Production Costs and Animal Welfare for Four Stylized Hog Production Systems

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Production Costs and Animal Welfare for Four Stylized Hog Production Systems

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Nonhuman animal welfare is arguably the most contentious issue facing the hog industry. Animal advocacy groups influence the regulation of hog farms and induce some consumers to demand more humane pork products. Hog producers are understandably reluctant to improve animal well being unless the premium they extract exceeds the corresponding increase in cost. To better understand the relationship between animal welfare and production costs under different farm systems, this study investigates 4 stylized hog production systems. The results show that increasing animal welfare for all hogs in the United States will increase retail pork prices by a maximum of 2% for a small welfare increase and 5% for a large welfare increase. The cost of banning gestation crates measured by this study is lower than the consumer willingness-to-pay from other studies.

During the past 20 years, a great deal of controversy has arisen over how hogs raised for food should be treated. Most hog production today takes place inside confinement facilities where hogs are housed with little space per nonhuman animal, on hard floors, and with little opportunity for expressing normal behaviors such as rooting. Among the alternative methods of raising hogs, these confinement facilities provide the lowest levels of animal care, especially for the
sow (Bracke, Metz, Spruijt, & Schouten, 2002a, 2002b). Some consumers have expressed a desire to pay higher pork prices in return for greater animal well being (Market Directions, 2004; Norwood, Lusk, & Prickett, 2007; Rauch & Sharp, 2005; Tonsor, Olynk, & Wolf, 2009). The pertinent question is whether consumer willingness-to-pay for better animal care exceeds the cost. In the case of hogs, no study has yet to articulate the change in production costs that corresponds to an increase in hog welfare.

This study measures the cost of hog production under three alternatives to the conventional hog confinement system. One alternative concerns a small modification for the housing of gestating sows; the other two alternatives concern more drastic changes to hog production practices. The methodology for measuring costs varies according to the prevalence of each method. To ensure costs are comparable across methodologies, all costs are constructed to reflect market conditions when the price of corn is $3.00 per bushel. This article describes each of the four systems and the method used to estimate production costs at the farm level. The conclusion summarizes the relative level of animal welfare and farm production cost for all four systems and articulates how large-scale conversions to alternative systems would impact retail prices. Periodically, equations used to calculate important parameters are suppressed to improve readability.

**CONFINEMENT-STALL SYSTEM**

**System Description**

The confinement-stall system is the most popular system in the United States and is often referred to as a “factory farm.” North Carolina is currently the second largest hog producing state (NASS, 2002), and virtually all of its hogs are raised in confinement facilities. The goal of a confinement-stall system is to house all animals in an atmosphere-controlled building that provides high levels of shelter, temperature comfort, and protection from predators. The floors are typically slatted so that excrement is collected in pits below the animals, which results in high levels of sanitation. Sows are often poor mothers, refusing to nurse their offspring and sometimes crushing them as they lie down carelessly. To mitigate this problem, confinement systems employ farrowing crates barely larger than the sow, which forces the mother to nurse and lie down gingerly and thereby increases the number of surviving offspring.

Because the buildings are expensive, producers seek to confine many animals under one roof, and cramped animals, especially sows, often resort to fighting and injuring one another. Thus, gestating sows are placed in gestation stalls (stalls slightly larger than the sow herself, as shown in the middle picture in Figure 1) to protect her from injury, which significantly restricts her movement.
### Cost Estimate

Due to the prevalence of the confinement-stall system, production budgets are readily available to estimate production costs. This study uses the farrow-finish
budget constructed by Dhuyvetter, Tokach, and Dritz (2007) to estimate production costs. This particular budget is chosen because it details the relationship between the corn price and feed costs, which enables one to modify the corn price and feed costs accordingly, so that we can project production costs at $3.00 per bushel corn. To illustrate, Table 1 recreates this feed budget exactly as in Dhuyvetter et al., except for the last column.

Sorghum and soybean meal prices are likely to be correlated with corn prices; therefore, the sorghum and soybean meal price should also be adjusted to better reflect conditions when the price of corn is $3.00 per bushel. To accomplish this, simple regressions are estimated with the sorghum or soybean meal price as the dependent variable and the corn price as the explanatory variable. Regressions use weekly corn and sorghum price data for the period 1988–2008 (obtained from the Livestock Marketing Information Center, http://www.lmic.info). The estimated regressions are shown here. By substituting a value of $3.00 for the corn price, the predicted sorghum/soybean meal prices are obtained and used to adjust the feed costs in the last column of Table 1. The cost per pig of other ingredients, complete feeds, and processing is unchanged from Table 1. With these adjustments, the total feed cost is changed from $74.44 to $62.05 per finished pig sold.

1. Sorghum Price = 0.082937 + 0.912392(corn price = 3) = $2.82 per bushel.
2. Soybean Meal Price = 96.85466 + 40.62979(corn price = 3) = $218.74 per ton.

Other items in the Dhuyvetter et al. (2007) budget include variable costs such as veterinary services, breeding equipment, and facilities repairs, which total $18.80

<table>
<thead>
<tr>
<th>Feed</th>
<th>Pounds Fed per Pig Sold\textsuperscript{a}</th>
<th>Cost per Pig Sold\textsuperscript{b}</th>
<th>Adjusted Cost Assuming $3.00 Corn\textsuperscript{c}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn ($3.85/bu)</td>
<td>132.8</td>
<td>$9.13</td>
<td>$7.11</td>
</tr>
<tr>
<td>Sorghum ($3.55/bu)</td>
<td>472.9</td>
<td>$29.98</td>
<td>$23.81</td>
</tr>
<tr>
<td>Soybean meal ($273/ton)</td>
<td>156.2</td>
<td>$21.29</td>
<td>$17.08</td>
</tr>
<tr>
<td>Other ingredients</td>
<td>22.0</td>
<td>$6.12</td>
<td>$6.12</td>
</tr>
<tr>
<td>Complete feeds</td>
<td>4.0</td>
<td>$1.41</td>
<td>$1.41</td>
</tr>
<tr>
<td>Processing ($16.61/ton)</td>
<td>783.9</td>
<td>$6.51</td>
<td>$6.51</td>
</tr>
</tbody>
</table>

Total 787.9 $74.44 $62.05

\textsuperscript{a}Includes annual feed fed to sow and boar divided by finished pigs sold per year. Assumes 19.5 finished pigs are produced per sow per year. \textsuperscript{b}One bu of corn weighs 56 lb. \textsuperscript{c}This column is not part of the original Dhuyvetter, Tokach, and Dritz (2007) budget.
TABLE 2
Cost Estimates for Confinement-Stall System

<table>
<thead>
<tr>
<th>Cost Component</th>
<th>Cost per Finished Pig Assuming $3.00 per Bushel Corn and 19.5 Finished Pigs per Sow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed costs</td>
<td>$62.05 per finished pig</td>
</tr>
<tr>
<td>Variable costs</td>
<td>$18.80 per finished pig</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>$26.88 per finished pig</td>
</tr>
<tr>
<td>Labor costs</td>
<td>$12.18 per finished pig</td>
</tr>
<tr>
<td>Total costs</td>
<td>$119.91 per finished pig</td>
</tr>
</tbody>
</table>

per pig sold. Fixed costs (such as buildings, legal fees, building depreciation, and interest) total $26.88 per pig sold. Labor costs, which are separated from variable costs for reasons stated later, equal $12.18 per pig sold. All numbers assume that 19.5 finished pigs are produced per sow per year. All costs considered, the projected production cost for the confinement-stall system is $119.91 per finished pig. Assuming a 265-lb finishing weight, this translates to $0.45 per pound of finished pig, as shown in Table 2.

CONFINEMENT-PEN SYSTEM

System Description

The confinement-stall system has received much scrutiny from animal advocacy groups. The most frequent complaint is the use of gestation stalls, which for two thirds of the sow’s life confines her to a stall so small she cannot turn around and, typically, experiences difficulty even lying down comfortably. Gestation stalls are banned in Florida, Arizona, Oregon, and California. Colorado producers agreed to voluntarily forego the use of these stalls in fear of such a ban. A bill pending in Congress would not allow the government to purchase pork from farms using gestation stalls, and due to pressure from activists, retailers like Burger King are phasing out purchases from farms using gestation stalls. Most farms that are being forced to phase out gestation stalls will replace the stalls with group pens, which are referred to here as confinement-pen systems. A confinement-pen system would still be labeled a “factory farm” to those opposed to modern livestock agricultural methods but is slightly more humane for the sow.

Group pens contain three to six sows per pen, as shown in Figure 1. Group sizes larger than six would lead to excess injury from sows fighting one another; even with these small groups, producers must maintain sows in familiar groups...
of similar size to reduce injury. The space per sow varies across farms, often depending on the type of barn floor, but is generally in the range of 16–24 square feet per sow. Although the sows have more freedom to move, they now must compete for food; due to the difficulty of containing and moving sows, providing health care for the sows becomes more labor intensive.

Although the primary goal of animal advocacy organizations is to force producers to convert from confinement-stall to confinement-pen systems, scientific research suggests this conversion may not improve the welfare of sows. In some papers, reviews of scientific studies conclude that sow welfare is comparable in both systems (McGlone et al., 2004; Task Force Report, 2005). Other studies that use mathematical models of animal welfare rank the confinement pen ahead of the confinement stall in terms of sow welfare (Bracke et al., 2002a, 2002b). Although scientific studies may disagree on the superiority of the confinement-pen system, animal advocacy groups like the Humane Society of the United States are unambiguously in favor of the group pen system.

Cost Estimate

Most systems that adopt the confinement-pen system are not constructing new confinement-pen systems but are converting from confinement-stall systems. Consequently, this section details two budgets: one budget for a conversion from confinement stall to confinement pen (conversion budget) and one budget for constructing a confinement-pen facility from scratch (nonconversion budget). For the conversion budget, the budget developed in the previous section is modified to reflect a swine farm that has operated a confinement-stall system for 10 years, converts the barn to a confinement-pen system, and will use this barn for 10 more years. These costs are then verified by comparing them with budgets produced from software made available by the National Pork Board (Boggess, 2007). The nonconversion budget is composed largely from this software. For consistency with the confinement-stall system, all budgets assume a 1,200-sow farrow-to-finish facility and a $3.00 per bushel corn price.

The important assumptions driving the conversion costs include a one-time cost of $225.00 to convert the stalls to pens (Adams, 2008; Boggess, 2007); because each sow is given more space in the same barn, the number of sows housed in the barn falls by 18% (Adams, 2008; Boggess, 2007). Due to no overwhelming evidence to the contrary, the productivity and variable cost of each sow is assumed unchanged when converting to group pens (McGlone et al., 2004; Task Force Report, 2005).

Utilizing these assumptions, the budget in Table 2 is converted as follows: the budget used by Dhuyvetter et al. (2007) assumes a 1,200-sow farrow-to-finish facility. Given that 1 sow spends approximately two thirds of her life in the gestation phase (PIGS, 2008), this suggests the barn contains \(1,200 \times (2/3) = 800\)
stalls). Multiplying 800 stalls times $225.00 per stall conversion price suggests a capital investment cost of $180,000. Assuming 19.5 finished pigs are produced per sow per year, a discount rate of 8%, and a 10-year life of the investment, the annualized investment costs per finished pig equals $1.146 (equation for this estimate available from the authors by request).

The nonconversion budget assumes the confinement-pen facility is built from scratch rather than the conversion of a confinement-stall facility. Thus, there are no conversion costs, but the construction cost of a building using group pens may differ from one using gestation stalls. To determine whether a cost difference exists, software developed by Boggess (2007) is consulted. This software projects an identical construction cost for group pen and gestation stall production facilities. However, the confinement-pen system will still house 18% fewer sows. Thus, fixed costs for the conversion and nonconversion budget are identical.

Loan payments on the hog buildings and similar fixed expenses remain the same after the conversion but must be spread over 18% fewer sows, which implies the number of finished pigs at the farm also decreases 18%. Thus, the fixed cost per finished pig in Table 2 is adjusted by dividing it by 0.82 (details available from the authors by request). Total labor costs are assumed unchanged despite the fact that there are 18% fewer sows. The reason is that gestation pens require more labor per sow. Individually caring for and breeding sows often requires the sow to first be removed from the group pen and temporarily placed in an individual stall. The moving of sows is a difficult process. Indeed, one of the major motivators of gestation stalls is its impact on labor productivity. Thus, the same labor costs are spread over fewer sows by dividing the per pig labor cost by 0.82. The results (Table 3) show that the per pound cost of producing finished hogs increases by three or four pennies.

CONFINEMENT-ENHANCED SYSTEM

System Description

Confinement systems are criticized on the grounds that they restrict movement, leave pigs vulnerable to injury by other animals, and prohibit animals from exhibiting natural behaviors. The confinement-enhanced system seeks to address these criticisms while maintaining the advantages of an enclosed production facility. These systems are rare, and no two systems are alike. This section articulates the confinement-enhanced system of two Iowa farms. Data on these systems are obtained through personal communication. These data include the break-even price for market hogs at $3.00 corn, as indicated by the farm operators in response to a carefully worded questionnaire. The farm identities are
TABLE 3
Cost Estimates for Confinement-Pen System

<table>
<thead>
<tr>
<th></th>
<th>Confinement-Pen System (Conversion Budget)</th>
<th>Confinement-Pen System (Nonconversion Budget)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Confinement-Stall System</td>
<td></td>
</tr>
<tr>
<td>Cost per finished pig, assuming $3.00 per bushel corn and 19.5 finished pigs per sow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barn conversion cost</td>
<td>$1.15</td>
<td>$0.00</td>
</tr>
<tr>
<td>Feed costs</td>
<td>$62.05</td>
<td>$62.05</td>
</tr>
<tr>
<td>Variable costs</td>
<td>$18.80</td>
<td>$18.80</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>$26.88</td>
<td>$32.78d</td>
</tr>
<tr>
<td>Labor costs</td>
<td>$12.18</td>
<td>$14.85</td>
</tr>
<tr>
<td>Total costs</td>
<td>$119.91</td>
<td>$130.00</td>
</tr>
</tbody>
</table>

Cost per pound of finished pig

<table>
<thead>
<tr>
<th></th>
<th>Confinement-Pen System (Conversion Budget)</th>
<th>Confinement-Pen System (Nonconversion Budget)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$0.45</td>
<td>$0.486</td>
</tr>
</tbody>
</table>

\( ^a \) Cost of converting gestation stalls to group pens. \( ^b \) Sow productivity is assumed unchanged in the pen versus the stall system. \( ^c \) Fixed and labor costs are increased by a factor \( (0.82)^{-1} \) compared with the stall system to account for fact that the group pen system can only accommodate 18% fewer sows. \( ^d \) The cost of building a stall and pen system from scratch are estimated to be roughly the same.

not revealed to protect confidentiality and are referred to simply as Farm A and Farm B. Both are large-scale farrow-to-finish farms with more than 2,000 sows.

Not only are Farms A and B different from the conventional confinement facility, they are quite different from each other. Farm A markets to specialty food retailers under a natural label. Surprisingly, they do not tout their high welfare standards on the label. Farm B has more than 3,500 customers, including many high-end restaurants. At the farrowing stage, both farms use farrowing boxes, one that allows the sow to build a nest with bedding material (Figure 1). The sow is free to leave the box but her offspring are not. The box is designed to reduce crushing by the sow, but not to the extent of farrowing crates, and allows bad mothers to neglect their young. Farm B’s box provides 48 square feet of space for the sow compared with 14 square feet in the normal farrowing crate; bedding is placed in the box on Farm A but not on Farm B.

Gestating sows are kept in groups on both farms. Both provide bedding material such as sawdust or straw with sow groups of 12 sows or more. The space allotments for gestating sows vary greatly between the farms. Farm B allows only 15 square feet per sow, the same as confinement facilities, whereas Farm A probably allows 3 times more. Growing pigs are provided with 10 square feet of space on Farm B and at least 2 times more on Farm A, and both
provide the pigs with bedding material to reduce boredom, provide comfort, and regulate heat. The provision of bedding differs between the farms. Farm A provides straw in all places except outdoor lots, whereas Farm B provides sawdust on half of the hogs’ area. The salient difference between the farms is access to the outdoors. Farm A allows gestating sows and growing pigs access to dry outdoor lots. The lots are concrete but allow sunshine and generous space. Farm B provides no outdoor access.

Both farms advertise natural pork and no antibiotic use. This reduces the rate-of-gain in growing pigs. Farm B specializes in the Duroc swine breed, and limiting itself to this single breed further impedes the hogs’ productivity. These “natural” production methods add to costs but are irrelevant for animal welfare. However, no effort is made to adjust costs for two reasons. First, such adjustments would be difficult and ultimately arbitrary. Second, evidence suggests that if producing pork under higher welfare standards the farm will almost certainly decide to produce natural, antibiotic-free pork. We know of no farm that utilizes higher welfare standards without also advertising natural and antibiotic-free. Moreover, survey research suggests consumers place little value on higher welfare standards unless the meat is also natural and antibiotic-free (Wilson, 2008).

Cost Estimate

Budgets are not available for the two farms. Consequently, cost estimates are obtained through personal communication. The farm operators are asked to consider all the costs of the production system from the breeding stock to the breeding, farrowing, and growing of the hogs. These costs include both fixed costs and variable costs. The farm operator is asked to assume that the price of corn is $3.00 per bushel and will remain at that price for a long period. Finally, the operator is asked the break-even price for market hogs that would allow him to continue operating but such that any lower price would force him to cease hog production.

These break-even prices are shown in Table 4 and are interpreted as the cost of live-hog production. Farm B, which provides less space and environmental enrichment for the hogs, reports a cost of $0.53 per pound of live hog; Farm A,

<table>
<thead>
<tr>
<th>TABLE 4</th>
<th>Reported Break-Even Price of Confinement-Enhanced Systems ($ per Pound Finished Pig)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assuming $3.00 per Bushel Corn</td>
</tr>
<tr>
<td>Farm A</td>
<td>$0.65</td>
</tr>
<tr>
<td>Farm B</td>
<td>$0.53</td>
</tr>
</tbody>
</table>
with its higher welfare standards, reports a cost of $0.65. The cost is predictably higher on Farm A as it provides greater space and amenities than Farm B. As a validation of the stated break-even prices, the producers are also asked their break-even price if the price of corn is $5.00 per bushel. Farm A reported $0.75, and Farm B reported $57.00 per pound.

If corn prices rise from $3.00 to $5.00 per bushel, the budget from the confinement-stall section contends hog production costs would rise from $0.23 to $0.33 per pound of finished pig (assuming a 265-lb pig). This $0.10 rise in costs is consistent with the $0.05–$0.10 increase stated by the Farm A and Farm B operators. The fact that both costs increase by similar amounts provides some validation for the accuracy of reported costs for the confinement-enhanced system—or, one might claim, provides validation for the confinement-stall budget.

SHELTER-PASTURE SYSTEM

System Description

Perceptions differ as to what type of system constitutes high farm animal welfare, but most animal advocates deem the standards set forth by the Animal Welfare Institute (AWI) to provide the highest standards. Fierce opponent of modern agriculture Robert F. Kennedy Jr. refers to these standards as “the gold standard for how farm animals should be taken care of” (AWI, 2008). The shelter-pasture system follows the AWI standards for pigs.

What follows is a stylized description for the shelter-pasture farms. In the shelter-pasture system, pigs have access to open pasture lots where they have the ability to run, root, interact with other pigs, and exhibit other natural behaviors. They also have ample shelter and bedding. Depending on the season, pigs are provided with individual or group portable huts in the pastures for farrowing and shelter (see Figure 1). The pasture lots can also be connected to barns that have deep bedding material for the pigs to seek shelter.

Gestating sows are kept in a pasture that allows approximately 1 acre of outdoor space for every 10 sows. The sows are fed a controlled amount of feed on concrete slabs or individually fed in stalls. The pastures always contain portable shelters or a large permanent structure, as those seen in Figure 1. These shelters provide a minimum of 32 square feet of covered area per animal. During farrowing, the sows are provided small, individual huts with bedding and 64 square feet of space. On this shelter-pasture farm, finishing hogs are kept in a lot that provides 100 square feet of outdoor space per hog with a capacity between 50 and 200 head. These hogs are separated into groups based upon similar size and sex. Finishing pigs are provided permanent or portable shelters with 14 square feet of covered area per pig when the pig is at its largest size and
Pasture is provided during parts of the year, and when pasture is unavailable hogs still have access to a dry lot and are always provided deep bedding so that they may express normal behaviors such as rooting. Castrations must be performed before 1 week of age to minimize pain, and minor surgeries such as teeth clipping and tail docking are prohibited. The shelter-pasture system provides enough space and environmental enrichment such that tail biting is not a problem. Weaning must occur after 6 weeks of age as opposed to a 2-week weaning under the confinement-stall system. Weaning at an early age interferes with the normal development of the pig and produces stressful pigs who have difficulties adapting to new environments. As with the confinement-enhanced system, the hogs are antibiotic-free and hormone-free and natural breeding is required.

These AWI standards mimic closely the standards set for organic pork (Organic Food Productions Act, 2000), but there are some minor differences. The organic certification allows tail docking whereas the AWI does not, but both require the animal to have access to both shelter and outdoor access with ample room to move and bedding for comfort, heat regulation, and rooting. The AWI has more stringent requirements, but the differences are not large. More important, organic producers tend to have farms that meet the AWI standards anyway. The organic standards allow the farmer to utilize farrowing crates if special permission is requested and granted. However, most organic producers opt to use individual huts as shown in Figure 1. Thus, for the purposes of this research, the only difference between the shelter-pasture system and the organic system is the type of feed used. Organic producers must utilize organic feed only, which is substantially more expensive that nonorganic feed. Organic production is not included as a fifth stylized farm system because the differences between organic and shelter-pasture systems do not involve animal welfare.

It should be noted that the shelter-pasture and organic systems do not score high on all animal welfare factors. Without the use of farrowing crates, producers must be careful to select sows who are good mothers. The freedom to leave the shelter for outdoor lots also gives the sow the freedom to neglect her young, so the sow must have an intrinsic desire to nurse her young regularly. Also, the sow must lie down with care as piglets are easily crushed by a careless mother. The potential for a higher prewean mortality rate is greater in the shelter-pasture system due to crushing, though reliable data are difficult to obtain. Personnel interviews often prove ineffective at identifying crushing rates. It seems that individuals who represent groups of shelter-pasture producers, such as the managers of niche pork cooperatives, tend to downplay the role of crushing—arguing that crushing presents little problem. However, conversations with individual shelter-pasture producers suggest otherwise; some communicate that up to one third of piglets born are killed by crushing. Additionally, surveys
of niche pork producers (who do not use farrowing crates) suggest that prewean mortality rates are around 25% and that crushing is the number one cause of these prewean deaths (Kliebenstein, Stender, Mabry, & Huber, 2007).

Cost Estimate

The fact that the shelter-pasture system is consistent with organic pork standards and the availability of organic hog production budgets allows modification of these budgets to estimate the costs of the shelter-pasture system. This study utilizes the organic pork production costs for continuous farrowing constructed by Kliebenstein, Hurley, Larson, and Honeman (2004). The feed costs within the budget are modified to reflect the cheaper price of nonorganic corn compared with organic corn, in addition to a few more minor changes. To estimate feed costs in a shelter-pasture system, the feed cost model developed in the confinement-stall system is modified to better reflect the shelter-pasture system. Differences in the two farm systems follow. For a variety of reasons, one being prewean crushing, the number of finished pigs per sow is only about 13 in the shelter-pasture system compared with 19.5 in the confinement-stall system. Also, the use of natural breeding techniques requires the use of more boars, which increases feed costs.

The Dhuyvetter et al. (2007) article provides sufficient information to estimate how feed consumption changes as the number of finished pigs per sow falls from 19.5 to 13. At this level of sow productivity, and assuming a corn price of $3.00 per bushel, the feed model from Table 1 predicts a per-finished-pig feed cost of $67.16 (calculated algebraically; details available from the authors by request). Replacing this feed cost for the cost in the Kliebenstein et al. (2004) budget suggests a production cost of $139.89 per finished pig. Consistent with the previous section’s assumption of a 265-lb market hog, this corresponds to a production cost of $0.53 per pound of market hog.

Another cost source is available from a niche pork cooperative that utilizes a pasture-shelter system consistent with the AWI guidelines. Personal communication with the cooperative producers indicates they receive a premium of $0.05–$0.10 per pound of live hog over the average market price. This premium is consistent with data reported in Hueth, Ibarbaru, and Kliebenstein (2007), who study this same cooperative. This “average market price” the producers use as a baseline refers to hogs produced primarily using confinement-stall facilities. For producers to remain in hog production, this premium must cover the additional expenses of a shelter-pasture system compared with a confinement-stall system. In a long-run competitive equilibrium, this premium will just equal the additional expenses. Given that confinement-stall system costs are estimated to be $0.45 per pound of finished hog, at $3.00 per bushel corn, the reported premiums indicate that shelter-pasture system production costs are $0.50–$0.55. The midpoint of
TABLE 5  
Production Costs of Shelter-Pasture Systems  
($ per Pound Finished Pig)

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td><strong>Assuming $3.00 per Bushel Corn</strong></td>
</tr>
<tr>
<td>Using cost data</td>
<td>$0.53</td>
</tr>
<tr>
<td>Using price data</td>
<td>$0.50–$0.55</td>
</tr>
</tbody>
</table>

this range is exactly the cost estimate using the modified organic budgets, as shown in Table 5.

These two data sources suggest that a shelter-pasture system, as currently implemented, can produce live hogs at a cost of about $0.53 per pound of live hog (when corn prices are $3.00 per bushel). This cost is less than those from the confinement-enhanced system, and it might be argued that the shelter-pasture system utilizes higher standards than the confinement-enhanced system. However, the shelter-pasture system probably results in higher crushing rates compared with the confinement-enhanced facilities, so accounting for the welfare of piglets the shelter-pasture system may not be superior to the confinement-enhanced farms.

COMPARISON OF FARM SYSTEMS

The flow of farm systems from (a) confinement-stall, (b) confinement-pen, (c) confinement-enhanced, and (d) shelter-pasture systems is intended to capture systems that are increasing in farm animal welfare in that confinement-enhanced and shelter-pasture systems are thought to be superior to the other two systems. The cost estimates indicate that increasing animal welfare raises production costs. This may not seem a surprising result, but some in the animal rights community have argued that higher standards of care are really less expensive and that farmers simply are not aware of this fact (Francione, 2008).

Table 6 summarizes the four systems in terms of animal well being and production costs. The animal welfare factors listed do not exhaust the number of items that affect farm animal welfare but are chosen due to their perceived importance by the scientific literature, expert assessment, and consumer opinion (Bracke et al., 2002a, 2002b; Norwood et al., 2007). Each animal welfare factor is given a score of very low, low, medium, high, or very high. Because these are stylized farm types and actual farms within each type will vary, some of the scores are listed as a range to reflect farm heterogeneity. The ratings are assigned based on readings in the scientific literature, with particular emphasis on the SOWEL model developed by Bracke et al. (2002a, 2002b).
### TABLE 6
Summary of Four Stylized Hog Production Systems

<table>
<thead>
<tr>
<th>Animal Welfare Factor</th>
<th>Confinement-Stall</th>
<th>Confinement-Pen</th>
<th>Confinement-Enhanced</th>
<th>Shelter-Pasture</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level of Provision of Each Factor</strong> (each factor is assumed good for animal well being)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access to food, water, and health care</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Space per animal</td>
<td>Very low</td>
<td>Low</td>
<td>High</td>
<td>Very high</td>
</tr>
<tr>
<td>Outdoor access</td>
<td>None</td>
<td>None</td>
<td>Very low-medium</td>
<td>Very high</td>
</tr>
<tr>
<td>Foraging and rooting materials</td>
<td>None</td>
<td>None</td>
<td>Medium</td>
<td>Very high</td>
</tr>
<tr>
<td>Ability to express normal husbandry behaviors</td>
<td>Very low</td>
<td>Very low</td>
<td>Medium-very high</td>
<td>Very high</td>
</tr>
<tr>
<td>No physical alterations (e.g., tail docking)</td>
<td>Very low</td>
<td>Very low</td>
<td>Medium-high</td>
<td>Very high</td>
</tr>
<tr>
<td>Survival rate of nursing piglets</td>
<td>Very high</td>
<td>Very high</td>
<td>Medium-high</td>
<td>Very low-medium</td>
</tr>
<tr>
<td>Subjective overall welfare assessment</td>
<td>Very low-low</td>
<td>Very low-low</td>
<td>Medium-very high</td>
<td>Very high</td>
</tr>
<tr>
<td>Cost per pound of finished hog (at $3.00 corn)</td>
<td>$0.45</td>
<td>$0.48–$0.49</td>
<td>$0.53–$0.65</td>
<td>$0.50–$0.55</td>
</tr>
</tbody>
</table>

*a* The rating can receive a score of very low, low, medium, high, or very high. Some farms receive a range of scores to reflect the heterogeneity within that farm type. *b* Based on the authors’ judgment, as informed by the scientific literature.
The confinement stall is commonly referred to as a “factory farm” and has been attacked by numerous animal advocacy organizations. The most contentious practice of this factory farm is gestation crates. Although the impact of using group pens instead of gestation crates is debated by scientists, it would undoubtedly please many animal advocacy organizations. Suppose that all pork was initially produced under the confinement-stall system and then converted to the confinement-pen system. The cost of this transition would be modest—increasing costs at the farm level by 9% and the retail level by 2%—if all costs were passed on to the consumer. In absolute terms, this implies the retail price of pork would increase by a maximum of $0.065 per retail pound. Will consumers pay this price? Fortunately, studies have been conducted to answer this question. Consumer surveys have shown that the average American is willing to pay $0.34 per pound more for pork produced in a confinement-pen system than a confinement-crate system (Tonsor et al., 2009). Thus, banning gestation crates creates an average value of $0.34 per pound but only costs an extra $0.065 per pound. Note that this is the first time the gestation crate ban has been placed under a cost-benefit analysis.

Consider another thought experiment, where all pork was initially raised under the confinement-stall system and then converted to a pasture-shelter system. Raising hogs on a shelter-pasture system provides a substantial increase in hog welfare and a corresponding increase in hog production costs of 18% at the farm level and 5% at the retail level if costs are passed on to consumers in full (details available from the authors by request).

The actual impact of changes in how hogs are raised depends crucially on the context. A number of producers have converted from confinement-stall to confinement-pen systems (farms owned by Smithfield Foods, Colorado farmers) but are unable to pass on any of their cost increases to the consumer because they must compete with other pork producers who still utilize the confinement-stall system. Unless the pork is marketed in a specific manner to extract a premium, consumers will tend to purchase the least costly pork. Only if all pork farmers simultaneously convert to higher welfare and higher cost systems will consumers share in paying the additional costs.

The reader may note that some pork is currently sold under the Animal Welfare Approved label, which corresponds to the shelter-pasture system. The premium for this pork is often 200–300% higher than traditional pork sold at conventional food retailers. This premium is obviously not consistent with the 18% increase in production costs for shelter-pasture pork over confinement-stall pork. Two reasons exist for this difference. First, shelter-pasture pork is not sold in traditional grocery stores but in high-end stores such as Whole Foods, which are associated with large premiums. Second, because shelter-pasture pork is sold only at these small, unique stores, they do not have access to the efficient marketing distribution systems of superstores such as Wal-Mart. This article only
measures the differences in costs at the farm level, whereas actual premiums are
affected by marketing distribution systems as well. However, if all pork were sold
under the Animal Welfare Approved label, then the shelter-pasture pork would
be marketed using Wal-Mart’s efficient distribution system, and premiums would
be much smaller than 200–300%.

The cost estimates of producing pork under four stylized hog production
systems presented here are informative but imperfect. The cost estimates cannot
be perfectly transferred to any region or scaled according to industry production.
That is, one cannot simply say that the cost of hog production, should all hog
producers switch to the shelter-pasture system, would be $0.53 per pound of live
hog (at $3.00 corn). The cost numbers for the confinement-enhanced and shelter-
pasture systems are taken from specific Iowa farms. Whether hog productivity
is higher or lower in the other regions of the United States is not known. Also,
the shelter-pasture systems are operated by producers with diversified farms
that maintain fewer than 150 sows. Their hog production systems are uniquely
designed to demand labor at times when their crops need less attention. The
herd sizes are also chosen for compatibility with farm labor. Consequently, the
cost of a shelter-pasture system might change dramatically if one attempted to
implement it with 1,000 sows.

FINAL THOUGHT

The farm animal welfare debate, like any debate, is replete with propaganda, talk-
ing points, and misleading arguments. Occasionally, though, the debate focuses
on the one pertinent question. Trent Loos is an agricultural advocate who writes
a weekly column for Feedstuffs. On January 29, 2007, he expressed the opinion
that “food animals do not need a ‘higher quality of life.’ They require that their
daily needs be met right up to the day we harvest them for human consumption.”
Expressing skepticism that individuals who disagree with him would voluntarily
pay the higher prices to provide a higher quality of life, he continued, “Are
we sure U.S. consumers are willing to pay the price of admission to attend the
showing of what is playing out in regard to the future of food production in this
country?” (p. 8).

Mr. Loos asked the correct question: Are we willing to pay the higher price
associated with increased farm animal welfare? Answering this question first
requires knowledge of what this “price” really is. The answer is not simple,
yet it can only be addressed by first asking what changes on the farm to
produce better animal care and how those changes alter the cost of production
at the farm. That is the question addressed by this research, and although the
answer provided has its limitations, it is the first step in answering this important
question.
REFERENCES

Adams, M. (Director). (2008, April 14). Colorado livestock groups agree to livestock handling restrictions in order to head off Humane Society backed ballot initiative. [Radio broadcast]. In J. Herath (Producer), AgriTalk Radio Show. Webster City, IA: KQWC.


