Producers' Willingness to Adopt an Alternative Technology: Market Opportunities to Export Pork to China

John Lai
Graduate Research Assistant
Department of Agricultural Economics[1]
Purdue University

H. Holly Wang
Professor
Department of Agricultural Economics[1]
Purdue University

Working selected paper prepared for presentation at the 2016 Agricultural & Applied Economics Association Annual Meeting, Boston, Massachusetts, July 31 – August 2

[1] Department of Agricultural Economics. Purdue University
403 West State Street, West Lafayette, IN 47907
Tel: (765) 494-4257 Fax: (765) 494-9176

Introduction

The hog and pig farming industry in the United States is a $24.2 billion industry which has grown at 6.3% annually for the past five years and sets the country as the world's third-largest producer of pork and largest exporter. Its primary activities include farrow-to-finish operations, feeder pig farming, hog feedlots, weaning pig operations, and hog and pig farms (which includes breeding, farrowing, nursery, and finishing activities). There are three types of producers: independent growers who raise hogs and pigs for themselves to market, contract growers raising hogs and pigs for someone else, and contractors using contract growers to raise some or all of hogs and pigs they own. The individual growers account for 85% of the number of farms and 46% of the number of hogs and pigs sold in 2012, 199.1 million. Similarly, contract growers represent 44% of the hogs and pigs sold whereas contractors were the remaining 10%.

For Indiana, pig farming is also one of the most important industries to the state's economy. As of the 2012 Census of Agriculture, Indiana was ranked 5th in sales at $1.3 billion with hogs and pigs ranked 5th in inventory at a quantity of 3,747,352 in the nation. By December 2014, inventory levels held steady at 3.7 million. The pork farmers in Indiana raised 8.5 million pigs in 2013, contributes $3 billion each year to Indiana's economy, employs 13,000 people, and spends more than $600 million in local and rural economics each year.

By the 2012 Census of Agriculture, there were 4,953 pork producers classified as family or individual operators in Indiana. These farmers depend more heavily on farm income and must actively seek agribusiness opportunities. Coupled with the state's pork investments initiatives to bolster the industry, supply of pork will outpace demand forcing the pork industry to seek opportunities beyond normal channels such as exporting to other countries. In recent years, however, some countries have introduced bans on pork from the U.S. produced with ractopamine, a beta agonist which promotes lean tissue growth in pigs that is widely used in the U.S. While no scientific evidence has thus far been produced to show any deleterious effect on humans, larger international purchases maintain these trade barriers for U.S. pork. This, in turn, can have severe consequences on producers in the U.S. further exacerbating the problem faced by Indiana hog farmers.

There has been considerable disputes, especially in international trade, over ractopamine use in hog production. In the past few years some countries have placed bans on imported pork such as the European Union and China. Whereas for Russia and Taiwan, a zero tolerance policy on ractopamine has residues has been established on domestic and imported pork. In 2013, pork exports in the U.S. fell 18.4% to approximately 397 million pounds – the single largest year-to-year drop since the outbreak of H1N1 virus. In the year previous, the U.S. also saw a large decline in shipments to China and Hong Kong, the largest overseas market for U.S. pork, of about 36% as the Chinese government increases its surveillance on imports.

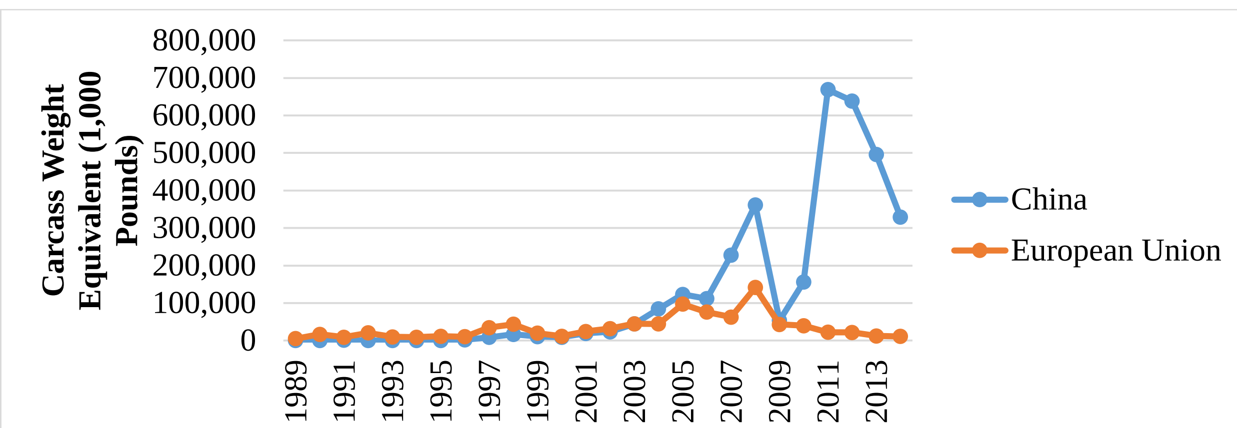

Figure 1 Annual U.S. pork trade.

While these bans and restrictions create market access challenges for U.S. pork, there still remains many trade partners who do accept U.S. pork. Under the North American Free Trade Agreement, Mexico and Canada represent over two billion dollar market for U.S. pork. Pork also is exported under the U.S. Central American Free Trade agreement to countries such as Honduras – a top 10 export market for U.S. pork in 2013, Dominican Republic - $180 million market in 2013, and Colombia – which was the leading export marketing in the Central South American region for 2013. These countries may help temporarily stem the loss of trade resulting from trade barriers.

The fact still remains that, as a country, China is the world's largest consumer of pork and represents a substantial export market for U.S. pork producers. With consistently growing per capital pork consumption and a quickly growing middle class, China is a very important trade partner. In 2013, Smithfield Foods was acquired by Shuanghui, which is a Chinese firm. Since then, the company has made considerable investments in converting existing plants to ractopamine free – including the world's largest hog processing facility – and highlighting the need to meet latent demand for ractopamine free pork export customers. By the end of 2013, over 50% of operations had no ractopamine as part of their feed rations.

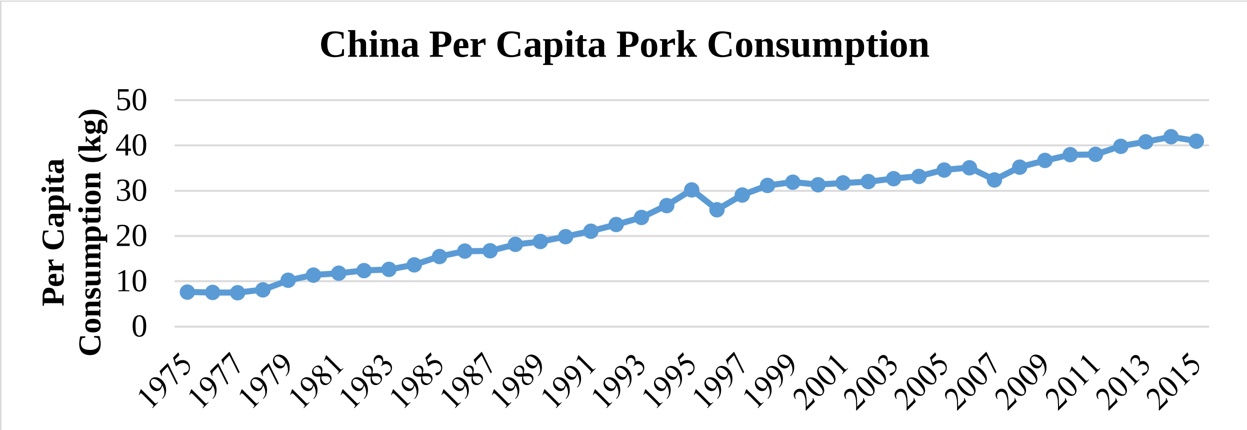

Figure 2 China per capita pork consumption.

In order for producers in Indiana to take advantage of this opportunity, producers must be willing to bar usage of the ractopamine chemical completely. With cheaper corn prices recently, the transition may not be arduous as the incentive to use ractopamine to promote lean meat growth is reduced. However, in the long term, there is a need for an economic study to be performed to determine the industry profitability without the use of ractopamine. The focus will need to begin at the decision point of farmers to convert to the ractopamine free production process. To conduct this economic study, a model must be developed in order to measure the producer's willingness to convert to the alternative production method.

A significant amount of literature has been generated in past several years on consumers' willingness to pay on product attributes such as food labeling (Gracia and Zeballos, 2005), food quality (Ortega, et al., 2014), and country of origin (Loureiro and Umberger, 2003). However, little but some focus has centered on the producer willingness to pay for inputs (Norwood, et al., 2005), voluntary check-off program contributions (Norwood, et al., 2006), option values of technologies (Olynk, et al., 2012), and attributes related to contracts (Roe, et al., 2004). Furthermore, little conceptual or empirical work has taken place to understand the monetary value placed on new production factors by producers (Zapata and Carpio, 2014). The purpose of this essay would be to extend the literature regarding producers' willingness to convert and use new technologies or other inputs.

A number of studies have examined the motivations of producers across several countries where conversions to alternative production methods have been adopted. These motivations have been summarized into two categories: farming related motives (financial, husbandry and technical reasons) and personal motives (personal health and general concerns). Studies in the past have also shown that demographics, such as age, gender, farm size, education, and social status, has played a role in the propensity to convert to organic farming (Padel, 2001).

In a highly commoditized industry like agricultural, agribusinesses and producers continuously look for new inputs, often of higher quality in the producer context (Hanemann, et al., 1991), and technologies that increase the margin between the cost of production and revenue. This is important because these improvements in inputs or technology can benefit consumers and producers. Take traceability as an example. When traceability systems are implemented, consumers believed that the new system bolstered their safety perceptions and confidence, and retailers believed benefits were gained by all players in the beef supply chain (Buhr, Gracia and Zeballos, 2005). Producers also gain from higher consumer confidence in their products and enhanced export shares (Buhr, Monjardino de Souza Monteiro and Caswell, 2004). One problem inherent to these novel inputs and qualities, however, is estimating the producers' willingness to pay because potential suppliers have little or no data from real markets. This problem is of great interest to agribusinesses such as seed and chemical companies, technology and equipment dealers, and agricultural service providers who often consider what innovative products or services to offer to their clients.

Contingent valuation methods have often been used to determine the value of nonmarket goods and services; especially in measuring individuals' willingness to pay for environmental services, health economics, real estate appraising, art valuation, and agribusiness (Banfi, et al., 2008, Boyle, 2003, Bromley, 1995, Lipscomb, 2011, Zapata and Carpio, 2014). In the area of agribusiness, willingness to pay has been further measured for a multitude of products or food quality improvements (Buhr, et al., 1993, Hayes, et al., 1995, Hoffman, et al., 1993, Lim, et al., 2014, Lusk and Hudson, 2004, Ortega, et al., 2014, Wang, et al., 2014, Weaver, et al., 1992).

Much literature has been generated on the consumer side without great focus placed on the producer; furthermore, little conceptual or empirical work has taken place to understand the monetary value placed on new production factors by producers (Zapata and Carpio, 2014). The purpose of this essay is to extend the literature regarding producers' willingness to pay for new technologies or inputs. The next section shows the layout of the proposed producer willingness to pay model.

Model

Traditionally, the goal of the producer is to maximize profit. The problem can be characterized as the following.

$$\max_{y} p * y$$
$$s.t. \, y \in Y \tag{1}$$

Some researchers have justified the use of the random utility model under Lancastrian utility theory based on the idea that producers internalize some externalities from the inputs that they choose or production methods. Here, we attempt to offer some additional proof that can offer a conceptual framework as a basis.

The producer maximizes utility, which is a function of profit, π, and an attribute, A, which is chosen by the producer, as shown in equation (14). This attribute represents a point on the continuum of the technology that the producer wishes to employ. It contributes to the producer's utility in additional to its profit contribution, either positively $U_A>0$ or negatively. Furthermore, π is a function of prices, p, outputs, y, and costs, C. Prices, outputs, and costs are all functions of A. The utility function is subject to three constraints shown in equation (15) to (16).

$$\max_{A} U(\pi(p(A), y(A), C(A)), A) \tag{2}$$

$$s.t.: \quad y = f(A) \tag{15}$$

$$p = g(A) \tag{16}$$

$$C = h(A) \tag{17}$$

To ensure maximization, the first order conditions must equal zero. First order conditions are as follows:

$$\begin{aligned} \frac{\partial U}{\partial A} &= \frac{\partial U}{\partial \pi} * \frac{\partial \pi}{\partial A} + \frac{\partial U}{\partial A} \\ &= \frac{\partial U}{\partial \pi} * \left[\frac{\partial \pi}{\partial \mathrm{p}} * \frac{\mathrm{dp}}{\mathrm{dA}} + \frac{\partial \pi}{\partial \mathrm{y}} * \frac{\mathrm{dy}}{\mathrm{dA}} + \frac{\partial \pi}{\partial \mathrm{C}} * \frac{\mathrm{dC}}{\mathrm{dA}}\right] + \frac{\partial U}{\partial A} = 0 \end{aligned} \tag{18}$$

To ensure unconstrained maximization, the second order conditions must be less than zero. Second order conditions are as follows:

$$\begin{aligned} \frac{\partial^2 U}{\partial A^2} = \frac{\partial^2 U}{\partial \pi \partial A}\left[\frac{\partial \pi}{\partial y} * \frac{dy}{dA} + \frac{\partial \pi}{\partial p} * \frac{dp}{dA} + \frac{\partial \pi}{\partial C} * \frac{dC}{dA}\right] \\ + \frac{\partial U}{\partial \pi}\left[\left[\frac{\partial^2 \pi}{\partial y \partial A} * \frac{dy}{dA} + \frac{\partial \pi}{\partial y} * \frac{d^2 y}{dA^2}\right] + \left[\frac{\partial^2 \pi}{\partial p \partial A} * \frac{dp}{dA} + \frac{\partial \pi}{\partial p} * \frac{d^2 p}{dA^2}\right]\right. \\ \left. + \left[\frac{\partial^2 \pi}{\partial C \partial A} * \frac{dC}{dA} + \frac{\partial \pi}{\partial C} * \frac{d^2 C}{dA^2}\right]\right] + \frac{\partial^2 U}{\partial A^2} < 0 \end{aligned} \tag{19}$$

The farmer must first choose among different production alternatives. Some alternatives the farmer has stronger affinity towards. Some examples of this in hog farming could include maternity pen free, organic, and ractopamine free pork. Within each of these alternatives is an associated utility gained by the farmer as well as the profit level achieved under the particular production method.

Survey

A survey instrument was administered online in the fall of 2015 to pork producers throughout the state of Indiana with the help of Indiana Pork Producers’ Association. A total of 46 participants participated in the survey. A choice experiment was also designed and included in the survey. SAS was used to create 40 choice scenarios using a D-optional fractional factorial design that allowed for all main and two way interaction main effects. These choice scenarios were further blocked into multiple groups to reduce respondent fatigue and time required to complete the survey.

In the choice experiment the producers were asked to consider a set of production methods which replicated their decision making process without real actions taking place. Farmers made production decisions among three alternatives pertaining to 200 pound carcass weight hogs with various attributes which related to ractopamine, organic, maternity pen usage, and price. The baseline production method was set as conventional production. Profit was expressed in dollars per head and ranged from -$2.00 to +$2.00 in increments of $0.50. Respondents were asked to consider each alternative's profit as compared to the conventional production method and not as a pure gain or loss on your entire operation. Thus, a decrease in profit is compared to the conventional production method and not as a pure gain or loss on the entire operation. Attributes such as organic, ractopamine, and maternity pens were either used throughout the operation or not used at all. In order to reduce hypothetical bias, a cheap talk script was included in the instructions: "Research has shown that decision makers tend to overestimate their willingness to pay so, please treat each choice scenario as you would in a real operation decision for your swine farm" (Ferris, 1994, Lusk, 2003).

Table 1 Producer Choice Experiment Example Scenario

	Option A	Option B	Option C
Profit ($/head)	-$2.00	-$1.00	
Individual Maternity Pens	Yes	No	
Organic	No	Yes	
Ractopamine	Yes	No	

I choose:	○	○	○

Summary Statistics

Demographic information is shown in Table 1. Among the survey respondents, 90% were male with average at of 50 years and 10% were female with an average age of 41 years old. 95% of respondents were White/Caucasian and the remaining 5% were Hispanic. The education of respondents ranged from a high school or G.E.D. to master's degree. A majority of respondents, 45%, held a four year college degree.

Table 2. Summary Statistics: Demographic Information

Demographic	% of Respondents
Gender	
Male (Avg. Age: 50)	90%
Female (Avg. Age: 41)	10%
Ethnicity	
White/Caucasian	95%
Hispanic	5%
Education	
Less than High School	0%
High School/GED	15%
Some College	30%
2-Year College Degree	5%
4-Year College Degree	45%
Master's Degree	5%
Doctoral Degree	0%

Among the producers, 12% were integrators while the remaining 12% were not. There respondents were almost evenly split among three different operation types: farrowing (27%), farrow to finish (39%), finishing (33%). Operation size was also recorded with the majority of operations with over 5,000 heads (53%). The next largest group was 2,000-4,999 head at 29%.

To measure the production capacity of each operation, the survey instrument also recorded information regarding the number of pig-spaces of finishing capacity owned. The 27% of producers had 15,001 of more pig-spaces, the largest group. These summary statistics are shown in Table 2.

Table 3. Summary Statistics: Operation Characteristics

Operation Characteristics	% of Respondents
Integrator	12%
Non-Integrator	88%
Operator Type	
Farrowing	27%
Farrow to Finish	39%
Finishing	33%
Operation Size	
1-99 head	6%
100-499 head	0%
500-999 head	12%
1000-1999 head	0%
2000-4999 head	29%
5000+ head	53%
Pig Spaces Owned	
0	13%
1-1000	7%
1001-2000	7%
2001-4000	13%
4001-6000	20%
6001-8000	0%
8001-10000	7%
10001-15000	7%
15001 or more	27%

Conclusion

Currently, the response rate of the survey is very low, and the data collection process is on-going. Literature suggests that for choice experiment data to be statistically viable, sample size must reach 100 respondents. Once this threshold has been achieved, empirical analysis can be conducted in order to provide an empirical component to the theory behind altruistic behavior of producers in their decision making process as it relates to production methods available and the connection to their utility maximization.

References

Banfi, S., M. Farsi, M. Filippini, and M. Jakob. 2008. "Willingness to pay for energy-saving measures in residential buildings." *Energy economics* 30:503-516.

Boyle, K.J. (2003) "Contingent valuation in practice." In *A primer on nonmarket valuation.* Springer, pp. 111-169.

Bromley, D.W. 1995. *The handbook of environmental economics*: Blackwell Publishers.

Buhr, B.L. "Traceability, trade and COOL: lessons from the EU meat and poultry industry." In.

Buhr, B.L., D.J. Hayes, J.F. Shogren, and J.B. Kliebenstein. 1993. "Valuing ambiguity: the case of genetically engineered growth enhancers." *Journal of Agricultural and Resource Economics*:175-184.

Ferris, K.P. 1994. "Parental responses of hispid cotton rats(Sigmodon hispidus) to intrusion by red imported fire ants(Solenopsis invicta) into simulated nests."

Gracia, A., and G. Zeballos. 2005. "Attitudes of retailers and consumers toward the EU traceability and labeling system for beef." *Journal of Food Distribution Research*:45-56.

Hanemann, M., J. Loomis, and B. Kanninen. 1991. "Statistical efficiency of double-boudned dichotomous choice contingent valuation." *American Journal of Agricultural Economics*:1255-1263.

Hayes, D.J., J.F. Shogren, S.Y. Shin, and J.B. Kliebenstein. 1995. "Valuing food safety in experimental auction markets." *American Journal of Agricultural Economics* 77:40-53.

Hoffman, E., D.J. Menkhaus, D. Chakravarti, R.A. Field, and G.D. Whipple. 1993. "Using laboratory experimental auctions in marketing research: A case study of new packaging for fresh beef." *Marketing science* 12:318-338.

Lim, K.H., W. Hu, L.J. Maynard, and E. Goddard. 2014. "A Taste for Safer Beef? How Much Does Consumers’ Perceived Risk Influence Willingness to Pay for Country‐of‐Origin Labeled Beef." *Agribusiness* 30:17-30.

Lipscomb, C. 2011. "Using contingent valuation to measure property value impacts." *Journal of Property Investment & Finance* 29:448-459.

Loureiro, M.L., and W.J. Umberger. 2003. "Estimating consumer willingness to pay for country-of-origin labeling." *Journal of Agricultural and Resource Economics*:287-301.

Lusk, J.L. 2003. "Effects of cheap talk on consumer willingness-to-pay for golden rice." *American Journal of Agricultural Economics* 85:840-856.

Lusk, J.L., and D. Hudson. 2004. "Willingness-to-pay estimates and their relevance to agribusiness decision making." *Applied Economic Perspectives and Policy* 26:152-169.

Monjardino de Souza Monteiro, D., and J.A. Caswell. 2004. "The economics of implementing traceability in beef supply chains: Trends in major producing and trading countries." *University of Massachusetts, Amherst Working Paper*.

Norwood, F.B., R.L. Luter, and R.E. Massey. 2005. "Asymmetric willingness-to-pay distributions for livestock manure." *Journal of Agricultural and Resource Economics*:431-448.

Norwood, F.B., C. Winn, C. Chung, and C.E. Ward. 2006. "Designing a voluntary beef checkoff." *Journal of Agricultural and Resource Economics*:74-92.

Olynk, N.J., C.A. Wolf, and G.T. Tonsor. 2012. "Production technology option value: the case of rbST in Michigan." *Agricultural Economics* 43:1-9.

Ortega, D.L., H.H. Wang, O. Widmar, and J. Nicole. 2014. "Aquaculture imports from Asia: an analysis of US consumer demand for select food quality attributes." *Agricultural Economics* 45:625-634.
Roe, B., T.L. Sporleder, and B. Belleville. 2004. "Hog producer preferences for marketing contract attributes." *American Journal of Agricultural Economics* 86:115-123.
Wang, S., L. Wu, D. Zhu, H. Wang, and L. Xu. 2014. "Chinese consumers' preferences and willingness to pay for traceable food attributes: The case of pork."
Weaver, R.D., D.J. Evans, and A.E. Luloff. 1992. "Pesticide use in tomato production: Consumer concerns and willingness ‐ to ‐ pay." *Agribusiness* 8:131-142.
Zapata, S.D., and C.E. Carpio. 2014. "The theoretical structure of producer willingness to pay estimates." *Agricultural Economics*.