AN ECONOMIC ANALYSIS OF ALTERNATIVES TO CONFINEMENT PORK PRODUCTION

By

LACEY SEIBERT

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Oklahoma State University

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AN ECONOMIC ANALYSIS OF ALTERNATIVES

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Thesis Approved:

Dr. Bailey Norwood

Thesis Adviser

Dr. Jayson Lusk

Dr. Derrell Peel

Dr. A. Gordon Emslie

Dean of the Graduate College

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

In the past twenty years, a great deal of controversy has arisen over how hogs, raised for pork, should be treated. Most hog production today takes place inside confinement facilities where hogs are housed in cramped quarters, on hard floors, and with little opportunity for expressing normal behaviors. While this system produces safe, inexpensive pork, some consumers prefer to pay higher pork prices in return for greater animal well-being (Norwood, Lusk, and Prickett, 2007; Market Directions, 2006; Rauch and Sharp, 2005). 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, while the other two concern more drastic changes to hog production practices.

A Brief History

The consideration of the humane treatment of animals goes as far back as 3000 BCE when Middle Eastern cultures believed their ancestor's came back to life in animal form. These religious beliefs created an almost human level of respect for animals (Somvanshi, 2006). In the late 1600's Europeans began infusing lessons in animal welfare into children's literature and the trend continued onto North America in the late 1700's and early 1800's (Salem & Rowan, 2003). In 1822 Richard Martin MP presented the first bill to Parliament that offered protection from cruelty to cattle, horses, and sheep. In 1824 he co-founded the first animal protection society, known as the Society for the Prevention of Cruelty to Animals (SPCA). By the 1840's he had the blessing of Queen Victoria and the society became the RSPCA. This society reached America in 1866 with the first chartered group in New York (About the RSPCA, 2008). The Cruelty to Animals Act of 1876 was passed in Britain to regulate animal experimentation, and Europe continued on a progressive track of animal welfare regulation. The United States was slow to join the animal welfare movement. The first Federal legislation in the U.S. did not pass until 1966 (Adams, 2007).

Humans and pigs have a long history. The domesticated pig dates back to 4900 B.C. in China, and by 1500 B.C. domesticated pigs were being raised in Europe. When Christopher Columbus sought China by traveling west across the unknown oceans, Queen Isabella, who funded the voyage, ordered he return in his Eastward voyage with eight pigs. Columbus of course did not reach China, but a new land uninhabited by pigs. In 1539, explorer Hernando de Soto reached what is now known as Tampa Bay, Florida with 13 pigs, by the time he died his herd had grown to 700 head. Along the way de Soto had given some of his herd to the Native Americans as peace offerings. Native Americans began pig farming, and from there, pig production spread throughout the new American colonies. Some of de Soto's herd escaped and became wild pigs. These wild pigs caused problems in the grain fields, which prompted a law that said every pig greater than or equal to 14 inches tall had to have a nose ring. By the end of the 1600's most farmers had at least four to five pigs on their farm. As pioneers headed west in the late 1700's their pigs accompanied them, and once the herds in the west began to increase in numbers and size, there became a need for pork processing facilities.

While most Americans have heard of cattle drives, few are aware of the pig drives that took place. By the 1850's, 40 to 70 thousand pigs per year were driven from Ohio to the eastern markets. These drives ended in the late 1860's when the refrigerated railroad allowed for slaughtering systems to be close to areas of production rather than close to areas of consumption. This is how the large terminal markets with near by packing plants came to be in cities such as Sioux City, IA, Kansas City, MO, and Chicago, IL. These improvements in transportation capability fueled the relocation of the pork industry to the Northern Midwest or the "Corn Belt". The feed grains produced in this area made it ideal for pork production. By the late twentieth century other areas of the United States were being able to produce pork competitively by using technological advancements in genetics and feed efficiency (Pork Story, 2008).

The Rise of Confinement Facilities

Until recently, hogs were raised primarily outside and were provided with shelter from harsh weather. The animals were given much freedom to act naturally, but not out of animal welfare concerns, but out of a lack of modern production technologies. Livestock feed did not contain all the nutrients hogs needed, and without knowledge of exactly what was missing, hogs needed the freedom to forage and root in search of these nutrients. Before farrowing stalls, high weaning rates required raising good mothers who instinctively knew how to care for offspring. Moreover, there were synergies to raising hogs in the open alongside cattle. Tankage and surplus dairy milk was fed to hogs for cheap feed and protein. Hogs were even used to consume cow manure, which contained large amounts of undigested corn. As a 1928 livestock production manual states, "*corn salvaged from cattle droppings is clear gain. Experimental results show that for every bushel of corn fed to cattle, enough feed is recovered by swine following them to produce one to two pounds of pork.*" (Davis et al., 1928).

As early as the mid 1950's total confinement facilities were beginning to be used, this emulated the increasing popularity of the poultry confinement buildings. These systems allowed for the hogs to be kept on concrete and confined from birth to market. The advantage to these facilities was the ability to sanitize and prevent hogs from being contaminated with parasites and diseases (Deyoe et al., 1954). Advancements in nutrition allowed hogs to receive all their nutritional needs in formulated feeds. Foraging was no longer necessary. Cattle feed with higher amounts of digestible grain implied the returns from raising hogs alongside cattle fell. As consumers substituted soybean oil into their diets instead of lard, the return to raising fat hogs fell. Lean hogs are harder to keep warm in winter if kept outside, and make for poorer mothers. In the confinement facilities animal fat was no longer necessary for warmth, and farrowing cages compensated for poor mothers.

On the typical modern farm, all hog production takes place inside temperature controlled buildings. Gestating sows are housed in individual stalls barely larger than the sow herself. This allows a large number of sows to be housed under one roof, reducing average fixed costs, and making sow management less labor-intensive. When giving birth, the sow is moved to a farrowing crate, which like the gestation stall, prohibits the sow from walking or turning around. The stalls are designed to force the mother to lie down gingerly, reducing the number of farrow deaths by crushing. Also, sows that prefer to neglect their offspring are forced to nurse their young. From weaning until harvest, the offspring are raised in groups in cramped pens. In all cases, animals never go outside, and are raised exclusively on hard floors.

The adoption of these hog production technologies has increased the productivity of hog farmers. From 1920-1950, the labor hours per pound of hog production remained roughly the same. Since 1960 the labor hours required to produce one pound of pork has steadily declined (Gardner, 2002).

The Search for Alternatives

Some producers have sought an alternative to the traditional hog market, hoping to produce a niche product that allows them to raise hogs without a confinement facility (Honeyman et al., 2006). Hog production is more expensive in these alternative systems, but if producers differentiate their product by promoting "natural", "antibiotic-free", or "humane" pork they can extract a premium (Nilsson, Foster, and Lusk, 2007). For example, recent work has found that the retail market share of pastured pork raised without antibiotics, growth promotants, and animal by-products in feed is priced at a 40% premium over traditional pork and would have a 25% market share (NPB, 2005). Niche producers have already explored antibiotic-free, hormone-free, and natural pork to some extent. More opulent food retailers regularly carry such items. The market for more humane pork is less tested, though to some extent the organic pork market is driven by animal welfare concerns.

The search for alternatives may not be voluntary for some producers. Gestation stalls have been banned in Florida, Arizona, and Oregon. 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. If the trend for greater farm animal welfare legislation continues, a number of other common practices could be banned.

The purpose of this research is to articulate the range of alternatives available to pork producers, estimate the production costs of these alternatives, and describe the level of animal well-being on each alternative.

METHODOLOGY

As the farm animal welfare debate becomes increasingly intense, regulation and consumer demand will encourage some pork producers to show greater interest in alternatives to the closed confinement facility. The extent of this interest will depend on the alternatives available, the production cost of the alternatives, and consumers' willingness-to-pay for pork produced under alternative farm settings. There are two objectives for this research. First, we seek to concisely convey the hog production alternatives available, with particular attention to farm animal welfare concerns, and second, to measure production costs of these alternatives.

Achieving these two objectives requires a variety of data collecting activities, which can be described as a combination of literature reviews, partial budgeting, phone interviews, and personal farm visits. The welfare of hogs is best described as a variety of attributes such as, space per hog, group sizes, and provision of shelter. Consequently, there are hundreds of hypothetical types of hog farms differing according to the level of each attribute provided. Achieving the first research objective requires visits to individual farms, phone calls with various pork producers, and gaining an understanding of the important attributes affecting farm animal well-being.

The farm visits include local, Oklahoma farms and a trip to several Iowa farms. The particular farms are chosen to illustrate the variety of production systems available, from large intense confinement to small pasture systems. A small phone survey is also employed, containing 13 producers chosen from the database of niche pork producers available at the Pork Checkoff website. The survey contained specific questions common across all producers but also allowed informal conversation. The farm sizes ranged from producing 2 to approximately 40,000 market hogs per year. The facilities varied from large environmentally controlled buildings with pens inside to entirely shelter-pasture systems. Some of the farms were very diverse and raised many other crops and livestock and then others only produced hogs. The phone survey is seen as a substitute for farm visits, intended for educational purposes and to generate qualitative data.

We then seek to concisely describe the various production methods employed across the U.S. by grouping all farms into one of four categories: confinement-stall, confinement-pen, confinement-enhanced, and shelter-pasture. These are not meant to be an exhaustive list of the farm types available, rather general categories of farm types and within each farm type differences in farm practices are discussed.

The second research objective is achieved by estimating the production cost of live hogs under these four farm systems. The confinement-stall and confinement-pen farm costs are obtained through established budgets and modification of these budgets (Dhuyvetter et al., 2007). While the confinement-enhanced system is arguably the most progressive, it is also the rarest. Thus, cost estimates could only be obtained through phone interviews with the farm operators. Cost estimates for the shelter-pasture system are obtained through published research and analysis of published budgets.

FINDINGS

This section provides an overview of the four production systems considered in this study. These four systems are representative of only a subset of the total number of production options available to producers. The systems chosen represent what we feel is an accurate, stylized description of the various methods producers currently employ in hog production, not the potential methods that may be pursued under alternative market conditions.

The objective is to provide a narrative of the strengths and weaknesses of each system in terms of animal welfare, farm management, and most importantly production costs. Cost data are taken from a variety of data sources that utilize different assumptions about feed costs, such as corn prices. Given that feed is the largest cost component in hog production, some data sources are modified to reflect expected costs under the assumption of $3.00 per bushel corn prices. For all systems, the production cost of interest is the per pound cost of finished pigs, including all aspects of production from the breeding, birthing, nursing, weaning, and finishing. Costs not related to pork production, such as marketing or processing of the pork product, to the greatest extent possible, are not included in the cost estimates.

Confinement-Stall System

The confinement-stall system is the most rapidly growing system in the U.S., and likely produces more pork than any other system. For example, North Carolina is currently the second largest hog producing state, and virtually all its hogs are raised in confinement facilities.[1]

Figure 1. Confinement-Stall System (*Shown from top to bottom is a farrowing crate, gestation crate, and finishing floor)*

The goal of a confinement-stall system is to house all animals in an atmosphere-controlled building, providing 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 or crushing their offspring. To mitigate this problem, confinement systems normally employ farrowing crates (Figure 1.) which force the mother to nurse and lie down gingerly, thereby increasing the number of surviving offspring.

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[1] 2002 Census of Agriculture.

Because the buildings are expensive, producers seek to confine as many animals as possible under one roof, and cramped animals, especially sows, often resort to fighting and injuring one another. Thus, the sows are placed in gestation stalls (Figure 1.) to protect them from injury, but significantly restricting their movement. Sows will spend at least two-thirds of their lives in gestation crates.[2]

All animals will undergo minor surgeries such as teeth clipping and tail docking, to reduce the injury they inflict on one another in tight spaces.[3] Animals not used for breeding will be placed on a "finishing floor" after weaning where they will be placed in groups of about 25 and given eight square feet of space per pig.[4] For all hogs, there is no bedding, no access to outdoors, and no environmental enrichment. However, the system allows for individual feeding and monitoring of swine health, which can reduce injury and disease, especially among the sows.

Due to the prevalence of the confinement-stall system, production budgets are readily available to estimate production costs. This study utilizes the farrow-finish budget constructed by Dhuyvetter et al. (2007). This particular budget is chosen because it details the relationship between the corn price and feed costs, allowing us to modify the corn price and feed costs accordingly. To illustrate, Table 1 recreates this feed budget exactly as in Dhuyvetter et al. Feed costs per pig sold is calculated by dividing the price of corn per pound by the number of pounds of feed consumed by each pig

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[2] PIGS Information Sheet. Pig Production & Welfare. Available at http://www.vegsoc.org/info/pigs.html. Accessed April 15, 2008.
[3] In the presence of boredom, pigs will often chew the tails of other pigs.
[4] The body of a hog ready for harvest will consume five square feet of space, taken from personal measurements.

sold, as shown below (e.g. $9.13 = ($3.85 per bushel)(56 pounds per bushel)$^{-1}$*(132.8 pounds per pig sold)). Thus, by simply changing the price of corn from $3.85 to $3.00 the budget can be altered to project production costs at $3.00 per bushel corn.

Table 1. Feed Cost Budget From Dhuyvetter et al. (2007).

Feed	Pounds Fed Per Pig Sold[1]	Cost Per Pig Sold[2]	Adjusted Cost Assuming $3.00 Corn[3]
Corn($3.85/bu)	132.8	$9.13	$7.11
Sorghum($3.55/bu)	472.9	$29.98	$23.81
Soybean meal ($273/ton)	156.2	$21.29	$17.08
Other ingredients	22.0	$6.12	$6.12
Complete feeds	4.0	$1.41	$1.41
Processing($16.61/ton)	783.9	$6.51	$6.51
Total	**787.9**	**$74.44**	**$62.05**

[1] *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.*
[2] *One bushel of corn weighs 56 pounds.*
[3] *This column is not part of the original Dhuyvetter et al. budget.*

Sorghum and soybean meal prices are likely to be correlated with corn prices, so the sorghum and soybean meal price should also be adjusted to better reflect conditions where 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.[5] The estimated regressions are as follows. 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 Table 1 above. The cost per pig of other ingredients, complete feeds, and processing is unchanged from Table 1. With

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[5] Data were obtained from the Livestock Marketing Information Center. Regressions for corn/sorghum utilized weekly data from January 7, 1988 through June 26, 2008, and regressions for corn/soybean meal used weekly data from January 5, 1996 through May 30, 2008.

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. include variable costs such as veterinary services, breeding equipment, and facilities repairs, which total to $18.80 per pig sold. Fixed costs such as buildings, legal fees, building depreciation, and interest total to $26.88 per pig sold. For reasons that will be apparent later, labor costs are separated from variable and fixed costs and are calculated to be $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 costs for the confinement-stall system are $119.9133 per finished pig. Assuming a 265 finishing weight, this translates to $0.45 per lb of finished pig, as shown in Table 2 below.

Table 2. Cost Estimates for Confinement-Stall System

Feed Costs	$62.05 per finished pig
Variable Costs	$18.80 per finished pig
Fixed Costs	$26.88 per finished pig
Labor Costs	$12.18 per finished pig
Total Costs	**$119.91** per finished pig $0.45 per lb of finished pig

Confinement-Pen System

The confinement-stall system has experienced great scrutiny from animal advocacy groups. The most frequent complaint is the use of gestation stalls (Figure 1.). This is because when confined in a small gestation stall for two-thirds of her life a sow cannot turn around and sometimes can have difficulty even lying down comfortably. As discussed previously, a number of states are phasing out the use of gestation stalls through legislation or social pressure. Most farms that are being forced to phase out gestation stalls will replace the stalls with group pens for sows.

Group pens contain 3-6 sows per pen. Larger group sizes would lead to excess injury from sows fighting one another, and even with these small group sizes 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. While the sows have more freedom to move, they now must compete for food, and due to the difficulty of containing and moving sows, providing health care for the sows becomes more labor-intensive.

Figure 2. Group pens are used as alternatives to gestation stalls (*compare these pictures to gestations stalls shown in the middle picture in Figure 1).*

Although the primary current goal of animal advocacy organizations is to force producers to convert from confinement-stall to confinement-pen systems, scientific research suggests this conversion will not improve the welfare of sows. Reviews of numerous studies have concluded that both the productivity and well-being of sows is similar in confinement-stall and confinement-pen systems. While sows in stalls exhibit less stereotypic behaviors[6] than sows in pens, which is good for animal well-being, sows in pens suffer greater injuries. Measures of the stress hormone cortisol are statistically the same in both systems. Thus, while each system has an advantage and a disadvantage in terms of sow welfare, the overall level of animal care is roughly the same for both (McGlone et al., 2004; Task Force Report, 2005).

Most farm systems who adopt the confinement-pen system are not constructing new confinement-pen systems, but are switching from confinement-stall to confinement-pen systems. Consequently, this section will detail 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 the ground up (*non-conversion budget)*. For the *conversion budget, t*he budget developed in the previous section is modified to reflect a swine farm that has operated a confinement-stall system for ten years, converts the barn to a confinement-pen system, and will utilize this barn for ten more years. These costs are then verified by comparing them to budgets produced from software made available by the National Pork Board (NPB). The non-conversion budget is comprised solely from the NPB. 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. Like the previous system, the confinement-pen system operators utilize conventional

[6] Appleby and Hughes define stereotypic behaviors as, "unvarying, repetitive behavior patterns that have no obvious goal or function. For sows, stereotypic behaviors include biting cage bars or pawing at the concrete floor. Such behavior is often observed in confined settings and thought to arrive from an animals' frustrated motivation system. A more familiar example of stereotypic behavior is the perpetual pacing of animals in zoos (Appleby and Hughes, 2005; Appleby, 1999)

swine breeds, and do not market hogs under a natural, hormone-free, or antibiotic-free label.

The important assumptions driving the conversion costs include a one-time cost of $225 to convert the stalls to pens[7] (AgriTalk, 2008), and due to the fact that each sow is given more space in the same barn, the number of sows housed in the barn falls by 18% (AgriTalk, 2008; Boggess, 2007). For the present, the productivity and variable costs of each sow is 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 one sow spends approximately two-thirds of her life in the gestation phase (PIGS, 2008), this suggests the barn contains (1,200*(2/3) = 800 stalls). Multiplying 800 stalls times $225 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 ten-year life of the investment, the annualized investment costs per finished pig equals $1.146.[8] Total labor costs are also assumed unchanged after this conversion. While there are less sows to manage after the conversion, sow management is more difficult under a pen system than a stall system.

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[7] Hog production budget software by Boggess (2007) are consulted to obtain an alternative conversion cost, but the software simply assumes a $60,000 regardless the size of the barn.

[8] 19.5 finished pigs per year times 1200 sows equals 23,400 total finished pigs each year. The investment cost of $180,000 is annualized by multiplying it by the capital recovery factor $\{0.08\}\{1 – (1.08)^{-10}\}^{-1}$, which equals $180,000*0.149 = $26,820. Divided by the 23,400 pigs each year, the total annualized investment cost per finished pig equals $1.146.

The non-conversion budget assumes the confinement-pen facility is built from the ground up, 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. Consequently, the non-conversion budget is identical to the conversion budget, except that there are no barn conversion costs.

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.[9] Whether labor costs will rise or fall is unknown, but no evidence has emerged to suggest the change will be dramatic. Thus, the same labor costs are spread over less sows by dividing the per pig labor costs also by 0.82. Given there is no evidence to suggest that the sows' productivity will be different in the group pen, or that variable costs such as feed and medicine for each sow is significantly altered, variable costs per finished pig is the same as in table 2.

[9] Let FC be the total fixed cost and the total number of finished pigs equal the 1200 sows times the 19.5 pigs per sow. Fixed costs per pig then equals $(FC)(1200*19.5)^{-1}$. If the number of sows is reduced 18%, this number then becomes $(FC)((0.82)1200*19.5)^{-1}$, which equals the old fixed cost per pig divided by 0.82.

Table 3. Cost Estimates for Confinement-Pen System ($ per finished pig)

	Confinement-Stall System	Adjustment	Confinement-Pen System *(Conversion Budget)*	Confinement-Pen System *(Non-Conversion Budget)*
Barn Conversion Cost	------------	$1.15	$1.15	$0.00
Feed Costs	$62.05	$0.00	$62.05	$62.05
Variable Costs	$18.80	$0.00	$18.80	$18.80
Fixed Costs	$26.88	$5.90	$32.78	$32.78
Labor Costs	$12.18	$2.67	$14.85	$14.85
Total Costs	**$119.91**	**$9.72**	**$130**	**$128.85**
	Cost per lb of finished pig			
	$0.45	*$0.06*	*$0.489*	*$0.486*

Note: assumes $3.00 per bushel price of corn, 19.5 finished pigs per sow and a 265 lb finished pig.

Confinement-Enhanced System

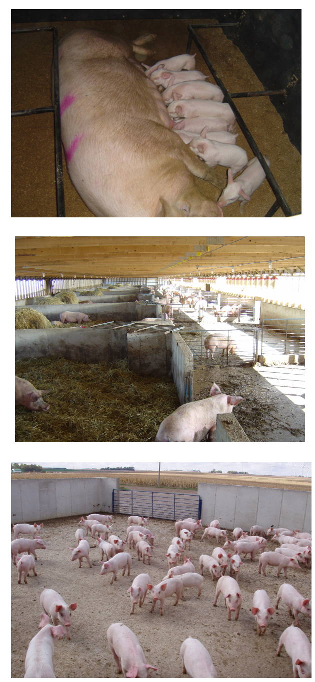

Figure 3. Confinement-Enhanced Production System

Confinement systems are criticized on the grounds that they restrict movement, leave animals vulnerable to attacks 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 system of two Iowa farms. Data on these systems are obtained through phone conversations, emails, and pictures. These data include the breakeven 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 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 over 2,000 sows each.

Not only are Farms A and B different from the conventional confinement facility, but quite different from each other. Both farms do all of their own marketing. Farm A markets under the USDA label standard, "all natural." Farm B has over 3500 customers including many high end restaurants. At the farrowing stage, Farm A utilizes farrowing boxes, which allow the sow to build a nest with bedding material. 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 some mothers to neglect their young.

Conversely, Farm B utilizes a progressive farrowing crate that has the advantages of the normal crate, but a unique design which allows the sow to turn around. This progressive crate contains 48 square feet of space for the sow, compared to 14 square feet in the normal farrowing crate. Unlike Farm A, the crate does not contain bedding material. Gestating sows are kept in groups on both farms, not gestation pens. 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, while Farm A probably allows three times more. Growing pigs are provided with 10 square feet of space on Farm B and at least two times more on Farm A, though both provide the pigs with bedding material to reduce boredom, extra comfort, and heat regulation. The provision of bedding differs between the farms. Farm A provides straw in all places except outdoor lots, while Farm B provides sawdust on half of the hogs' area. A major difference between the farms is access to outdoors. Farm A allows gestating sows and growing pigs access to dry outdoor lots. The lots are concrete, but allow sunshine and great space. Farm B provides no outdoor access. Both farms advertise natural pork and use no antibiotics or growth promotants. This reduces productivity. Farm B specializes in the Duroc breed and limiting itself to this single breed further impedes the hogs' productivity. An outbreak of disease recently occurred on Farm A, and while the producer was asked to consider the breakeven price required over many years, and not just the years over which the outbreak, occurred, this occurrence certainly had some impact on his response. Thus, the cost differences in this farm and the previous two farms represent more than differences in animal well-being. Due to the uniqueness of these farms, cost budgets. Consequently, cost estimates are obtained from both farms in response to a carefully-worded questionnaire. 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 per bushel. Finally, the operator is asked the breakeven-price for market hogs that would allow them to continue operating, but such that any lower price would force them to cease hog production.

Table 4. Breakeven Price of Confinement-Enhanced Systems ($ per lb finished pig)

Farm A	$0.65
Farm B	$0.53

Note: assumes a $3.00 per bushel price of corn.

These breakeven prices are shown in Table 4, and are interpreted as the cost of market hog production. The cost is predictably higher on Farm A, as it provides greater space and amenities than Farm B. As a validation of the stated breakeven prices, the producers are also asked their breakeven price if the price of corn is $5 per bushel. Farm A reported $0.75 and Farm B reported $57 per lb. The fact that both costs increased with corn prices, and in similar amounts, provide some validation for their accuracy.[10]

Shelter-Pasture System

The shelter-pasture system addresses all of the animal welfare freedoms stated by Appleby. In the shelter-pasture system, pigs have open pasture lots where they have the ability to run, root, interact with other pigs, and exhibit other natural behaviors. Depending on the season, pigs are provided with individual or group portable huts in the pastures for farrowing and shelter. The pasture lots are also connected to barns that have deep bedding material for the pigs to seek shelter. This system is similar to the types used in the early 20th century and before. In the past, hogs were allowed freedom to roam and root because the inadequacy of feed required the pigs to seek the nutrients the feed lacked. Plus, due to the lack of knowledge regarding how pigs can be raised indoors, the animals need the freedom to exhibit natural behaviors to ensure their needs are met.

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[10] The feed budget discussed in the confinement-stall section can be used to project how feed costs will rise when the corn price rises from $3 to $5 per bushel. This rise increases feed costs in the budget from $0.23 to $0.33 per lb 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.

Figure 4. Shelter-Pasture System

Early experiments with the confinement systems saw advantages, such as the concrete floors which enhanced sanitation, reducing parasites and disease (Deyoe et al., 1954). The increase in cleanliness, along with other advantages, came at the expense of other animal needs, such as freedom of movement. Reverting back to systems resembling older production methods is motivated primarily by a desire to increase hog well-being. Staunch defenders sometimes attack this method on the grounds that a "pasture" system would leave the animals vulnerable to predators and weather, but this is largely an intentional mischaracterization to make confinement systems appear humane. Shelter must always be provided to ensure high animal well-being, and except in rare cases, is provided.[11] It is this reason why this system is explicitly referred to as a *shelter*-pasture system.

To illustrate the setting of a shelter-pasture system, extension fact sheets from Huhnke et al. are consulted. According to Huhnke et al., gestating sows are kept in a pasture that allows 1 acre of 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

[11] In numerous visits, conversations, and phone calls with individuals knowledgeable of hog production systems, only one farm did not provide shelter for the hogs. This was an individual from Minnesota who finishes only a few hogs for himself and a few customers, and only raises hogs in the summer.

contain portable shelters or a large permanent structure. These shelters provide 15-20 square feet of roofed area per animal. In the winter the shelters are kept closed except for an opening on the south side and deep bedded in order to keep cold winds out and provide warmth. In the summer the shelters are opened to allow air circulation and bedding is provided for comfort.

During farrowing the pigs are housed in large, insulated buildings with floors or in small, portable houses without floors. In the large houses the pigs are each provided with 20-30 square feet of space. Bedding is also provided in both house types. As with the gestation houses the shelter doors are kept open in the summer and all but one side are closed in the winter. For the first week after farrowing there is a 2′x6′ board placed at the bottom of the opening to the house in order to keep the piglets in the house. Remember that this is a stylized description and the specifics will vary. For example, some producers may utilize houses that close all sides during the winter except for a small door.

On this shelter-pasture farm, finishing hogs are kept in a lot that provides 100 square feet per hog with a capacity between 50-200 head. These hogs are separated into groups based upon similar size and sex. Finishing pigs are provided permanent or portable shelters with 5-6 square feet of roofed area per pig. These shelters are also kept open in the summer and closed except for one side in the winter.

Many individuals consider the shelter-pasture system to exhibit a high degree of animal well-being, especially compared to confinement systems. It is not surprising then that some certification programs focusing on animal welfare contain standards that describe a shelter-pasture system. One is the Animal Welfare Institute's *Animal Welfare Approved* certification and the USDA's organic pork standards (Animal Welfare Institute, 2008). The Animal Welfare Institute's Animal Welfare Approved seal is unique in that it sets perhaps the highest animal welfare standards in the U.S. The label seeks to accredit, farms that practice production with high animal welfare standards. Farmers in the program are set apart by their enthusiasm towards raising animals in a more humane manor. *Animal Welfare Approved* farmers are subject to a minimum of one visit a year from *Animal Welfare Approved* staff or agents. Visits may be more frequent based upon need. Participation in the program must be renewed annually. Allowances are made for temporary deviations from the standards due to unexpected circumstances that are not under the control of the farmer.. The objective of the *Animal Welfare Approved* standards is that during production animals are allowed to behave naturally.

The required *Animal Welfare Approved* (AWA) criteria allow pigs the opportunity to perform natural and instinctive behaviors essential to their health and well-being. The standards are set to ensure physical and psychological well-being as well as social interaction and comfort. The standards require that pigs be kept in groups, not in isolation. Exceptions are made for individual farrowing huts or pens, but the sow must be within sight and sound of other pigs. The animals are to have ample space for movement, including access to explore for food and ability to find resting spots without competing with other pigs. In housing areas, gestating sows are required to have a minimum of 32 square feet per sow, and farrowing sows are allowed a minimum of 64 square feet. Finishing pigs are provided a minimum of 14 square feet each at their largest weight. These space allocations refer only to the indoor area; the AWA requires additional space they refer to as the (loafing area) which may or may not be covered or bedded.

Bedding is required for all animals, piglets may not be weaned before six weeks of age[12], castrations must be performed before one week of age, and other minor surgeries such as castrations are prohibited. From the age of 10 days, all pigs must have access to pasture with forage (Animal Welfare Institute, 2008).

The USDA's certified organic program has requirements set for the production and handling of livestock. Aside from the organic feed requirements the USDA also embraces high levels of welfare for this certification. These requirements say that the producer must select species and types of livestock with regard to suitability for site-specific conditions and resistance to prevalent diseases and parasites. Appropriate housing, pasture conditions, and sanitation practices to minimize the occurrence and spread of diseases and parasites must be provided. Animals in an organic livestock operation must be maintained under conditions which provide for exercise, freedom of movement, and reduction of stress appropriate to the species. Additionally, all physical alterations such as tail docking must be performed to promote the animals' welfare and in a manner that minimizes stress and pain. The organic system plan must reflect a proactive approach to health management, drawing upon allowable practices and

[12] Piglets weaned too early do not develop mentally and experience greater amounts of stress and aggression in their life (Hog Genius, 2007).

materials. Animals with conditions that do not respond to this approach must be treated appropriately and diverted to non-organic markets. Living conditions must maintain the health and natural behavior of the livestock. Access to the outdoors, shade, shelter, exercise areas, fresh air, and direct sunlight suitable to the species, its stage of production, the climate, and the environment must be provided. Also animals should be provided with appropriate clean, dry bedding, and, if the bedding is typically consumed by the species, it must comply with applicable organic feed requirements. The producer must provide shelter designed to allow for the natural maintenance, comfort level, and opportunity to exercise appropriate to the species. The shelter must also provide the temperature level, ventilation, and air circulation suitable to the species and reduce the potential for livestock injury. The producer may provide temporary confinement of an animal because of inclement weather; the animal's stage of production; conditions under which the health, safety, or well-being of the animal could be jeopardized; or risk to soil or water quality. These requirements provide USDA Certified Organic pigs with an organic diet as well as a lifestyle that affords them high levels of welfare (Organic Food Productions Act, 2000).

The AWA and organic certifications have their differences and their similarities. For example, the organic certification allows tail docking while the AWA does not, but both require the animal to have access to both shelter and outdoor access. The AWA has more stringent requirements, and probably higher standards of care. However, their similarities make both specific examples of the stylized farm system described here as shelter-pasture system.

It should be noted that the shelter-pasture systems do not necessarily score high on all animal welfare factors. Without the use of farrowing crates, producers must be careful to select for sows that 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 pre-wean mortality rate is greater in the shelter-pasture system due to crushing, though reliable data is 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, indicating it presents little problem. However, conversations with individual shelter-pasture producers suggest otherwise, that up to one-third of piglets born are killed by crushing. Additionally, surveys of niche pork producers suggest that pre-wean mortality rates are around 25% and that crushing is the number one cause of pre-wean death (Kliebenstein et al., 2007).

Crushing can be mitigated through the use of "crushing bars" which provide the piglet access to an area where the mother cannot lie, and through the careful selection of breeding stock. Some producers have expressed that crushing can prevented solely by the selection of breeding sows. Others have attempted to farrow in pastures, but quickly returned to farrowing crates due to crushing. It is unclear whether the discrepancy in reported crushing rates is due to differences in farm breeding stock or individuals' desire to keep the public unaware of this problem associated with shelter-pasture systems. It is said that fattier sows are better mothers, and the trend towards leaner hogs may have required the use of farrowing crates to counteract poorer mothers. However, our impression is that some individuals are not completely forthcoming of the extent to which crushing is a problem. Thus, the level of animal welfare provided by the shelter-pasture system depends heavily on the importance placed on the pre-wean mortality and the extent to which it occurs. However, crushing appears to be the only obvious weakness of the shelter-pasture farm.

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 et al. (2004). The feed costs within the budget are modified to reflect the cheaper price of non-organic corn compared to 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 are modified to better reflect the shelter-pasture system. Differences in the two farm systems are as follows. For a variety of reasons, one being pre-wean crushing; the number of finished pigs per sow is only 12.74 in the shelter-pasture system, compared to 19.5 in the confinement-stall system. The use of natural breeding techniques requires the use of more boars, which increases feed costs but will reduce other budget items such as semen expenses.

The Dhuyvetter et al. (2007) article provide sufficient information to estimate how feed consumption changes as the number of finished pigs per sow falls from 19.5 to

12.74.[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. Replacing this feed cost in the Kliebenstein et al. (2004) budget suggests a production cost of $139.89 per finished pig. Consistent with previous section's assumption of a 265 lb market hog, this corresponds to a production cost of $0.53 per lb of market hog. Another cost source is available from a niche pork cooperative that utilizes a pasture-shelter system consistent with the Animal Welfare Institute guidelines. Data on prices received by the cooperative producers indicates they receive a premium of $0.05-$0.10 per lb of live hog over the average market price. This average market price represents the market for hogs, primarily supplied by producers utilizing confinement-stall facilities. For producers to remain in hog production, this premium must cover the additional expenses of a shelter-pasture system, compared to a confinement-stall system. In a long-run competitive equilibrium, this premium will just equal the additional expenses. Given that a confinement-stall system costs are estimated to be $0.45 per lb of finished hog, these price data indicate a shelter-pasture system costs are $0.50-$0.55. The

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[13] Feed costs per finished pig is calculated by summing feed consumption for all pigs, sows, replacement gilts, and boars, and dividing this number by the number of finished pigs. This can be represented algebraically as *lbs feed per finished pig* = (*lbs feed consumed by each growing pig*) + *(lbs feed consumed by effective sow) / (finished pigs per sow)*, or, $feed = x + S/FPS$, where "effective sow" includes the total pounds of feed consumed by boars, replacement gilts, and sows, divided by the number of sows. The derivative of this function with respect to *FPS* is $\Delta feed = -S(FPS)^{-2}\Delta FPS$. Data in Dhuyvetter (2007) provide values of $\Delta feed$, *FPS*, and ΔFPS, allowing a calculation of *S*. Once *S* is known, data on *feed* and *FPS* can be used to solve for *x*. At this point, when *x* and *S* are known, the lbs of feed per finished pig can be calculated for any value of finished pigs per sow.

midpoint of this range is almost exactly the cost estimate using the modified organic budgets.

Table 5. Production Costs of Shelter-Pasture System ($ per lb finished pig)

Using Cost Data	$0.53
Using Price Data	$0.50-$0.55

Note: assumes a $3.00 per bushel price of corn.

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 lb of live hog. This cost is less than those from the confinement-enhanced system, and it might be argued results in higher farm animal welfare. However, a few important aspects of the shelter-pasture system should be noted. The data are obtained from farms containing less than 150 sows, while confinement facilities can handle many more sows. Perhaps the shelter-pasture system requires a larger profit per head to compensate for the fewer number of market hogs sold. Both systems are freely available for adoption, so some prices or constraints must be present making producers roughly indifferent over which system to employ. The shelter-pasture systems tend to be employed on diversified farms where the family provides most of the labor, whereas most all confinement facilities require full-time help, though typically consisting of migrant labor, and the producers tend to be primarily hog farmers. The confinement system is specifically designed to be used with unskilled labor, whereas managing sows in a shelter-pasture system requires considerable experience. For instance, confinement facilities preclude the need for herding pigs, which can be a particular difficult task.

CONCLUSION

Comparison of Farm Systems

The flow of farm systems from (1) confinement-stall (2) confinement-pen (3) confinement-enhanced and (4) shelter-pasture system is intended to capture systems that are increasing in farm animal welfare, in that a shelter-pasture system is thought to be superior to the other three systems, and the confinement-pen system is thought to be superior only to the confinement-stall system. As expected, the cost of production rises as one moves from the lower to higher states of farm animal welfare. The purpose of this section is to describe the change in welfare and costs, and to articulate the limitations of this analysis.

Table 6 below 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 perceive importance by the scientific literature, expert assessment, and consumer opinion. Also, the attributes listed are largely those that differ across farms. For example, some studies consider whether the animals are genetically selected to have a proper body structure that minimizes pain. This study assumes all farms utilize the same, standard pig and so ignores this factor. It should be noted that the animal welfare assessments provided below are partly based on detailed observation, but partly based on our impression and understanding from farm visits, readings, and phone conversations. Thus, they are partly subjective.[14]

Table 6. Summary of Four Stylized Hog Production Systems

Animal Welfare Factor	**Confinement-Stall**	**Confinement-Pen**	**Confinement-Enhanced**	**Shelter-Pasture**
	Level of Provision of Each Factor			
Access to food, water, and health care	**high**	**high**	**high**	**high**
Space per animal	**Very low**	**low**	**high**	**Very high**
Protection from injury	**Sows: Very high Growing Pigs: very low**	**Sows: very low Growing Pigs: very low**	**Medium-very high**	**Very High**
Outdoor access	**Very low**	**Very low**	**Very low-medium**	**Very high**
Foraging and rooting materials	**Very low**	**Very low**	**medium**	**Very high**
Ability to express normal husbandry behaviors	**Very low**	**Very low**	**medium**	**Very high**
No physical alterations (e.g. tail docking)	**Very low**	**Very low**	**Low-high**	**Medium-very high**
Survival rate of nursing piglets	**Very high**	**Very high**	**Low-high**	**Very low-medium**
Overall Welfare Assessment	**Very low**	**low**	**Medium-very high**	**Very high**
Cost/ lb of finished hog (at $3.00 corn)	***$0.45***	***$0.48-0.49***	***$0.53-0.65***	***$0.53-$0.55***

[14] An objective welfare assessment of farm systems is provided in Bracke et al. (2002A, 2002B), but only considers the welfare of sows and the farms considered do not match perfectly with the four systems in this study.

The confinement-stall system is commonly referred to as a "factory farm" and has been attacked by numerous animal advocacy organizations. In some states they have been banned. The confinement-stall system provides high levels of shelter, and temperature control, but so do the other systems.[15] Because the females are contained in individual stalls they receive high levels of protection, but growing pigs are contained in such small spaces their tails must be docked to prevent them being chewed by other pigs. However, it greatly restricts animal movement, socialization, and ability to exhibit natural behaviors such as rooting. Animal welfare models constructed from scientific studies and expert opinion conclude that space per animal is the most important determinant of farm animal welfare, and that movement comfort and ability to exhibit natural behaviors are also important. As a result, the confinement-stall system is generally deemed to provide the lowest level of welfare for sows compared to most other farm systems, except for farms that replace the gestation stall with a tether (Bracke et al., 2002A, 2002B).

U.S. consumers also believe that allowing hogs to express natural behaviors and exercise outdoors are the most important determinants of animal welfare besides the obvious necessities such as food, water, and health

[15] It should be noted that it is assumed that all farms provide high levels of shelter and temperature control. In practice this is not always the case. For example, we visited a shelter-pasture system that was under poor management. While shelter was provided, dry bedding was not, so the animals had no dry place to sleep.

(Norwood, Lusk, and Prickett, 2007), causing consumers to also disapprove of the confinement-stall system. When the corn price is $3.00 per bushel, we estimate it costs $0.45 per lb of live hog produced under the confinement-stall system.

The confinement-pen system is generally thought to be an improvement over the confinement-stall system for breeding sows, but this is debatable. While sows are not confined to individual stalls and are given more space, they are more susceptible to injury from aggressive sows. While some meta-analyses and expert panels suggest the two are compatible in terms of animal welfare (Task Force Report, 2005), others find an improvement in sow well-being (Bracke et al., 2002A, 2002B). The difference in costs between the two systems is less debatable, though, as the costs of a single lb of live hog under the confinement system is $0.03-$0.04 more than the confinement-stall system.

The confinement-enhanced and shelter-pasture systems represent clear improvements in well-being for breeding and market hogs, though the impacts on nursing piglets is debatable. These two systems attempt to meet all the needs of hogs, though they differ in degree. Both provide animals with greater space and allowing them to exhibit natural behaviors such as rooting and in some cases nest building. Both also require greater expenditures to produce pork. One confinement-enhanced system which provides greater space, no individual stalls, some bedding but no outdoor access costs $0.08 more than the confinement-stall system to produce one pound of live hog, while another which does allow outdoor access and greater amounts of space and bedding costs a large $0.20 more.

The shelter-pasture system meets all the major animal requirements, providing ample space, bedding, access to pasture, and allows mothers to build nests and care for their young in a natural setting. The nursing piglets pay a cost for this arrangement, in terms of higher crushing rates. The problem of crushing can also arise in the confinement-stall system, depending on the type of farrowing pen used. One reason for the high cost on one of the confinement-enhanced systems may be the advanced farrowing system they employ. Our impression is that it provides the highest level of sow and piglet welfare than any other system considered.

As table 6 shows, increasing animal welfare raises production costs. This may not be a surprising result, but some in the animal rights community have argued that higher standards of care are really less expensive, but farmers simply are not aware of this fact (Francione, 2008). The overall welfare for each system is based on scientific studies comparing hog welfare under various systems (Bracke et al., 2002A, 2002B) and consumer surveys (Norwood, Lusk, and Prickett, 2007). However, it should be noted that transferring the results of these studies to the particular farm systems in Table 6 is not simple, and requires some judgment on our part. Thus, our judgment is certainly open to scrutiny – and welcomed. Also, the overall welfare assessments assigns a relatively low importance to the crushing of nursing piglets, but this is also open to scrutiny. It has been common to ignore the welfare of nursing piglets, but becoming increasingly obvious that crushing can be a major problem in non-confinement systems.

It is important to recognize that the overall welfare assessments are partly by construction. From the outset this study sought to compare costs from the farms with the lowest and highest standards of welfare. Thus, they are relative, not absolute. The labels very low, low, …, high, and very high are relative. While the shelter-pasture system is deemed to provide very high standards are care, it is impossible to know for certain whether the hogs are "very happy" in this system and "very unhappy" in the confinement-stall system.

Limitations of Study

The cost estimates of producing pork under four stylized hog production systems are informative but imperfect. The cost differences reflect more than just animal welfare, and the product they produce is not necessarily the same. Data from the confinement-enhanced and shelter-pasture systems use specific breeds that are developed with a greater emphasis on taste than the traditional hogs.

For example, one producer only uses the Duroc breed because his consumers prefer the taste of a Duroc, but the producer could produce hogs at less cost by cross-breeding the Durocs. Also, these producers abstain from the use of growth hormones or sub-therapeutic antibiotics, which reduces the conversion of feed to muscle. Because they do not employ farrowing crates they must select sows which produce fast growing pigs but are also good mothers. Having to compromise between selecting motherly hogs and offspring with efficient feed uptake reduces the overall efficiency of the farm, compared to a farm that can breed any sow regardless of their motherly instincts.

The cost estimates cannot easily be transferred to any region or scaled according to industry production. That is, one cannot simply say that the cost of hog production after all hog producers switch to the shelter-pasture system would be $0.55 per lb of live hog or less. The cost numbers for the confinement-enhanced and shelter-pasture systems are taken from Iowa farms. Whether hog productivity is higher or lower in the Southern region of the U.S. is not known. Also, the shelter-pasture systems are operated by producers who also harvest grains and maintain less than 150 sows per person. 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 laborer. Consequently, the cost of a shelter-pasture system may change dramatically if one attempted to implement it with 1,000 sows. For this reason, attempts to convert all U.S. hog production to a shelter-pasture system may be associated with production costs different than $0.53-$0.55 per lb of live hog estimate of this research.

Final Thought

The farm animal welfare debate, like any debate, is satiated with propaganda, talking points, and misleading arguments. Occasionally, though, the debate focuses on the central question of the debate. 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.*" In regards to the recent debate on whether animal welfare should be improved, he continues, "*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?"*

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 need to be made 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 while the answer provided has its limitations, it is the first step in answering this important question.

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VITA

Lacey Seibert

Candidate for the Degree of

Master of Science

Thesis: AN ECONOMIC ANALYSIS OF ALTERNATIVES TO CONFINEMENT PORK PRODUCTION

Major Field: Agricultural Economics

Biographical:

Education:
Completed the requirements for the Bachelor of Science in Agri-Business at Oklahoma State University, Stillwater, Oklahoma in May, 2007.

Completed the requirements for the Master of Science in Agricultural Economics at Oklahoma State University, Stillwater, Oklahoma in December, 2008.

Experience: Research Assistant for the Agricultural Economics Department at Oklahoma State University.

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Name: Lacey Seibert Date of Degree: December, 2008

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: AN ECONOMIC ANALYSIS OF ALTERNATIVES TO CONFINEMENT PORK PRODUCTION

Pages in Study: 42 Candidate for the Degree of Master of Science

Major Field: Agricultural Economics

Scope and Method of Study: In the past twenty years, a great deal of controversy has arisen over how hogs, raised for pork, should be treated. Most hog production today takes place inside confinement facilities where hogs are housed in cramped quarters, on hard floors, and with little opportunity for expressing normal behaviors. While this system produces safe, inexpensive pork, some consumers prefer to pay higher pork prices in return for greater animal well-being 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, while the other two concern more drastic changes to hog production practices.

Findings and Conclusions: The flow of farm systems from (1) confinement-stall to (2) confinement-pen to (3) confinement-enhanced and to (4) shelter-pasture system is intended to capture systems that are increasing in farm animal welfare, in that a shelter-pasture system is thought to be superior to the other three systems, and the confinement-pen system is thought to be superior only to the confinement-stall system. The increasing animal welfare from confinement-stall to shelter-pasture raises production costs.

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