considerably from negotiated cash hog market prices. Depending upon how the formula is established, the base could be above or below the negotiated cash price by \$5 per hundredweight or more (carcass basis).

Retail Pork Base Prices

Retail pork prices are yet another possible source of an external reference price to use when formulating base prices. Certainly, the motivation for wholesale base pricing, moving closer to consumers, is also a major motivation for tying base prices to retail pork prices. Historically, retail pork price reporting was not reliable enough to use in base price formulas. However, beginning in October 2002 USDA began reporting a volume weighted-average retail pork price series for a sample of retailers that may offer more promise for using retail price to formulate a base price. Unfortunately, the issues regarding variability in margins over time as noted for pork cutout prices are multiplied several times when trying to use retail prices as a base in commodity grids. Therefore, at present, it would be difficult to implement a base price formula reliant on retail prices in most settings.

Technology Used To Measure Pork Carcass Composition and Fresh Meat Quality

The *quality* of any marketed product is the most important factor for establishing customer loyalty. Therefore, improvements made in the quality of a product will increase consumer demand and ensure repeated purchase. At one point in the pork industry, carcasses (and the meat marketed from them) were perceived by the consuming public as being too fat. This was a quality issue. Establishment of carcass merit pricing programs that paid premiums for lean carcasses and discounted fatter carcasses helped the industry alleviate this negative quality issue. Pigs marketed in the United States are now leaner and more heavily muscled than ever before. The implementation of electronic equipment to quantify pork carcass lean-meat yield encouraged the shift within the industry. However, increased emphasis on selection for leanness has resulted in indirect

selection against other pork quality factors. Current industry discussions regarding pork quality focus on such attributes as flavor, juiciness, tenderness, color, and water-holding capacity. Because of this contradiction between heavy muscle and functional fresh pork quality, many packers have modified their pricing systems. They have reduced premiums paid for extremely lean and heavily muscled pigs, and adopted electronic technologies to further assess fresh pork quality.

Measuring Pork Carcass Lean-Meat Yield

Many packing plants have implemented carcass merit pricing systems to send an economic signal to producers in an effort to obtain a consistent supply of lean pork. To ensure the success and acceptance of a carcass merit pricing system, human involvement must be minimal. Producers will not accept true value-based marketing unless carcass value is determined via objective mechanical instrumentation (Cross and Belk, 1994).

Optical Grading Probes

The general design of all optical grading probes is similar, consisting of a stainless steel tube fitted with a light emitting diode followed in series by a photo diode. The LED emits an infrared light and the photo diode detects the reflectance differences between the fat and lean tissues operating on the principle that the white fat will reflect more light than the darker (red) lean. This allows the probe to distinguish between the two tissues and generate a fat and lean tissue depth. The most common site for probe insertion on pork carcasses is between the 3rd and 4th from last rib (counting from the ham end of the carcass; Figure 9). Fat and muscle tissue depths are incorporated into prediction equations to report a percentage of carcass lean for each carcass. The Fat-O-Meater is a trade name for an

Over-emphasis on pork carcass leanness resulted in pork quality problems. Packers are adopting technology to measure pork quality attributes and pay associated premiums for higher quality.

Figure 9. OGP Operations.

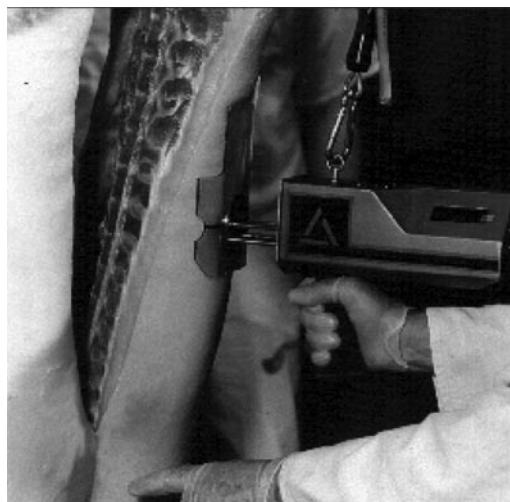

<p>Advantages:</p> <ul style="list-style-type: none">• Speed of operation• Equipment cost• Consistency• Low repair and maintenance costs• High level of accuracy <p>Disadvantages:</p> <ul style="list-style-type: none">• Single point measurement taken on the loin• Subject to operator error (i.e. probe angle, improper rib placement)	
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Figure 10. CVT Operations.

<p>Advantages:</p> <ul style="list-style-type: none">• Rapid measurement• Averages fat and muscle depths over the loin• Measurement can be verified on a monitor attached to the scanning head• Noninvasive <p>Disadvantages:</p> <ul style="list-style-type: none">• Subject to operator error (i.e. probe angle, improper placement)• Ultrasound may not adequately penetrate fatter carcasses• Ultrasound does not penetrate chilled carcasses	
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land) and the Destron PG-100 (Destron Technologies, Markham, Ontario, Canada).

Ultrasonic Evaluation Carcass Value

Technology. Animal Ultrasound Services, Inc (Ithaca, NY) has developed *Carcass Value Technology Systems* (CVT Systems), which is an automated and computerized ultrasonic system for evaluating pork carcass composition.

This technology can be used to evaluate pork carcasses commercially at chain speeds of 1,200 carcasses per hour. The first of several CVT Systems was installed in a commercial plant in 1994. With the CVT system, the operator places the transducer head longitudinally on the pork carcass approximately 2 inches from the split back midline, extending from the last rib to the tenth rib (Figure 10). The ultra-

sound beam is transmitted parallel to the backbone providing a strong reflection from the bottom of the muscles associated with the loin. Images representing the interfaces of the skin, fat, and muscle appear bright and the image of the homogeneous part of the tissue appears dark. Based on these characteristics of an ultrasonic image, a computer formula for edge detection of animal fat and muscle interfaces was developed. After fat and loin tissue depths are determined by the system, a percentage of carcass lean is determined in a manner similar to that of the optical grading probe.

optical grading probe manufactured by SFK Technology (Peosta, IA). The Fat-O-Meater (FOM) pork carcass grading system is currently the most widely used technology for grading pork carcasses in the U.S. packing industry. In existence since the early 1980s, the FOM is a fast and objective method of determining pork carcass lean content. Packing plants then establish pricing grids based on the FOM derived lean percentage with premiums and discounts for carcasses relative to their specific pricing grid. Other optical grading probes used in the United States include the Hennessy Grading Probe (Auckland, New Zea-

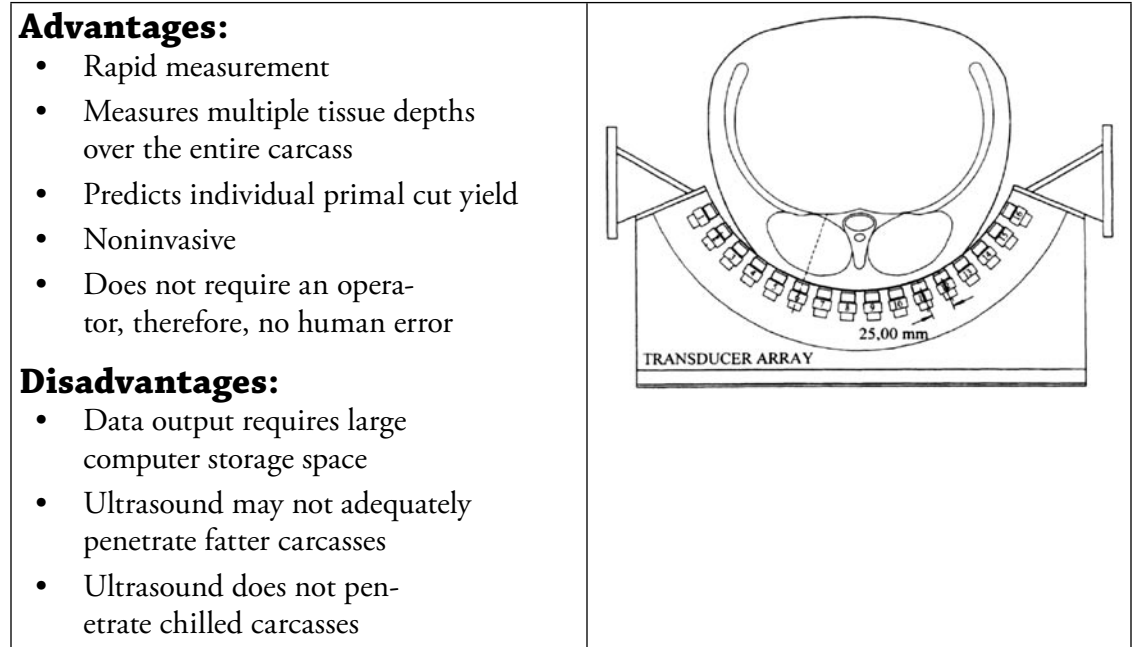
AutoFOM. SFK Technology (Herlev, Denmark) introduced the AutoFOM as a pork carcass grading system in 1995. Widely used in Europe, the AutoFOM is gaining acceptance in U.S. plants. The system is based on pulse echo ultrasound technology, with 16 scanning transducer heads aligned and imbedded along a U-shaped frame (Figure 11). The carcass is pulled over the transducers on-

line by the gambrel and trolley, the AutoFOM is initiated automatically, and the carcass is scanned in real time. Each transducer produces an ultrasonic image for a total of up to 3,200 measurements per carcass relative to fat and muscle tissue depths. The data are sent to a central computer for processing to determine which readings are necessary for the desired output. The AutoFOM can operate at a speed of 1,200 carcasses per hour predicting individual primal cut weights (bone-in or boneless), percentage of primal cuts, or percentage of carcass lean tissue. United States pork plants that utilize AutoFOM technology find it an effective tool for selecting carcasses for case ready production and reduced fat bacon.

Measuring Pork Carcass Meat Quality

The 2002 National Pork Quality Survey (sponsored by the National Pork Board) revealed that pale, soft, and exudative (PSE) pork is on the rise in U.S. pork plants. Packing plants reported that incidence of PSE in pork loins rose from 10.2 percent in 1992 to 15.5 percent in 2002. In order to affect change and improvements in pork qual-


Figure 11. AutoFOM Operations.



ity, the industry must identify a means to measure the problem. Measurement of functional pork (meat) quality is a much greater challenge to the industry than electronic measurement of carcass composition. Development or identification of electronic equipment capable of measuring pork quality is extremely difficult in part because it must discern functional quality differences based upon basic meat biochemical, physiological, molecular, and structural factors that influence the ultimate quality of pork. Solutions to the problem of poor quality pork have been confounded by the large number of factors attributed to the reduction in the various aspects of meat quality. Meisinger (2002) listed 12 *Quality Control Points* in a system for assuring pork quality: 1) genetic inputs; 2) nutrition inputs; 3) on-farm hog handling 4) handling hogs during transport; 5) pre-slaughter handling; 6) stun, stick, and early postmortem handling of carcasses; 7) handling of carcass during evisceration; 8) chilling of carcasses; 9) fabrication of pork cuts; 10) further processed fresh pork; 11) packaging of fresh pork; and 12) cooking of fresh pork.

Measurement of functional pork quality is more difficult than measuring carcass composition.

Figure 12. *pH STAR Operations.*

<p>Advantages:</p> <ul style="list-style-type: none">• Ease of operation and calibration• Rapid measurement• Accurate pH determination• Potential for repeated measures on same carcass over time• Capable of computer interface for matching quality data with composition data for each carcass measured <p>Disadvantages:</p> <ul style="list-style-type: none">• Potential for breakage of glass-tipped probe• Muscle pH only accounts for 25 to 50% of the variation in fresh pork drip loss• Requires specialist for maintenance	
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the pH*K21 is capable of performing a “repeated measures” option. For example, a carcass can be measured at 45 minutes postmortem and again at 24 hours postmortem. The pH*K21 will automatically relate the second measurement to the first.

Conductivity Probes

LF-Star CPU. The LF-STAR is a handheld, portable conductivity-measuring instrument that provides an index output relative to intact muscle cell integrity. SFK Technology also markets

Measurement of pH

Early postmortem measurement of pH and temperature are common measurements taken to identify potential meat quality problems.

pH-STAR. SFK Technology (Peosta, IA) markets a pH probe capable of rapid, on-line pH measurement (Figure 12). The PH-STAR pistol allows computer-based measurement of meat quality similar to the on-line capabilities of a Fat-O-Meater grading probe. The PH-STAR pistol is capable of serial transmission of data to the plants main computer. On-line data collection will allow print-outs of pH values for suppliers, buyers, or other internal use such as primal cut or carcass classification and sorting. The PH-STAR pistol has an ergonomic shape for ease of operation and is advertised to be accurate within 0.01 pH units.

pH*K21. SFK recently introduced the next generation of pH pork carcass measurement. The new pH*K21 has all the favorable features of the original PH-STAR glass tipped pH probe with three notable improvements. First, a retractable, telescopic, stainless steel sleeve protects the glass probe tip. The second improvement is an increased reaction time for faster data readout. Third,

it. The general design is based on a discontinued instrument; the Meatcheck conductivity probe (formerly marketed by the defunct Sigma Electronic GmbH, Erfurt, Germany). The working end of the LF-STAR consists of two parallel, high-grade steel electrodes approximately 5 cm long spaced approximately 2.5 cm apart (Figure 13). The LF-STAR is designed to measure the “*structural condition*” and temperature of fresh pork. Measurement of the structural condition correlates with the drip loss of the muscle that is being probed based on the electrical impedance (resistance and reactance) of the lean tissue positioned between the two probe tips. A high conductance reading is indicative of greater muscle cell damage and greater extracellular (free) water, which would ultimately generate more purge from the cut lean surface. Limited information and data is currently available on the LF-STAR. However, the Meatcheck was capable of rapid measurement and was reported to be an adequate classification tool for identifying PSE carcasses (Kauffman *et al.*, 1997).

Electronic color evaluation

Video image analysis of color. There is a certain degree of error associated with subjective human evaluation of fresh pork color as humans may unintentionally reject pork possessing acceptable quality or keep that with poor quality. Several companies have developed computerized vision analysis systems that can identify and sort acceptable and unacceptable pork based on color evaluation. These systems use video image analysis of the cut lean surface of either the ham or the blade or sirloin end of the loin. The general setup includes a video camera positioned on-line to capture images of the cut lean surface of primal cuts as they pass the camera. The image is then evaluated pixel by pixel by a neural network that has been calibrated to identify unacceptable color (or unacceptable variation of color) to facilitate automatic sorting of those primals from the processing line. One such system is the AutoVision automatic primal cut grading system offered by SFK Technologies (Figure 14).

Colorimeters, Chromameters, and Spectrophotometers. Classification of meat color can also be performed with colorimeters or spectrophotometers. Morgan *et al.* (1997) describe color as a three dimensional coordinate system such as color space or color scale. The CIE L*, a*,

Figure 13. LF-STAR Conductivity Probe.

Advantages:

- Ease of operation and calibration
- Rapid measurement
- Capable of multiple measurements
- Capable of computer interface for matching quality data with composition data for each carcass measured

Disadvantages:

- New technology relatively untested
- Readings influenced by muscle fiber orientation relative to conductivity probe tips
- Requires specialist for maintenance



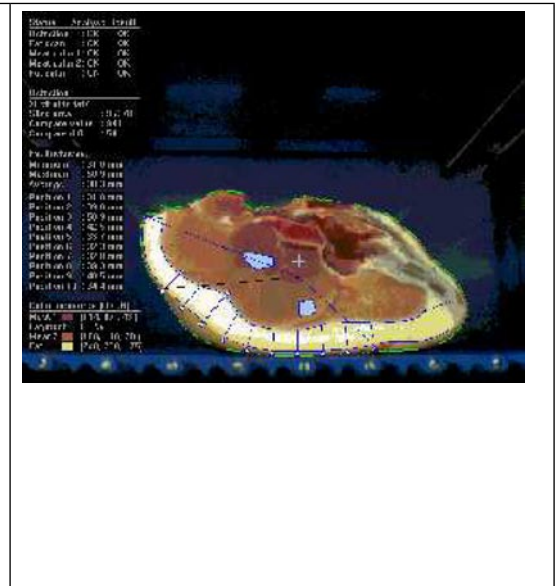
Figure 14. Image of the Cut Lean Surface of a Ham Generated by AutoVision.

Advantages:

- Very rapid measure of lean color or two-toning
- Sorts off primal cuts of unacceptable color
- Capable of determining primal cut composition as well


Disadvantages:

- Evaluation of primal cuts does not allow for price incentives or discounts to be assessed back to the producer of high or low quality pork
- Expertise necessary for system setup and troubleshooting



b* system has been used to standardize products that have been pigmented or died such as textiles, paints, and plastics. This scale was designed to represent the human perception of color. The a* scale is a measure of the relative intensity of red and green while b* considers the intensity of the colors blue and yellow (both sets of colors are considered opposite on the color scale). The L* value represents the overall lightness or darkness of the object (0 = black: 100 = white). The Minolta chromameter (Figure 15) and the Hunter spectrophotometer are two of the more common colorimeters

Figure 15. Data Collection with a Minolta Chromameter.

<p>Advantages:</p> <ul style="list-style-type: none"> • Measure degrees of lightness (L*), redness (a*), and yellowness (b*) • Ease of calibration and data recovery • Widely used and understood in a research setting <p>Disadvantages:</p> <ul style="list-style-type: none"> • L* value has moderate correlation with fresh pork drip loss • Limited application on-line due speed of line operations • Require measurements on exposed lean that does not allow for price incentives or discounts to be assessed back to the producer of high or low quality pork 	
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ing grids. The quality issue is much more complex than the issue of genetic selection for lean. Forrest *et al.* (1997) reported that even though pork quality problems involve a complex combination of biological and environmental factors, the quality defects of pork are understood well enough that their occurrence could be reduced. Value-based quality procurement will be necessary to address the problem

used to measure meat lightness (L*), redness (a*), and yellowness (b*).

Ensuring Delivery of High-Quality Lean

Slaughter plants that pay premiums for delivery of lean pork and discount fatter carcasses to ensure the delivery of lean carcasses to the front end of the market chain have established price

incentive for change. Consistent growth in the pork export market (especially to Japan) may have begun to provide this incentive. Grandin (1993) stated that when slaughter plant managers watched Japanese graders reject up to 40 percent of their pork loins due to PSE, a strong economic incentive was created. Table 3 lists the criteria necessary for a workable on-line quality buying system as described by Bjornson (1997).

Table 3. Criteria Necessary for an On-line Pork Quality Buying System¹.

Fast	The buying system must operate at 1,250 carcasses per hour. If a plant does not operate at that speed in the United States, it will not be profitable
Automatic	Preferable no operator required. Packers are not receptive to any operations that require more personnel. The equipment must require minimal training if an operator is necessary.
Foolproof	Must be durable to the packing plant environment.
Minimal or noninvasive	Preferably no invasion of the product.
Accurate	Must have an acceptable degree of accuracy, predictability, and repeatability.
Measures multiple locations	Good or bad meat quality is not isolated to one segment of the pig. Typically a loin muscle dark at the sirloin end could be pale at the shoulder.
Establishing carcass identity	The system needs to ultimately trace any hog back to the producer.

Problems with Quality Value-Based Pricing

Establishment of an on-line pork quality buying system will mean that someone will have to take the blame for the bad quality product. Therefore, this question must be answered: “Who is to blame for the pork quality problem?” We mentioned above that Meisinger (2002) had outlined 12 different factors across the pork production chain that can influence the appearance and quality of pork. Grandin (1994) reported that ultimate pork quality was a responsibility given 50 percent to the producer and 50 percent to the packer. Producers are responsible for selection of swine genotypes that possess acceptable pork quality traits and

¹Bjornson, 1997

must provide environmental conditions to optimize *composition* (growth) and *quality* of the final food product. The producer must guarantee proper selection, care, and handling to the point of delivery to the packing plant; including trucking, which may be out of producer control. Packers are responsible for optimizing pre- and post-slaughter conditions to ensure optimal meat quality. It will be very difficult for the producer to accept discounts for delivery of poor quality pork if they assume that the poor quality is also a factor of processing of the meat. Currently, processors accept the good with the bad. Processors suffer discounts associated with not having market outlets for PSE pork, yet receive premiums for marketing high quality, darker pork to white-tablecloth restaurants and export markets.

Accurate instrumentation allowing packers to identify pork carcasses with inferior meat quality early in processing would allow ample time for sorting and possibly establish a basis of premiums and discounts for these carcasses. Functional pork quality can be determined by laboratory methods evaluating various physicochemical aspects of the lean tissue, yet rapid, on-line methods of evaluation have yet to exhibit a high degree of accuracy. Until technology is developed that accurately predicts fresh pork quality, every level of the pork production chain should strive to use existing production and processing techniques to develop a system that assures every pig will possess excellent pork quality.

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Objective pork quality measurement will increase acceptance of quality grading.

Technology to evaluate pork quality rapidly and accurately has not yet been developed.

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