The Potential for Marketing Pork Products with Embedded Environmental Attributes: Results from an Experimental Study

Selected Paper Presented at the American Agricultural Association Meetings
August 8 – 11, Nashville, TN

Sean P. Hurley (Contact)
Research Assistant
Department of Economics
260 Heady Hall
Iowa State University
Ames, IA, 50011
Phone: 515-294-2177
e-mail: shurley@iastate.edu

James B. Kliebenstein
Professor
Department of Economics
260 Heady Hall
Iowa State University
Ames, IA, 50011
Phone: 515-294-7111
e-mail: jklieben@iastate.edu

Abstract

Environmental issues such as air and water quality related to livestock production currently receive much attention. Potential methods for environmental improvement range from regulation to market solutions. This study looks at consumer willingness to pay for pork products with embedded environmental attributes. Experimental auctions showed that over one-half of the participants (62%) paid a premium, that did not vary significantly between differing regions of the United States. (JEL Codes Q13, Q25)

Introduction

Environmental issues related to livestock production have received much attention. These include surface and ground water quality and livestock odors. A standard way of dealing with non-point source pollution from livestock production has been to encourage the use of best management practices (BMP). While this approach may improve the environment, economic incentives for farmers to adopt these practices are needed as well.

Recently there has been a rise in interest for organic agriculture. The importance of organic agriculture stems from the perceived attributes embedded within organic products. Klonsky and Tourte identify an existing perception that organic agriculture provides solutions to problems related to environmental quality, food safety, the viability of rural communities, and market concentration. Hence, organic farming has the perception of a market which provides incentives to farmers to follow good environmental production practices.

Due to this rise in interest of organic agriculture, issues such as willingness-to-pay for organic produce (Misra et al.) and marketing organic products (Thompson and Kidwell; Thompson; Lohr; Krissoff; Duram) have received increased attention. While premiums are being paid for organic agriculture (Dobbs), it is difficult to know which attributes within organic products are commanding these premiums. There have been many studies that have investigated one of the perceived attributes, the issues of food safety (Roosen et al.; Fox et al., 1994; Fox et al., 1995), but little has been done in the area of embedded environmental attributes with no physical or health attributes.

This paper presents results from measuring what pork consumers indicate an improved (sustainable) environment is worth to them. Participants included urban and

rural residents from Iowa, Kansas, Vermont, Oregon, and North Carolina. Surveys and experimental auctions were used to obtain participant willingness-to-pay for pork products produced with potentially different environmental improvements and/or impacts. Specifically, the environmental improvements in this study were related to a reduction in livestock odor, and surface and ground water impacts through swine manure storage and application methods.

Several hypotheses are tested. One is whether consumers indicate they will pay a premium for pork products with embedded environmental attributes. Another is whether there is a significant difference between these premiums for different regions of the United States. A third hypothesis is whether premiums differ significantly as environmental attribute levels increase or are combined. We demonstrate in this paper that consumers are willing to pay a premium for pork products that are produced in systems that have improved environmental attributes.

Study Design and Data

Data collection consisted of two main parts: surveys and auction experiments. There were two surveys conducted during each experimental session. The first survey was conducted before the auction and collected personal information and information on participants' perception about industry issues. Some of the specific information collected was age, gender, household income, and education. The second survey was conducted immediately following the auction. This survey dealt with participant knowledge about pork production and contained questions pertaining to methods of obtaining environmental attributes in products. These questions were related to issues such as methods of manure storage and application and livestock production facilities.

The auction method used was a second-priced sealed-bid auction segmented into five bidding rounds. There have been many studies that have demonstrated the usefulness of experimental auctions for this type of marketing research (Hoffman et al.; Hayes et al.; Melton et al., Oct. 1996; Melton et al., Nov. 1996). It has been found that in multiple round experimental second price auctions, participants learn that the dominant strategy is to bid their true valuation for a good (Coppinger et al.; Cox et al., Shogren et al., 1994). Hence, it is in the best interest of the participants to reveal their true valuation for the item being auctioned. This implies that the second price auction is theoretically demand revealing (Hoffman et al.; Menkhaus et al.) which was first discovered by Vickrey.

To familiarize the participants with the second price auction, we first used a preliminary auction to sell candy bars. This allowed the participants to become familiar with the second price auction. After this first auction was completed, we ran a multiple trial second price auction with the pork products. In the first three rounds of this auction, participants bid only on the physical attributes of the product having no other information except for the previous round's bids. This allowed participants to become familiar with the auction process and obtain feedback on price information. In the fourth round, the participants were informed of the specific environmental attributes associated with the respective products. This information shock allowed us to determine what the effect of releasing environmental information had on participants' bids. In the fifth round, the implications of the environmental attributes were further explained and the participants were allowed to bid a final time. Following Fox et al. (1995, 1996), we controlled for

wealth effects[1] by randomly choosing at the end of the experiment both one round and one product from that selected round to be the product sold.

The products used to elicit bids were two-pound packages of uniformly cut, boneless, 1¼ inch pork loin chops. These pork loin chops were cut and packaged to look as uniform as possible. The first three rounds of bidding allowed us to identify if the packages provided were perceived as similar. Thus, in round four, participants were only bidding on the environmental attribute information provided. Bid responses would reflect the value of the environmental attribute. The participants were allowed simultaneously to bid on ten different packages of pork chops each having different environmental attributes. The packages of pork chops were arranged in a row, and placed on ice in one of three white coolers. Each of the ten packages were labeled as Package i, where i = 1,.., 10. For each experiment, after the third round each participant was told that one package was a "typical package" with no particular environmental attributes. In this same round, the other nine packages were assigned varying levels of environmental attributes dealing with ground water, surface water, and odor. Odor reduction was at two levels: a 30-40 percent reduction, and an 80-90 percent reduction over the "typical" product. Ground water and surface water impacts were also available at two levels: a 15-25 percent reduction and a 40-50 percent reduction over the "typical" product. Packages were provided with single attributes (only air, ground water, or surface water), double attributes, or all three attributes embedded. The double and triple attribute pork packages were all at the high reduction levels.

[1] Wealth effects are when participants change their bids because they won an earlier trial (Fox et al., 1995) See Davis and Holt for a discussion of wealth effects in experimental markets.

Experiments were conducted in six different areas of the United States: Ames, Iowa; Iowa Falls, Iowa; Manhattan, Kansas; Raleigh, North Carolina; Burlington, Vermont; and Corvallis, Oregon. Three experiments were conducted at each site. Two sites for the Iowa experiments represented a rural site (Iowa Falls) where there is a high concentration of hog production and a site (Ames) with a lower livestock concentration. For North Carolina, a total of six experiments were conducted. Two sets of experiments were conducted in the Raleigh, North Carolina area because it was determined following the first experiment that a random procedure was not followed in selection of participants. Thus, a second set of experiments was conducted. The last six surveys/experiments were conducted in Burlington, Vermont and Corvallis, Oregon.

At each site, each experiment lasted about two hours. The first experiment was conducted at 9:00 a.m., the second at 11:30 a.m., and the third at 2:00 p.m. To control for bias in package labeling, we switched the corresponding package number with the assigned environmental attribute for each of the different time slots. A random sample of individuals from the area being studied was used to obtain participants for the study. This sample was obtained by a random computer generated sample drawn from telephone numbers in the respective local telephone directory. Each participant was paid forty dollars for participating in the experiment.

Results and Discussion

Of the 333 participants in our study, results from 329 were usable. (See Table 1 for the break down of the number of participants by region.) Premium payers are defined as those who increased their bid from the no information round (round three) to the

information round (round four) on the most environmental package.[2] Using this definition, we found that approximately 62 percent of the 329 participants increased their bid for the most environmental good, the product with all three attributes—air, ground water and surface water quality improvements.

Information in Table 1 summarizes the distribution of participants by study region. The range in number of participants was 60 for the Corvallis, Oregon location to 27 for Burlington, Vermont. The number of participants willing to pay a premium ranged from 55 percent at Burlington, Vermont to 67 percent at Manhattan, Kansas. Hence, in all the study regions more than one-half of the participants indicated a willingness to pay for the pork product with all three environmental attributes of air, ground water, and surface water embedded.

Table 1: Number of Participants by Area

Experiment Area	Number of Participants	Number of Premium Payers	Number of Non-Premium Payers	Percent Premium Payers
All areas	329	204	125	62
Ames, IA	49	30	19	61
Manhattan, KS	60	40	20	67
Raleigh, NC (6/28/97)	31	19	12	61
Burlington, VT	27	15	12	56
Iowa Falls, IA	58	35	23	60
Corvallis, OR	60	38	22	63
Raleigh, NC (6/27/98)	44	27	17	61

For the entire group, the average premium paid for the most environmental two-pound package of pork loin chops was $0.94, while the typical package decreased by

[2] By defining the premium in this manner, we avoid the problem that the Vickrey auction in laboratory settings is biased. Cox, Smith and Walker and Kagel, Harstad and Levin have shown that these biases remain somewhat constant across bidding rounds. Coursey and Smith have also found that the bias in absolute terms tends to be the same. Hence by calculating the willingness to pay by taking the difference from the no information round to the information round should give us an unbiased true revelation of the premium a participant would be willing to pay.

$0.52 (Table 2). The bids in the no information round are much tighter than the bids in the round in which the environmental information was released. The difference between the average high and low bid in the no information round is only $0.35. This would reflect the participant perception of the visual quality of the packages. For the most environmental package, the premium was significantly different from zero at the 0.001 significance level. This result also holds true when looking at the premiums from each region.

The bids take on a methodical pattern once the information was released. In the no information round, the bids appear to be scattered randomly among the packages. Once the information was released about the environmental attributes, the bids followed the pattern of the more environmental pork packages getting the higher bids and the less environmental packages getting the lower bids. Thus, values for the single attribute packages were slightly higher than the typical package. Participants paid more for the dual attribute packages than the single attribute packages, while the triple attribute package commanded the highest premium.

When testing the hypothesis of whether premiums differ significantly as environmental attribute levels are increased or combined, we found that at the five percent level each tier of attributes were significantly different from the other tiers. Hence, the package with three high level attributes was significantly different from the packages with two attributes, as well as, with the packages with just one attribute. It did not seem to matter what level of attribute was embedded in the package, rather it was the number of attributes. These results hold for the comparison of all participants as well as for the comparison of the premium payers.

Table 2: Participant Bid Levels by Environmental Attribute Information (All Participants)

	Average Bid Level per Package ($)		Premium Bid	
Pork Chop Environmental Attributes (Level of Improvement)	**No Information**	**Environmental Attribute Added**	**Absolute Change***	**Percent Change**
No Specific Attributes (Typical)	4.13	3.61	-0.52[a]	-12.53
Odor 30-40%	4.26	3.87	-0.39[a]	-9.19
Odor 80-90%	4.05	3.92	-0.13[b]	-3.23
Ground water 15-25%	3.91	3.85	-0.06[b,c]	-1.45
Ground water 40-50%	4.03	3.94	-0.09[b,c,d]	-2.12
Surface Water 15-25%	4.15	3.99	-0.16[b,c,d]	-3.94
Surface Water 40-50%	4.06	4.10	0.04[c,d]	0.97
Odor 80-90%/Ground Water 40-50%	4.25	4.56	0.31[e]	7.41
Odor 80-90%/Surface Water 40-50%	4.17	4.58	0.41[e]	9.88
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	4.19	5.13	0.94	22.42

* Corresponding letters indicate that at the five percent level of significance the null hypothesis of the two premiums being equal could not be rejected.

Evaluation of the premium payers shows that the average premium was $1.60 for the most environmental package—a premium of 37 percent (Table 3). The premium payers decreased their bid for the typical package when the environmental information was released. Hence, this suggests that there could be a backlash with respect to the typical good once an environmental good hits the market. Premium payers followed the same methodical bidding pattern as the whole group. As shown in Table 3, the bids for the package with a single environmental attribute package from an eight percent decline (odor 30-40 percent) to a four percent increase (surface water 40-50 percent) following release of information. The bids for the double attribute packages increased from 12 to 16 percent while the bid for the triple attribute package increased by 37 percent.

Table 3: Participant Bid Levels for Premium Payers

	Average Bid Level per Package ($)		Premium Bid	
Pork Chop Environmental Attributes (Level of Improvement)	**No Information**	**Environmental Attribute Added**	**Absolute Change**	**Percent Change**
No Specific Attributes (Typical)	4.44	3.81	-0.63	-14.11%
Odor 30-40%	4.53	4.15	-0.38	-8.47%
Odor 80-90%	4.33	4.29	-0.04	-0.91%
Ground water 15-25%	4.14	4.17	0.03	0.63%
Ground water 40-50%	4.34	4.40	0.06	1.28%
Surface Water 15-25%	4.41	4.31	-0.10	-2.20%
Surface Water 40-50%	4.36	4.54	0.18	4.11%
Odor 80-90%/Ground Water 40-50%	4.57	5.13	0.56	12.20%
Odor 80-90%/Surface Water 40-50%	4.47	5.21	0.74	16.47%
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	4.37	5.98	1.60	36.70%

Bid premiums for the most environmental product are provided by study area in Table 4. For participants, the highest average premium of $1.11 was obtained from the second group from Raleigh, North Carolina and the lowest average premium of $0.79 was obtained in Iowa Falls, Iowa. When looking at just the premium payers, the highest average premium of $1.89 was in Burlington, Vermont, while the lowest average premium of $1.33 was from the first group from Raleigh, North Carolina. Using a standard statistical test of difference between means (Freund), we found, at the five percent significance level, no significant differences between regions for the most environmental package. This was similar for when all participants or when premium payers were evaluated. Thus, there was not a significant difference in bid premiums between areas.

Table 4: Bid Premiums ($) for the Most Environmental Package by Area (All Participants and Premium Payers)

Pork Chop Environmental Attributes (Level of Improvement)	Location							
	All Areas	Ames, IA	Manhattan, KS	Raleigh, NC (97)	Burlington, VT	Iowa Falls, IA	Corvallis, OR	Raleigh, NC (98)
All Participants								
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	0.94*	1.03*	0.89*	0.80*	0.95*	0.79*	1.00*	1.11*
Premium Payers								
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	1.60*	1.74*	1.38*	1.33*	1.89*	1.60*	1.59*	1.84*

*denotes significantly different from zero at the 0.001 level.

D. Conclusions

Of the 329 participants in the experiment, 62 percent paid a premium for the product with all three environmental attributes: air, ground water and surface water. For the entire group, the average premium paid for the most environmental two-pound package of pork loin chops was $0.94—a premium of 22 percent. When evaluated for the premium payers (the 62%) the average premium was $1.60 per package—a premium of 37 percent.

Results show that participants were willing to pay higher prices for pork products produced in systems with improved environmental attributes. The premium for products with embedded multi-environmental attributes was significantly greater than for those with single environmental attributes. The level of willingness to pay did not vary significantly across regions for the most environmental package. Participants were also willing to pay more for the product with improved surface water, ground water, and odor emissions than for the product with just two of the attributes. Thus, it appears that the product with the greatest chance of success is one that has all three attributes embedded.

For the most environmental package, bid premiums did not differ significantly between areas studied. Moreover, the percent of participants paying selected premium

levels did not vary between regions. For example, for the triple attribute product, 62 percent of the participants indicated a willingness to pay a premium. This ranged from 56 to 67 percent across the study area.

This research shows that opportunity exists in developing a market for meat products that embody environmental attributes. Consumers are concerned about the environment and are willing to pay more for products that are produced in a way that reduces environmental impacts. This research suggests that as the industry develops methods that help sustain or improve the environment, there is a segment of society that will support a market for such products.

Bibliography

Coppinger, Vicki M., Vernon L. Smith, and Jon A. Titus. "Incentives and Behavior in English, Dutch, and Sealed-Bid Auctions." *Econ. Inquiry* 18 (January 1980): 1-22.

Coursey, Don L. and Vernon L. Smith. "Experimental Tests of an Allocation Mechanism for Public, Private, or Externality Goods." *Scandinavian Jour. of Econ.* 86 (1984): 468-484.

Cox, James C., Vernon L. Smith, and James M. Walker. "Expected Revenue in Discriminative and Uniform Price Sealed-Bid Auctions." In *Research and Experimental Economics*, Vol. 3, ed., Vernon L. Smith, pp. 183-232. Greenwich: JAI Press, 1985.

Davis, Douglas D. and Charles A. Holt. Experimental Economics. Princeton, New Jersey: Princeton University Press, 1993.

Dobbs, Thomas L. "Price Premiums for Organic Crops." *Choices* (Second Quarter, 1998): 39-41.

Duram, Leslie A. "Organic Agriculture in the United States: Current Status and Future Regulations." *Choices* (Second Quarter, 1998): 34-38.

Fox, John A., Brian L. Buhr, Jason F. Shogren, James B. Kliebenstein, and Dermot J. Hayes. "A Comparison of Preferences for Pork Sandwiches Produced from Animals with and without Somatotropin Administration," *Jour. of Animal_Sci.* 73(1995):1048-1054.

Fox, John A., Dermot J. Hayes, James B. Kliebenstein, and Jason F. Shogren. "Consumer Acceptability of Milk from Cows Treated with Bovine Somatotropin." *Jour. of Dairy Sci.* 77(1994): 703-707.

Fox, John A., Dermot J. Hayes, Jason F. Shogren, and James B. Kliebenstein. "Experimental Methods in Consumer Preference Studies." *Jour. of Food Dist. Res* (July, 1996): 1-7.

Freund, John E. *Mathematical Statistics*. Fifth Edition, pp. 398-416, Englewoods Cliff, New Jersey: Prentice Hall, 1992.

Hayes, Dermot J., Jason F. Shogren, John A. Fox, and James B. Kliebenstein. "Testing New Food Products Using a Multitrial Nonhypothetical Experimental Auction. *Psychology and Marketing* (July, 1996): 365-379.

Hoffman, Elizabeth, Dale J. Menkhaus, Dipankar Chakravarti, Ray A. Field, and Glen D. Whipple. "Using Laboratory Experimental Auctions in Marketing Research: A Case Study of New Packaging for Fresh Beef." *Marketing Science* 12 (Summer 1993): 313-338.

Kagel, John H., Ronald M. Harstad, and Dan Levin. "Information Impact and Allocation Rules in Auctions with Affiliated Private Values: A Laboratory Study." *Econometrica* 55(1987):1275-1304.

Klonsky, Karen and Laura Tourte. "Organic Agricultural Production in the United States: Debates and Directions." *Amer. J. Agr. Econ.* 80 (Proceedings 1998): 1119-1124.

Krisoff, Barry. "Emergence of U.S. Organic Agriculture – Can We Compete? Discussion." *Amer. J. Agr. Econ.* 80 (Proceedings 1998): 1130-1133.

Lohr, Luanne. "Implications of Organic Certification for Market Structure and Trade." *Amer. J. Agr. Econ.* 80 (Proceedings 1998): 1125-1129.

Misra, Sukant K., Chung L. Huang, and Stephan L. Ott. "Consumer Willingness to Pay for Pesticide-Free Produce." *West. Jour. of Agi. Econ* 16 (December, 1991): 218-227 (1991).

Melton, Bryan E., Wallace E. Huffman, Jason F. Shogren, and John A Fox. "Consumer Preferences for Fresh Food Items with Multiple Quality Attributes: Evidence from an Experimental Auction of Pork Chops." *Amer. J. Agr. Econ.* 78 (November, 1996): 916-923.

Melton, Bryan E., Wallace E. Huffman, and Jason F. Shogren. "Economic Values of Pork Attributes: Hedonic Price Analysis of Experimental Auction Data." *Rev. of Agr. Econ.* 18 (October, 1996): 613-627.

Menkhaus, Dale J., George W. Borden, Glen D. Whipple, Elizabeth Hoffman, and Ray A. Field. "An Emperical Application of Laboratory Experimental Auctions in Marketing Research." *J. of Agr. And Res. Econ.* 17 (July, 1992): 44-55.

Shogren, Jason F., John A. Fox, Dermot Hayes, and James B. Kliebenstein. "Bid Sensitivity and the Structure of the Vickrey Auction." *Amer. J. Agr. Econ.* 76(December, 1994): 1089-1095.

Shogren, Jason F., Seung Y Shin, Dermot Hayes, and James B. Kliebenstein. "Resolving Differences in Willingness to Pay and Willingness to Accept." *Amer. Econ. Rev.* (March, 1994): 255-270.

Roosen, Jutta, John A. Fox, David A. Henessey, and Alan Schreiber. "Consumer's Valuation of Insecticide Use Restrictions: An Application to Apples" *J. of Agr. And Res. Econ.* 23 (December 1998): 367-384.

Thompson, Gary and Julia Kidwell. "Explaining the Choice of Organic Produce: Cosmetic Defects, Prices, and Consumer Preferences." *Amer. J. Agr. Econ.* 80 (May, 1998): 277-287.

Thompson, Gary. "Consumer Demand for Organic Foods: What We Know and What We Need to Know." *Amer. J. Agr. Econ.* 80 (Proceedings 1998): 1113-1118.

Vickrey, William. "Counterspeculation, Auctions, and Competitive Sealed Tenders." *Jour. of Finance* 16 (1961):8-17.