ELECTRONIC ANIMAL IDENTIFICATION SYSTEMS AT LIVESTOCK AUCTION MARKETS: PERCEPTIONS, COSTS, AND BENEFITS

by

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Abstract

Electronic animal identification systems are becoming more common in livestock auction markets because of increased numbers of cattle being electronically identified. More cattle are being individually identified because of increasing enrollment in marketing alliances and verification programs. Also, the National Animal Identification System (NAIS) has increased awareness and perhaps use of electronic identification. In this study, individual characteristics of livestock markets were analyzed to determine how they relate to a livestock market operator's views, concerns, and knowledge of the NAIS as well as adoption of RFID reading equipment. Investments in RFID tagging services and RFID reading equipment by livestock markets were estimated and price premiums associated with RFID tagged and preconditioned cattle were estimated. Data were from a national survey of livestock auction markets and cattle transaction data were obtained from three Kansas livestock markets.

Auction markets that indicated they currently plan to add a RFID tagging service are likely to have more knowledge of the NAIS program standards, how to adopt the NAIS practices, and the probable costs involved. Managers of facilities that sell a large volume of livestock annually tend to have a higher level of understanding of how to adopt the NAIS practices and be more knowledgeable of the NAIS standards than operators of small-volume facilities. Managers of markets that have operating RFID reader systems tend to be more understanding of how to adopt the NAIS practices and of costs associated with adopting the NAIS. Livestock market managers tend to be highly concerned that adoption of individual animal identification systems will adversely impact sale speed and tend to view the NAIS as a threat to their business. Large-volume facilities, facilities that have registered their premises, and facilities that plan to add a RFID tagging service are more likely to adopt RFID reader systems. Economies of scale exist in RFID system adoption and RFID tagging services for auction markets. Preconditioned and RFID tagged cattle brought a significant premium at only one of three facilities where data were collected.

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CHAPTER 1 - Introduction

There is growing interest in adopting electronic animal identification services at livestock markets. The National Animal Identification System (NAIS) has provided broad recognition of the need for, and supplied momentum for development of, premises registration and associated animal identification systems. Furthermore, specialized marketing programs that target beef products to particular customer markets, especially export trade, are increasingly requiring individual animal identification.

Livestock markets are a major center for cattle trade, as 66% of feeder cattle sales, occurring in the top 15 cow-calf producing states, occurs through local auction markets (Schmitz, Moss, and Schmitz; 2003). For disease tracing and control reasons, animal identification systems become especially important at the time cattle are marketed. When an animal leaves its farm or ranch of origin is when individual identification and movement information is electronically recorded. Because of the high percentage of cattle marketed through livestock markets, electronic individual animal identification scanning will be an important addition at auction facilities.

Some livestock auction markets have already adopted premises identification, tag reading and recording, and animal tracking information systems. Others are considering adoption and investigating potential costs and benefits of such a system and related services. Auction markets have substantial economic incentive to provide a package of marketing services to attract a large, loyal customer base of both buyers and sellers. All livestock auctions provide the primary service of bringing sellers and buyers together in a central location to discover prices for individual transactions in a public auction. One way auction markets might differentiate themselves is by offering additional services, such as a package of animal identification and tracking services.

1.1 The National Animal Identification System

The NAIS is a voluntary (at the federal level) state - federal - industry partnership that plans to help producers protect their investment and health of livestock in the case of an animal disease outbreak (NAIS – A User Guide, 2006). The NAIS is an animal tracing system composed of three components: 1) premises registration, 2) animal identification, and 3) animal tracing. To facilitate the ultimate goal of establishing a system that can provide complete trace back information within 48 hours of detecting a disease, commercial livestock owners need to participate in all three levels of the program. Currently, USDA's primary efforts with regard to the NAIS program are focused on premises registration. The animal identification component is available for some species and in development for other species; animal tracing is in progress for all species (NAIS, 2007).

1.1.1 Premises Registration

Premises registration (where the location of livestock operations are assigned a nationally unique Premises Identification Number [PIN]) is the primary building block of the NAIS program. Without knowing the premises where animals have been, efficacy of conducting a disease trace back process is limited, at best. Premises registration has been an ongoing activity for the past couple of years. As of September 17, 2007, 417,312 premises (approximately 29%) of the 1.4 million livestock operations in the United States were registered with NAIS (NAIS, 2007). Currently, premises registration is being used to inform owners/caretakers of animal disease outbreaks that may present a risk to them. In the future, premises registration information, in conjunction with individual animal identification numbers, will be used to record animal movements in private/state administered animal tracking databases.

1.1.2 Animal Identification

Animal identification is especially important for disease control programs when animals from multiple premises/locations come into contact or are commingled. These locations could include ranches or concentration points such as livestock markets. In these situations, the risk of disease transfer is an important concern. There are two broad options of livestock identification, either individual animal or group/lot identification. Group/lot identification is designed for animals typically raised as one group that travel through the production chain as a single group. An example would be a group of hogs that move from farrowing, to growing, to finishing, and to harvest as a unit going through each phase without commingling with other animals.

When commingling with other animals during the production or marketing processes is common, as it is with cattle, individual animal identification is necessary for successful animal tracking. The NAIS, when individual identification is warranted, identifies animals with a unique 15-digit number that remains with the animal throughout its lifetime. An analogy often used is that this animal ID number is comparable to a person's social security number (i.e., it is unique and stays with the animal throughout its life). Other official numbering systems may also be used in the NAIS.

The NAIS User Guide indicates that "USDA has not designated any specific identification technologies…". Meaning the USDA is taking a "technology neutral" stance, with regard to what technology will best work for producers while meeting the needs to successfully trace animal movements to support responses to a potential disease outbreak. For cattle, bison, deer/elk, and pigs many radio frequency identification (RFID) tags have been approved for use with the NAIS (NAIS, 2007).

1.1.3 Animal Tracing

The animal tracing segment of the NAIS is currently under development with the participation of state and industry partners. In 2006, USDA entered into interim cooperative agreements with 14 private industry and state organizations with animal tracking databases (ATDs) that met certain technical requirements. Working with states and industry, USDA developed the technical requirements necessary for full integration of private/state ATDs with USDA's Animal Trace Processing System (ATPS) – a Web-based portal that will allow authorized animal health officials to request information from ATDs in certain disease situations. USDA published a guidance document with these requirements on February 1, 2007. USDA is now progressing with the implementation (production) phase and will establish formal cooperative agreements with interested organizations and states whose systems meet the technical specifications. In May 2007, state/private ATDs began the process of coming online for integration with the ATPS.

Owners of livestock will choose the animal tracking database they want to be affiliated with and report all movements deemed as a significant risk in disease transmission. Species working groups are recommending which movements should be reported for the individual species. The databases will record reported individual animal movements and be able to identify other animals the individual livestock have come into contact with. If a disease outbreak occurs, these records would be helpful in discovering potentially infected livestock and the scope of the disease. The NAIS requires only the premises identification number, animal identification number, date of event, and the event type (move-in or move-out) to be recorded for animal tracing. Many of the animal tracking databases may also offer additional "production management" services for livestock producers at a cost. The livestock owner will decide what tracking database and level of service they want to use.

1.2 Opportunities for Livestock Markets

Livestock markets can participate in the NAIS by tracking animal movements that occur through their facilities. To do this, livestock markets need to be able to read individual animal identification numbers so animal movement can be reported to a NAIS-compliant animal-tracking database. However, because identification methods can vary by species, livestock markets may need multiple systems. For example, with cattle, the livestock market would need to be able to read ISO (International Organization for Standardization) compliant RFID tags by using a RFID reading system.

The systems put in place to record individual animal identification and movement records will need to be electronically based, so as not to interfere with the speed at which livestock market sales are conducted. Traditional paper-based means of recording animal movements through livestock markets offer two drawbacks with respect to conducting a fully functioning animal identification program. First, there are tremendous opportunities for data entry errors in a paper-based system. Secondly, a paper-based system does not support capturing individual animal identification information at the "speed of commerce" and would potentially slow the livestock market selling process.

Other opportunities that exist for livestock markets to offer their customers are tagging services, data management, and program verification (age/source process verification) among others. Because livestock identification and tracing systems are relatively new in the United States, market segmentation and service differentiation opportunities exist for auction markets. These opportunities enable a livestock market to vertically align with industry partners to capture value from animal tagging and tracing services. Some auction markets that have discovered benefits associated with these services have aligned with process certification or related programs (e.g., source- and age-verification sales) to offer customer services and animal information exchange that are not available at more traditional auction markets. Added services can potentially increase the customer base and potentially enhance profits for an auction market.

1.3 Research Objectives

The purpose of this project is to provide information about the adoption of electronic animal identification systems at livestock auction markets based upon data collected from a national survey of livestock auctions, pilot study interviews, and auction market transaction data. The goal is to provide information that is useful to auction markets considering adopting animal identification services, to provide facts useful to policy makers and regulators as they consider alternative animal identification and tracking policy options, and to assess needs for knowledge development and dissemination to facilitate animal identification system adoption. Specific objectives include:

- Summarize data collected describing operation size, services offered, and characteristics of livestock markets surveyed
- Determine livestock market operator knowledge levels, concerns with, and perceptions about animal identification systems
- Estimate determinants of electronic animal identification technology adoption among livestock markets
- Determine RFID tagging service investments and costs for livestock auction markets
- Estimate electronic animal identification system investment requirements and associated costs for livestock auction markets
- Determine price premiums associated with RFID tagged cattle at Kansas livestock markets

To accomplish these objectives ordered logit models, binary logit models, cost/investment analysis, and a hedonic pricing model will be used on the data collected.

Livestock market survey respondents were asked to rank their level of understanding of the NAIS standards, costs of adoption, and adoption methods. Respondents were also asked if they view the NAIS as a threat or opportunity to their business and their level of concern of electronic animal identification systems slowing their speed of sale. These data were used in ordered logit models to determine systematic characteristics of livestock market operators' knowledge of standards, cost of adoption, and adoption methods of the NAIS, as well as their view of the program and concerns with electronic animal identification systems. By knowing characteristics of livestock markets that have little understanding of the NAIS, view the program as a threat to their business, or are concerned about speed of sale being affected, program information dissemination can be more efficient.

The probability of a livestock market adopting electronic animal identification systems based on certain systematic characteristics was estimated using a binary logit model. Livestock market respondents were asked if they had adopted electronic animal identification technology, a binary logit model was used to determine systematic characteristics of those facilities.

Respondents that believed they would offer a RFID tagging service in the future provided information on the costs necessary to initiate RFID tagging at their facility. This information was used to estimate the annual cost of offering a RFID tagging service and a predicted cost function was found. Respondents that had adopted RFID reading technology provided information on the required investment and costs necessary for adoption. This information was used to estimate the annual cost of a RFID reader system and a predicted cost function.

Cattle transaction data were collected at three livestock markets in Kansas to determine if price premiums exist for RFID tagged and preconditioned feeder cattle. The data collected were used in a hedonic model to determine if premiums exist for these cattle. This information could be useful to producers and buyers of feeder cattle.

CHAPTER 2 - Data Collection

To collect data necessary to complete the objectives of this study, a national survey was mailed to livestock auction markets across the United States (a copy of the survey is provided in Appendix A). An attempt was made to identify the entire population as opposed to simply a sample. The survey asked questions pertaining to general characteristics of the livestock market such as size, technology use, and operating expenses; services the livestock market may add to adopt the NAIS components; knowledge and concerns of animal identification and movement tracking; and costs of electronic animal identification systems (realized or anticipated). Livestock markets that had already adopted electronic animal identification systems answered an additional set of survey questions relative to those that had not adopted this information technology.

The survey instrument was developed by researchers at Kansas State University with assistance from the Livestock Marketing Association. The surveys and postage-paid return envelopes were mailed by the Livestock Marketing Association (LMA) and the National Livestock Producers Association (NLPA) to their livestock auction market member and non-member lists. Both organizations included a personal cover letter with the surveys highlighting the importance of completing and returning the survey (Appendix B contains the cover letters). The organizations also periodically encouraged and reminded their members to fill out and return the survey. LMA and NLPA distributed 1,096 and 60 surveys, respectively. The surveys were mailed in late November of 2006 and completed surveys were returned by February 2007. There were also 10 livestock auction markets that were participants in a Kansas pilot study (Bolte, Dhuyvetter, Schroeder, and Rickard, May 2007) that completed the survey directly through Kansas State University. Overall, 189 surveys were completed representing a 16% (189/1,166) response rate. On November 22, 2006, during the time the surveys were in the mail to the livestock markets, USDA announced that the NAIS would remain a voluntary program. This announcement may have adversely affected the survey response rate and could have influenced how some questions were interpreted and answered by livestock market operators.

Livestock markets that responded to the survey varied in size, structure, and covered a broad geographic region. Table 2.1 summarizes the average annual head of livestock typically sold among the survey respondents. The main species sold at livestock markets were cattle followed by hogs, sheep, goats, and horses. The survey respondents on average sold 52,522 head of cattle per year ranging from zero to 320,000 head. Figure 2.1 shows the average number of livestock sold annually among respondents by region. Table C.1 in appendix C contains a list of individual states included in each of the five regions.

Table 2.1 Average Annual Typical Head of Livestock Sold Among Auction Market Survey Respondents

Species	Average Annual Head Sold	Standard Deviation	Minimum Head Sold	Maximum Head Sold
Cattle	52,522	45,603	0	320,000
Hogs	2,482	6,921	0	45,000
Sheep	1,457	3,763	0	35,000
Goats	1,029	2,972	0	30,000
Horse	329	959	0	7,800
Other[1]	75	1,003	0	14,000

[1]Other includes buffalo, llama, mules, donkeys, and exotic animals

Figure 2.1 Average Livestock Sold Annually by Region Among Auction Market Survey Respondents

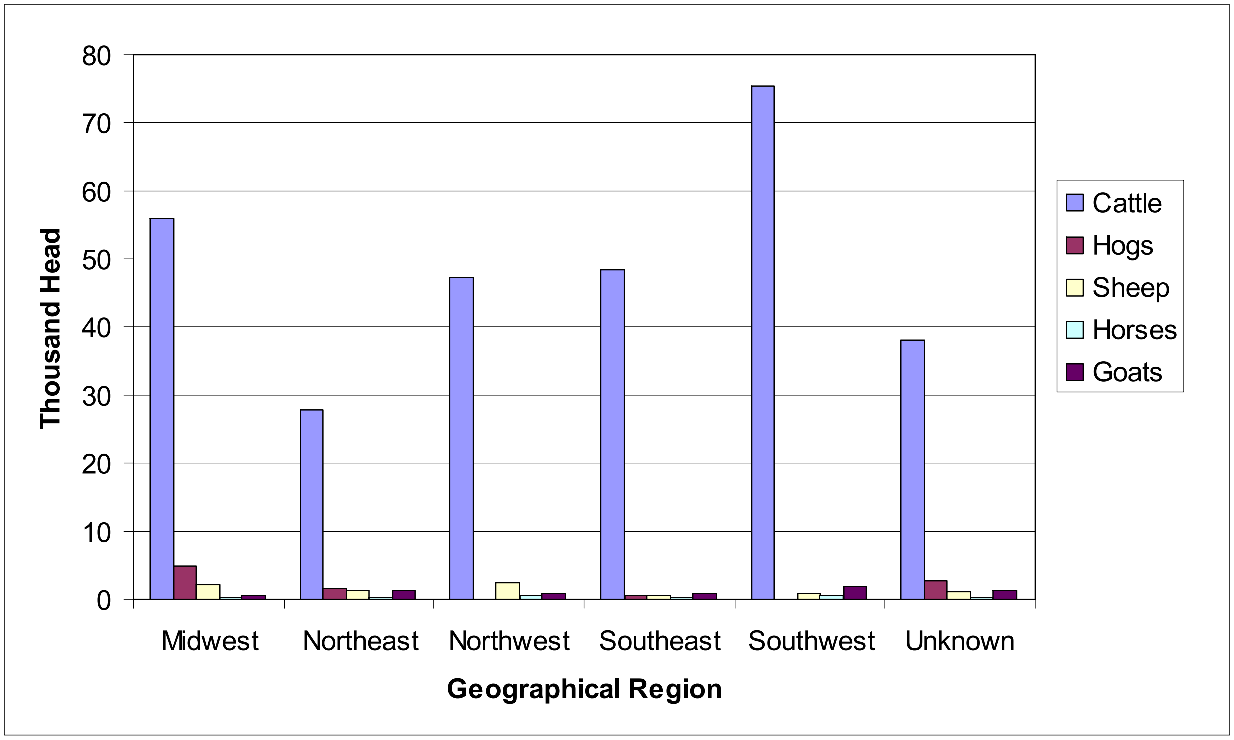
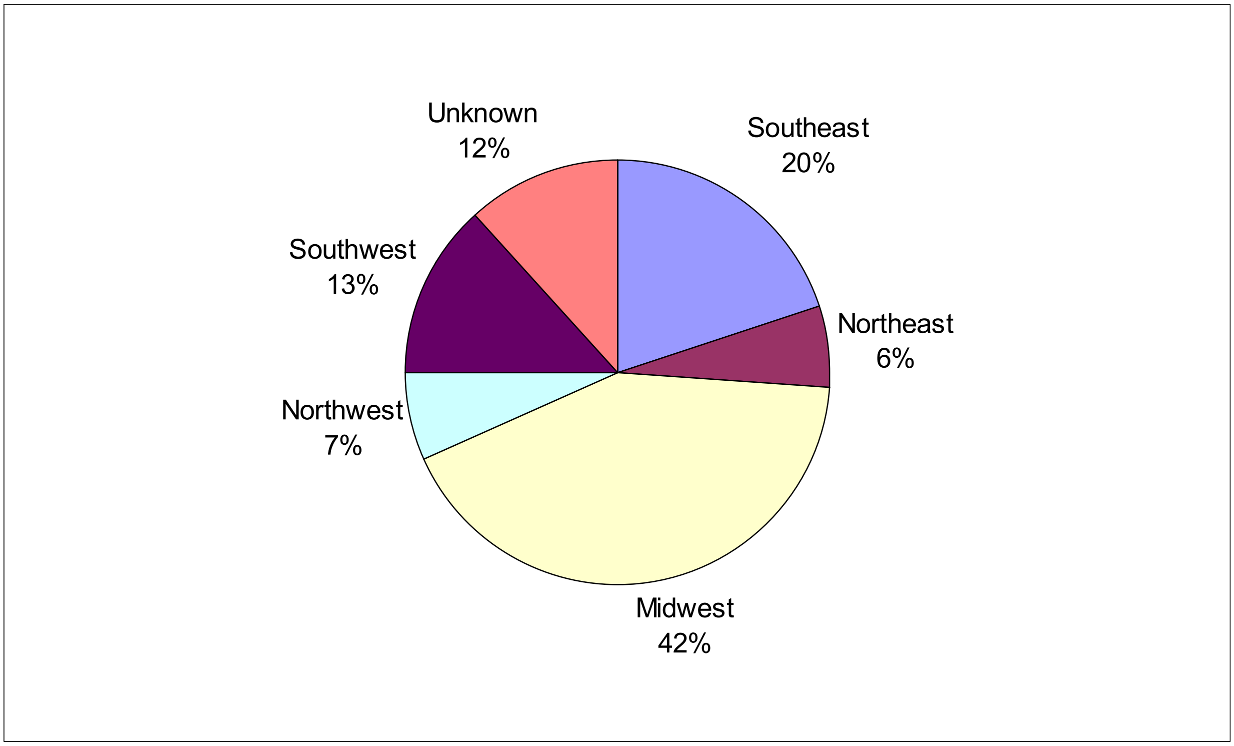


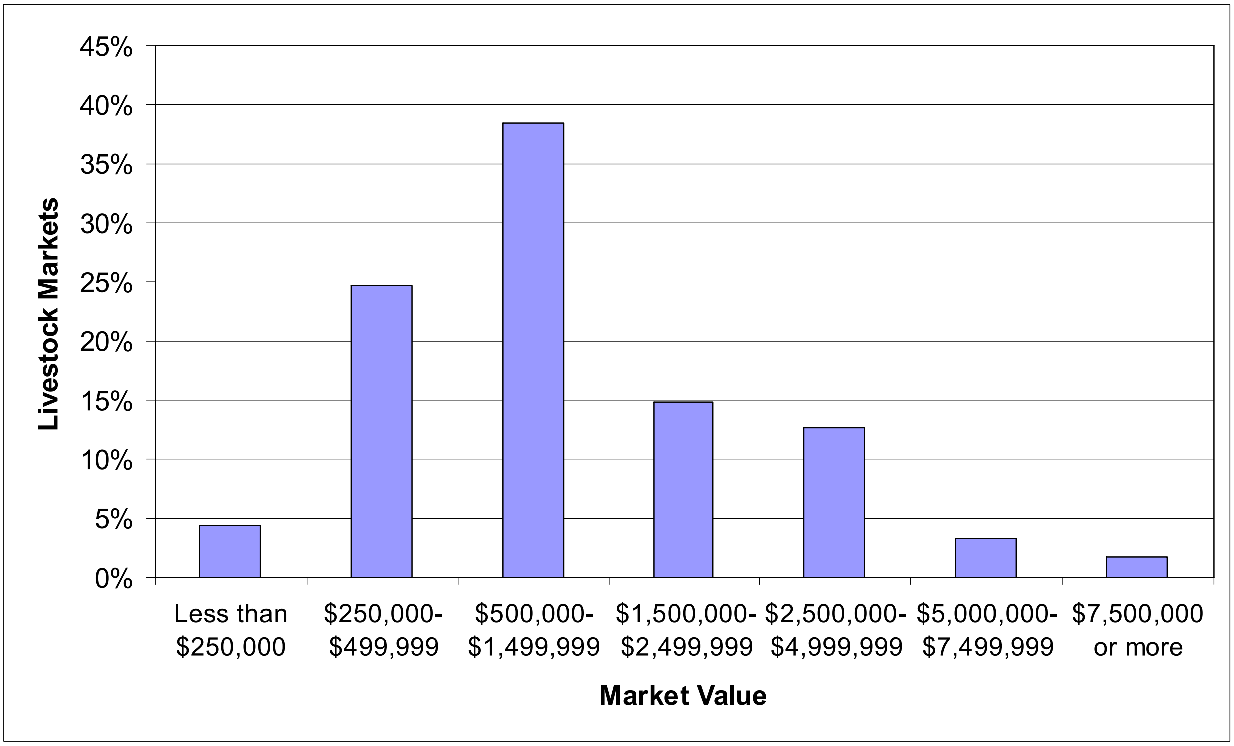
Figure 2.2 illustrates the regional distribution of survey respondents. The majority of the completed surveys were from auction markets located in the Midwest region (42%), followed by the Southeast, Southwest, Northwest, and Northeast regions respectively. Respondent region was determined by return address if provided (this was optional) or by the postmark on the return envelope, "unknown" regions were those without a postmark.

Figure 2.2 Regional Distribution of Survey Respondents



The distribution of reported auction facility market values among respondents is summarized in figure 2.3. Thirty-eight percent of livestock markets estimated their facility value to be between $500,000 and $1,499,999. Twenty-five percent of survey respondents estimated their facility value to be between $250,000 and $499,999 and only 2% of livestock markets reported facility values of $7,500,000 or more.

Figure 2.3 Market Value of Facilities Among Survey Respondents



For those livestock market respondents that sell cattle (all but one of the respondents), the average number of cattle sold on a peak sale day was 2,108 head. The minimum sold on a peak day was 80 head and the maximum was 17,000 head. The average number of cattle sold on a non-peak sale day was 779 head with minimum of 35 head and the maximum of 8,000 head. Figures 2.4 and 2.5 illustrate the frequencies of peak and non-peak cattle sales volumes by livestock markets. Peak sale days refer to times of the year when more cattle are sold per day than normal (i.e., fall weaning) and non-peak sale days refer to all other times.

Figure 2.4 Number of Cattle Sold on a Peak Day Among Survey Respondents That Sell Cattle

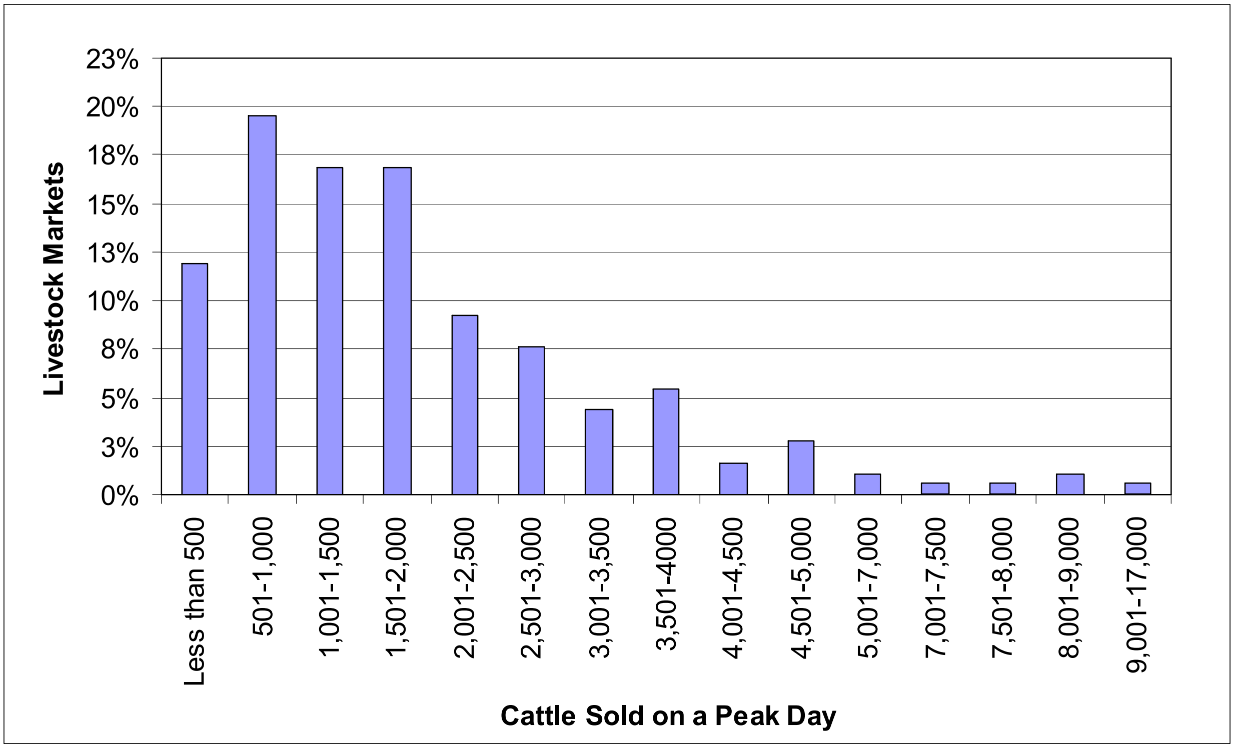
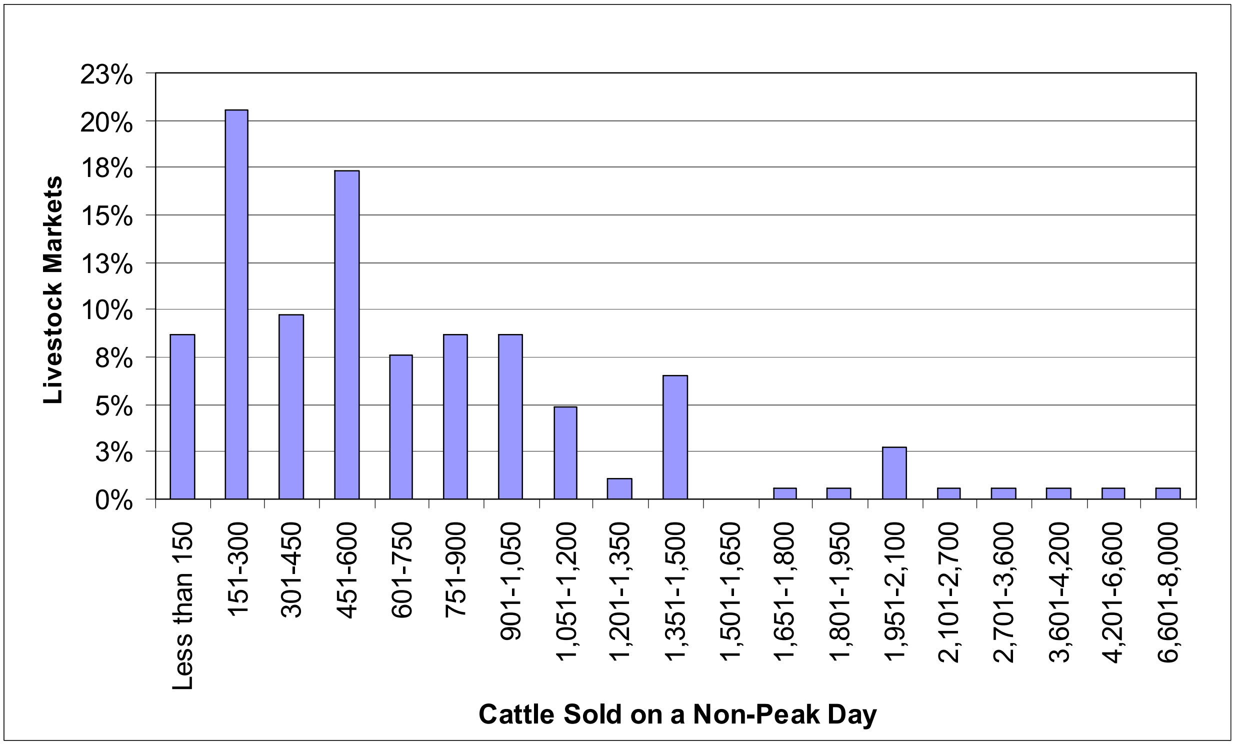


Figure 2.5 Number of Cattle Sold on a Non-Peak Day Among Survey Respondents That Sell Cattle



On average, 74% of cattle lots sold were calves, yearlings, or replacement heifers with the other 26% being cows and bulls. Table 2.2 shows that on average 41% of calf, yearling, or replacement heifer lots were sold one head at a time, 28% were sold in 2-10 head lots, 22% in 11-50 head lots, and 9% in lots greater than 50 head. On average, more than 50% of the lots of cows/bulls, swine, and goats/sheep are sold as single head lots. An estimated 74% of calves, yearlings, and replacement heifers are sold in lots of 11 or more head and an estimated 27% of cows and bulls are sold in lots of 11 or more head. Only 28% of swine are sold in lots of less than 11 head; however 48% of goats and sheep are sold in lots of less than 11 head.

Table 2.2 Distribution of Average Lot Size, by Species of Livestock, Marketed Through Survey Respondent's Facility

Livestock Type	Lot Size							
	Single Head		2-10 Head		11-50 Head		Greater than 50 Head	
	Percent of Lots[1]	Estimated Percent of Head[2]	Percent of Lots[1]	Estimated Percent of Head[2]	Percent of Lots[1]	Estimated Percent of Head[2]	Percent of Lots[1]	Estimated Percent of Head[2]
Calves, Yearlings, Replacement Heifers	41%	11%	28%	15%	22%	44%	9%	30%
Cows/Bulls	80%	49%	15%	25%	5%	19%	1%	8%
Swine	51%	7%	33%	21%	14%	56%	2%	15%
Goats/Sheep	58%	23%	30%	25%	10%	34%	2%	18%

[1] Percent of Lots is the simple average of livestock market respondents.
[2] Estimated Percent of Head is an approximated volume-weighted percentage using the mid-points of size categories for 2-10 head and 11-50 head and 65 head for 50 or greater category.

CHAPTER 3 - Knowledge, Concerns, and Views of the NAIS

The NAIS is a voluntary program (at the federal level) made up of a streamlined information system designed to help animal health officials and producers respond to animal health threats in a timely manner (NAIS). Electronic individual animal identification systems will likely be the popular choice of identification among cattle producers who adopt individual animal identification systems. Because of the important role auction markets have in being the first market for many cattle, livestock market operator knowledge, concerns, and views of the NAIS and animal identification and movement tracking systems are important to understand. If livestock market operators do not understand the NAIS or animal identification systems, information may be misconstrued. It is also important to identify concerns livestock market operators may have about electronic animal identification systems, so issues can be addressed.

In order to determine how individual characteristics of livestock markets relate to levels of knowledge, views, and concerns of the NAIS, a statistical modeling procedure referred to as ordered logit models was used. The purpose of this analysis is to determine whether there are systematic characteristics of auction markets that relate to survey respondent answers to particular questions. If there are systematic factors related to responses of specific questions, this knowledge can be used to better target information dissemination programs.

3.1 Previous Research

Because it is such a new program, little research has been completed on the knowledge and perceptions of the NAIS among livestock market operators. However, ordered logit models have been used in similar circumstances to explain factors affecting survey respondent opinions regarding policy and related issues.

Grunewald, Schroeder, and Ward solicited cattle feeder opinions about the effectiveness of mandatory price reporting (MPR). Cattle feeders from Kansas, Iowa, Texas, and Nebraska responded to a survey in 2002. The survey asked cattle feeders to rank their opinions of three items from 1 (strongly disagree) to 9 (strongly agree). Cattle feeders were asked to give their level of agreement to: (a) MPR is benefiting the beef industry; (b) information on regional/national daily fed cattle cash prices, base prices used in grid pricing, premiums/discounts used in grid pricing, and boxed beef prices have increased; (c) MPR has enhanced my ability to negotiate cash prices, base prices or formulas, grid premiums/discounts with packers. The researchers determined the opinions of cattle feeders regarding MPR and quantified how feedlot characteristics influenced producer agreement with the three statements by using ordered logit models.

Byrne, Gempesaw, and Toensmeyer used ordered logit models to determine consumer confidence in various channels used to communicate potential risks of pesticide residues in fresh produce supply. Data were retrieved from a survey of opinions about fresh produce sent to consumers in the Delmarva Peninsula (Delaware, eastern shore of Maryland, and two counties in Virginia). The study analyzed consumer concerns with levels of pesticide residues (1 being very concerned to 7 being unconcerned) and levels of belief in statements made by various groups about produce safety (1 being do believe to 7 do not believe). The researchers determined certain demographics of consumers with concerns about pesticide residues and how they affected the likelihood of consumer beliefs about statements made by various groups about produce safety.

Ascough et al. analyzed a survey completed by Great Plains producers examining computer usage and satisfaction by producers. Producers ranked their perceived usefulness of computers (0 being not useful to 2 being useful), frequency of computer usage (0 being few times per year to 3 being daily), and number of software applications used (0 being one or two to 3 being seven or more). The researchers used ordered logit models to determine how certain explanatory variables affected producer computer usage, satisfaction, and software use.

Though only a small sample of studies are discussed here, much past research has used ordered logit models similar to those used in this study. The studies discussed above used surveys to collect data on respondent's ranked perceptions of MPR, residues on fresh produce, and agricultural producer use of computers. The three studies all used empirical models as presented by Greene.

3.2 Empirical Model

This analysis determined how individual characteristics of livestock markets relate to levels of knowledge and perceptions of the NAIS. Specifically, the following statements were reviewed: (a) knowledge of the NAIS program standards, (b) understanding of what an auction market facility needs to do to comply with the NAIS, (c) understanding of costs necessary to adopt NAIS within a facility, (d) views of the NAIS, and (e) concerns of sale speed being adversely impacted by the NAIS.

Survey responses to statements (a), (b), and (c) were ranked from 1 to 9, 1 reflected having no knowledge or understanding and 9 indicated complete knowledge or understanding. Responses to statement (d) were ranked from 1 to 3, where 1 = threat, 2 = neither threat or opportunity, and 3 = opportunity. Statement (e) was ranked from 1 to 5, 1 indicated least concern and 5 reflected most concern. Consequently, each livestock market respondent's perception had ordinal rank. Similar explanatory variables were used in analyzing responses of livestock market operators (y_i) to each of these questions. An empirical representation of the ordered logit model is (Greene, 1997, also Capeau, Decoster, and Vermeulen, 2003):

(1) $$y_i^* = x_i^{'}\beta + \varepsilon_i,$$

where *i* refers to individual livestock market operators, y_i^* is an unobservable variable linearly dependent on the explanatory variables, *x*, and ε is random error. The random error is assumed to be logistically distributed, i.e., $F(\varepsilon_i) = \frac{1}{1+\exp(-\varepsilon_i)}$. Survey responses observed, y_i, are based on y_i^*:

(2) $$\begin{aligned} y_i &= 1 \text{ if } y_i^* \le \eta_1 \\ y_i &= 2 \text{ if } \eta_1 < y_i^* \le \eta_2 \\ y_i &= 3 \text{ if } \eta_2 < y_i^* \le \eta_3 \\ &\vdots \qquad\qquad \vdots \\ y_i &= J \text{ if } \eta_{J-1} < y_i^*, \end{aligned}$$

where the thresholds, η_k, are unknown values that are estimated along with the β coefficients and *J* is the number of categories. Because it is assumed that the error is logistically distributed, the following probabilities hold:

$$
\begin{aligned}
(3)\quad \Pr(y_i = 1) &= \Pr(x_i^{'}\beta + \varepsilon_i \le \eta_1) \\
&= \frac{1}{1+\exp(x_i^{'}\beta - \eta_1)}, \\
\Pr(y_i = 2) &= \Pr(x_i^{'}\beta + \varepsilon_i \le \eta_2) - \Pr(x_i^{'}\beta + \varepsilon_i \le \eta_1) \\
&= \frac{1}{1+\exp(x_i^{'}\beta - \eta_2)} - \frac{1}{1+\exp(x_i^{'}\beta - \eta_1)}, \\
\Pr(y_i = 3) &= \Pr(x_i^{'}\beta + \varepsilon_i \le \eta_3) - \Pr(x_i^{'}\beta + \varepsilon_i \le \eta_2) \\
&= \frac{1}{1+\exp(x_i^{'}\beta - \eta_3)} - \frac{1}{1+\exp(x_i^{'}\beta - \eta_2)}, \\
&\vdots \\
\Pr(y_i = J) &= \Pr(\eta_{J-1} \le x_i^{'}\beta + \varepsilon_i) \\
&= 1 - \frac{1}{1+\exp(x_i^{'}\beta - \eta_{J-1})}.
\end{aligned}
$$

The marginal effects associated with the probabilities can be shown as:

$$
(4)\quad \frac{\partial \Pr(y_i = J)}{\partial x_i^J} = -\beta_J \left[\frac{\exp(x_i^{'}\beta - \eta_J)}{(1+\exp(x_i^{'}\beta - \eta_J))^2} - \frac{\exp(x_i^{'}\beta - \eta_{J-1})}{(1+\exp(x_i^{'}\beta - \eta_{J-1}))^2} \right],
$$

where $\eta_0 = -\infty$ and $\eta_J = \infty$.

The following equations were estimated to identify determinants of individual livestock market respondent opinions of the NAIS (subscript *i* is dropped for notational convenience):

Knowledge Equations

$$
(5)\quad standards = \begin{array}{l} \beta_0 + \beta_1 herfin + \beta_2 cattid + \beta_3 \ln(lvstk) + \beta_4 tagging + \beta_5 RFID \\ + \beta_6 premises + \beta_7 NE + \beta_8 SE + \beta_9 SW + \beta_{10} NW + e \end{array}
$$

$$
(6)\quad adoption = \begin{array}{l} \beta_0 + \beta_1 herfin + \beta_2 cattid + \beta_3 \ln(lvstk) + \beta_4 tagging + \beta_5 RFID \\ + \beta_6 premises + \beta_7 NE + \beta_8 SE + \beta_9 SW + \beta_{10} NW + e \end{array}
$$

$$
(7)\quad costs = \begin{array}{l} \beta_0 + \beta_1 herfin + \beta_2 cattid + \beta_3 \ln(lvstk) + \beta_4 tagging + \beta_5 RFID \\ + \beta_6 premises + \beta_7 NE + \beta_8 SE + \beta_9 SW + \beta_{10} NW + e \end{array}
$$

Perception Equations

$$(8)\quad view = \begin{array}{l}\beta_0 + \beta_1 herfin + \beta_2 cattid + \beta_3 \ln(lvstk) + \beta_4 tagging + \beta_5 RFID \\ + \beta_6 premises + \beta_7 NE + \beta_8 SE + \beta_9 SW + \beta_{10} NW + e\end{array}$$

$$(9)\quad salespeed = \begin{array}{l}\beta_0 + \beta_1 herfin + \beta_2 cattid + \beta_3 \ln(lvstk) + \beta_4 tagging + \beta_5 RFID \\ + \beta_6 premises + \beta_7 NE + \beta_8 SE + \beta_9 SW + \beta_{10} NW + e\end{array}$$

All variables are defined in table 3.1 and summary statistics for the variables are reported in table 3.2. The explanatory variables used were selected because they were expected to be the most likely factors that would have an effect on the variables of interest.

Table 3.1 Variable Definitions Used in Statistical Logit Models

Dependent Variables	**Definition**
adoption	Understanding of how to adopt the NAIS practices (1 = no understanding to 9 = complete understanding)
costs	Understanding of the costs associated with adopting the NAIS (1 = no understanding to 9 = complete understanding)
salespeed	Level of concern of the NAIS adversely affecting sale speed (1 = low concern to 5 = high concern)
standards	Knowledge of the NAIS program Standards (1 = no knowledge to 9 = extremely knowledgeable)
view	Livestock market respondent view of the NAIS (1 = threat, 2 = neither threat or opportunity, 3 = opportunity)
Independent Variables	**Definition**
cattid	Categorical number representing the percentage of cattle currently sold with any type of identification tag (1 = 0-25%, 2 = 26-50%, 3 = 51-75%, 4 = 76-100%)
herfin	Herfindal-type index measuring the concentration of species sold at a livestock market (1 = many different species sold to 10 = one species sold[1])

ln*(lvstk)*	Continuous variable measuring the natural log of the total number of livestock sold at a livestock market annually.
premises	Binary variable equal to 1 if the livestock market has registered their premises with the NAIS, 0 otherwise
RFID	Binary variable equal to 1 if the livestock market currently uses a RFID reader system, 0 otherwise
tagging	Binary variable equal to 1 if the livestock market will offer a RFID tagging service when the NAIS is fully implemented, 0 otherwise[2]
NE	Binary variable equal to 1 if livestock market from the Northeast region of U.S., 0 otherwise
NW	Binary variable equal to 1 if livestock market from the Northwest region of U.S., 0 otherwise
SE	Binary variable equal to 1 if livestock market from the Southeast region of U.S., 0 otherwise
SW	Binary variable equal to 1 if livestock market from the Southwest region of U.S., 0 otherwise
Midwest/Unknown	Base/Default region
β_i	Parameter coefficients to be estimated by the modeling procedure

[1]Herfindal calculations: A livestock market's herfindal index is the summation of all of the squared specie shares for each facility. The specie shares were calculated by taking the number of head of one species sold annually at a livestock market divided by the total number of livestock sold annually at the facility, multiplied by 100, squared, and divided by 1,000. This procedure was repeated for each species sold at a facility.

[2]When the survey was constructed the authors envisioned the statement of the NAIS being "fully implemented" to refer to mandatory NAIS at the federal level. However, during the time the surveys were mailed to the livestock market operators, USDA announced that the NAIS would remain voluntary (at the federal level). Therefore, in this report the term "fully implemented" could have been interpreted by livestock market respondents differently.

Table 3.2 Summary Statistics of Variables Used in Statistical Logit Models

Variable	Mean	Most Common Response[1]	Standard Deviation	Minimum	Maximum
adoption	5.23	7	2.30	1.00	9.00
costs	4.81	6	2.41	1.00	9.00
salespeed	4.29	5	1.24	1.00	5.00
standards	5.75	7	1.89	1.00	9.00
view	1.73	1	0.78	1.00	3.00
cattid	1.74	1	1.04	1.00	4.00
herfin	8.56		2.00	2.30	10.00
ln*(lvstk)*	10.67		0.87	6.76	12.68
premises	0.56	1	0.50	0.00	1.00
RFID	0.14	0	0.35	0.00	1.00
tagging	0.55	1	0.50	0.00	1.00
NE	0.06	0	0.24	0.00	1.00
NW	0.07	0	0.25	0.00	1.00
SE	0.20	0	0.40	0.00	1.00
SW	0.13	0	0.34	0.00	1.00

[1] Most Common Response is not displayed for continuous variables.

The concentration of species sold (*herfin*) and number of livestock sold annually (ln*(lvstk)*) were expected to have an effect on livestock market operator's knowledge and perceptions of the NAIS. As concentration or annual sales increased operators may be more knowledgeable of the NAIS standards, costs, and adoption methods for the species sold. Also, they may be more concerned about sale speed and the variables may even affect the operator's view of the program.

The percentage of cattle sold at a facility with any type of identification tag (*cattid*) (excluding market back tags) was expected to influence livestock market manager's knowledge and perceptions of the NAIS as well. Regions where more cattle are tagged may be areas of quicker technology adoption. Whether a livestock auction market operator had registered their premises (*premises*), adopted RFID reader technology (*RFID*), or planned to add a RFID tagging service (*tagging*) was also expected to impact an operator's knowledge and perceptions of the NAIS. A livestock market that had adopted any of these would be expected to have more knowledge of the NAIS, less concern, and more positive views of the program. Region (*NE*, *SE*, *SW*, and *NW*) was also thought to play a role in the knowledge, concerns, and views of the NAIS as state participation in premises registration varies greatly across the United States (NAIS, 2007).

3.3 Data

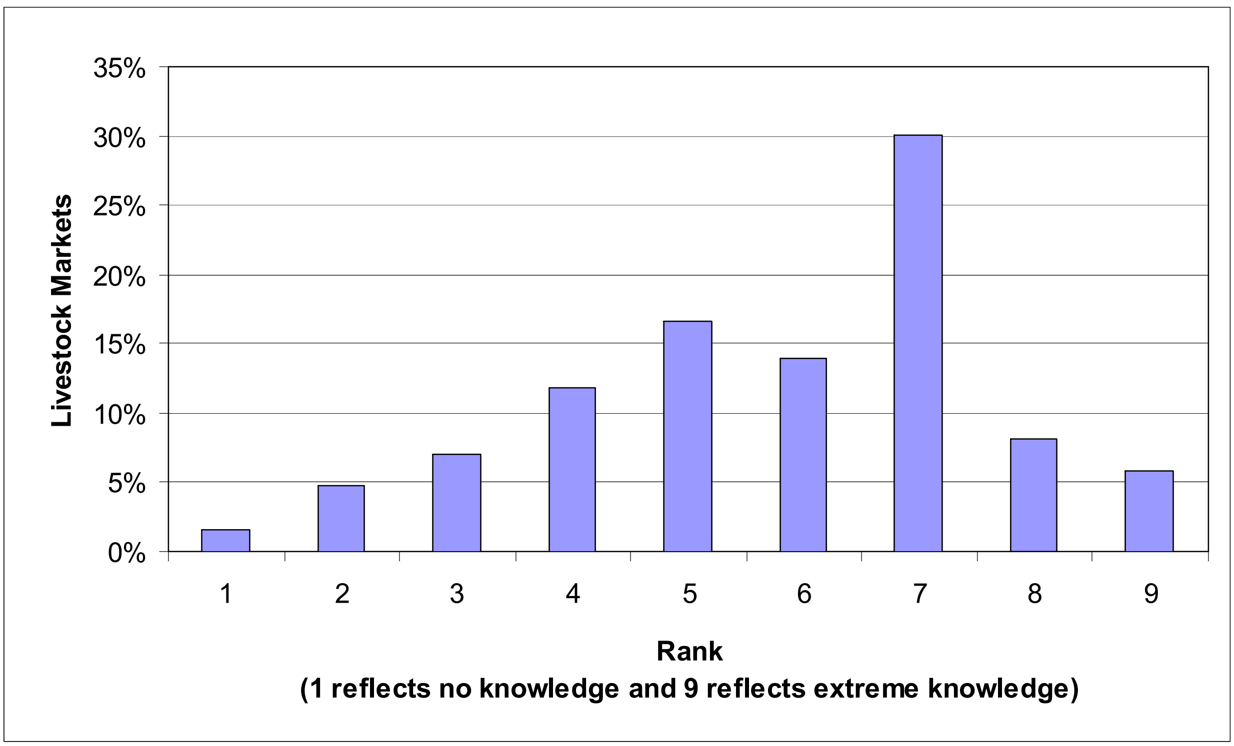
The data used in this analysis were from the national survey of livestock market operators summarized in chapter 2. A section of the survey asked for feedback on the NAIS in regard to knowledge of the program standards, understanding of how to adopt and costs of adoption, views of the program, and concerns about the NAIS. Table 3.2 contains summary statistics of data used in the empirical models and table 3.3 provides correlation coefficients of the explanatory variables. The highest correlation coefficient was 0.341, between *RFID* and *premises*. This illustrates that livestock market operators that have RFID reader systems in place are more likely to have registered their premises.

Table 3.3 Correlation Coefficients of Explanatory Variables Used in Ordered Logit Model

Variable	***herfin***	***cattid***	**ln*(lvstk)***	***tagging***	***RFID***	***premises***	***NE***	***SE***	***SW***	***NW***
herfin	-									
cattid	-0.081	-								
ln*(lvstk)*	0.052	-0.093	-							
tagging	-0.055	0.190	0.022	-						
RFID	-0.109	0.250	0.215	0.145	-					
premises	-0.129	0.148	0.172	-0.017	0.341	-				
NE	-0.152	0.256	-0.176	0.191	-0.042	-0.077	-			
SE	0.159	-0.252	-0.049	0.038	-0.126	0.017	-0.128	-		
SW	0.138	-0.092	0.138	-0.012	-0.117	-0.113	-0.100	-0.196	-	
NW	-0.000	0.191	0.028	0.161	-0.049	-0.056	-0.068	-0.134	-0.105	-

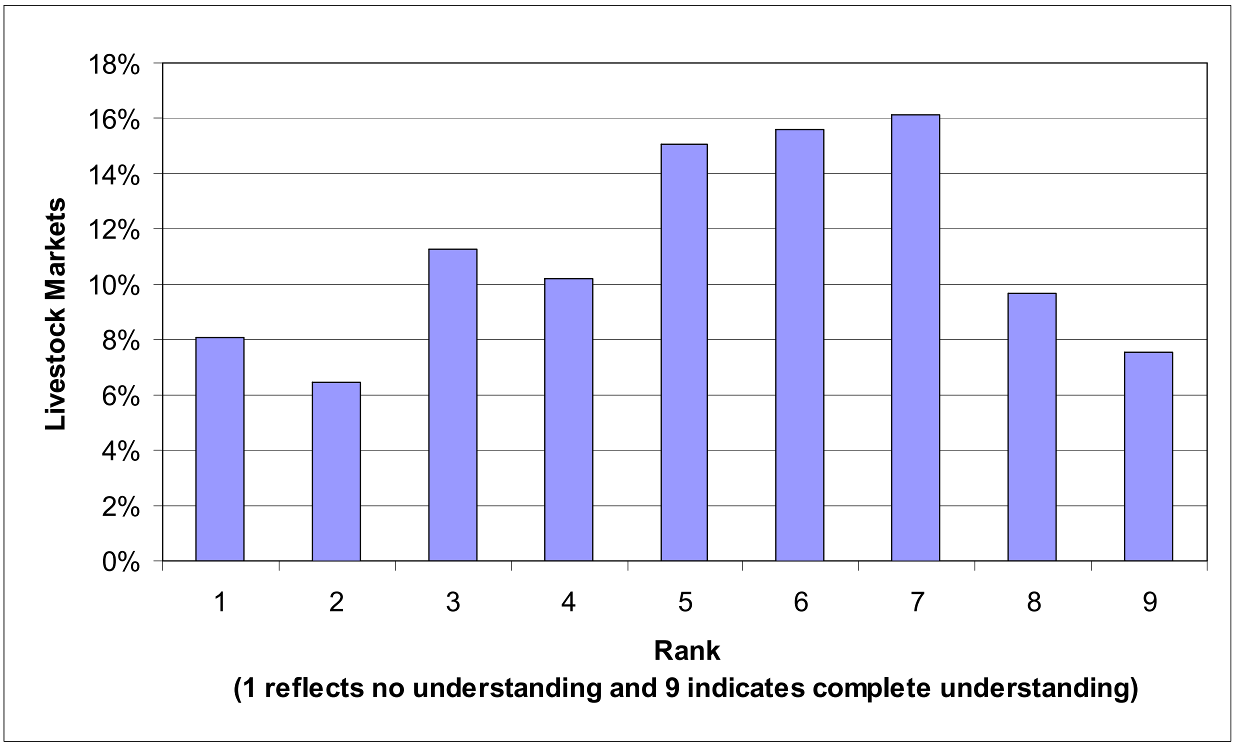
On average, livestock market operators ranked their knowledge of the program standards of the NAIS at 5.8 (on a scale from 1 to 9, where 1 reflects having no knowledge and 9 indicates extreme knowledge). This indicates a moderate level of self-reported understanding of the NAIS standards among livestock market respondents. Figure 3.1 shows that only 6% of livestock market respondents indicated feeling as though they were extremely knowledgeable (level 9) of the NAIS program standards. Though most auction market operators (58%) responded with a knowledge value of 6 or higher, there is still a sizeable number (42%) indicating intermediate or less understanding of the NAIS. This indicates further information dissemination and educational programs for auction market operators regarding the NAIS is needed.

Figure 3.1 Knowledge of the NAIS Program Standards Among Survey Respondents (Average 5.8)



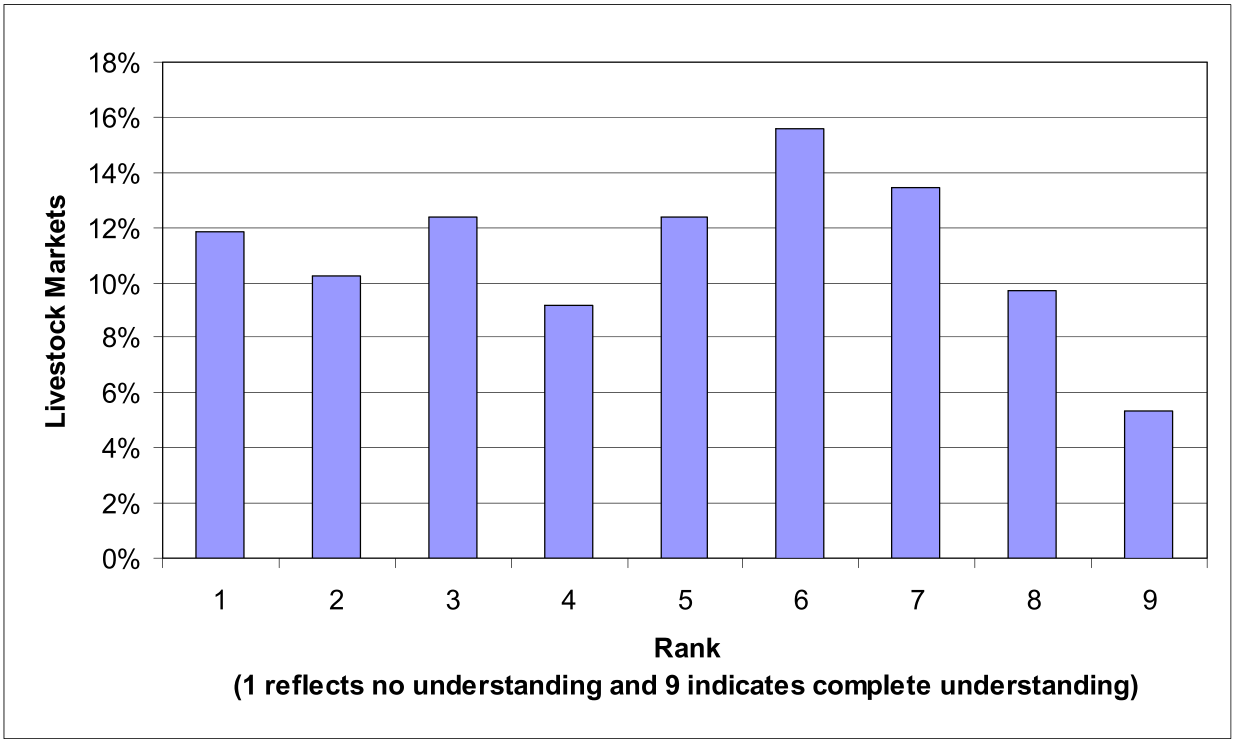
When asked to rank their level of understanding of what their facility would need to do to adopt the NAIS services, the average response was 5.2 (on a scale from 1 to 9, where 1 reflects having no understanding and 9 indicates complete understanding). This indicates livestock market operators have a moderate level of understanding of what needs to be done to adopt the NAIS at their facilities. Figure 3.2 shows the responses to this question. Slightly over half of the auction market operators (51% with a score of 5 or less) feel they do not fully understand what they would need to do to adopt the NAIS.

Figure 3.2 Knowledge of How to Adopt the NAIS Among Survey Respondents (Average 5.2)



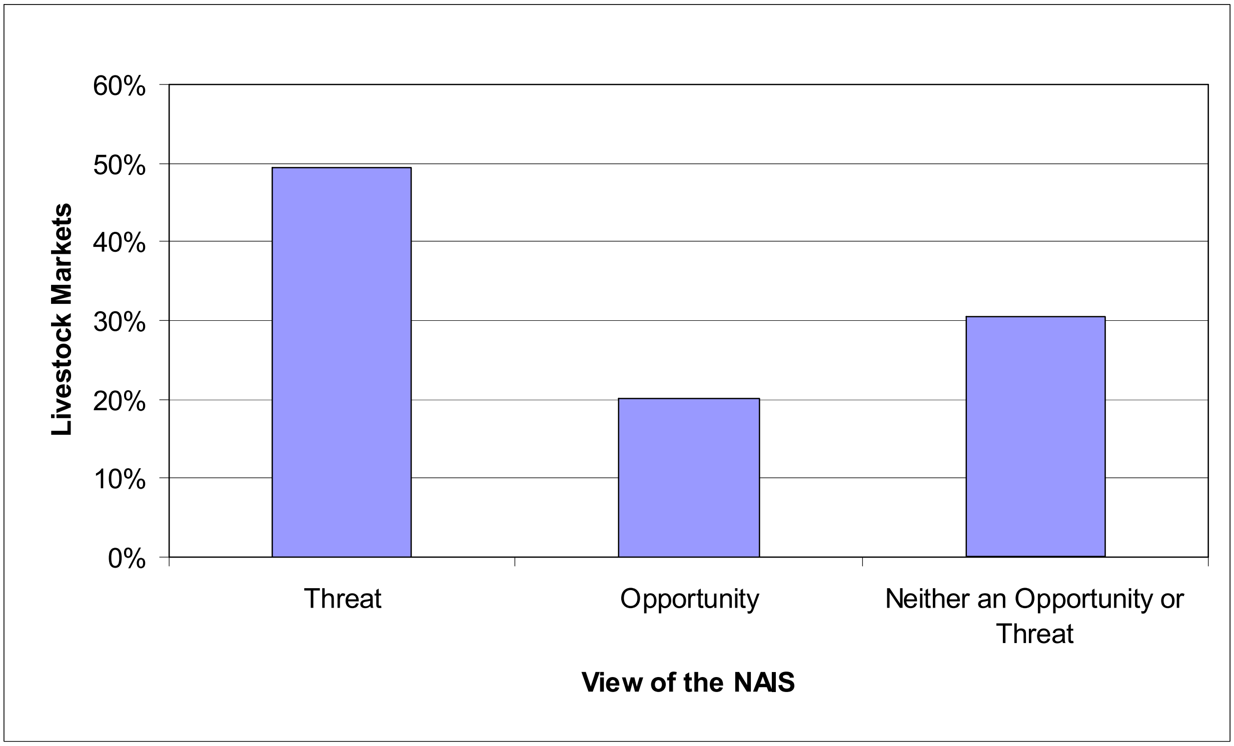
Livestock market operators were asked to rank their level of understanding of the costs that will likely be incurred in order to adopt the NAIS services. The average response was 4.8 (on a scale from 1 to 9, where 1 reflects having no understanding and 9 indicates complete understanding). This shows livestock market operators moderately understand the costs they would incur to adopt the NAIS. Figure 3.3 summarizes the livestock market responses. Not surprisingly, given the results of figure 3.2 indicating that most operators do not fully know what they would need to do to adopt the NAIS, a similar percentage of operators indicated they do not know the costs of adoption.

Figure 3.3 Knowledge of Cost to Adopt the NAIS Among Survey Respondents (Average 4.8)



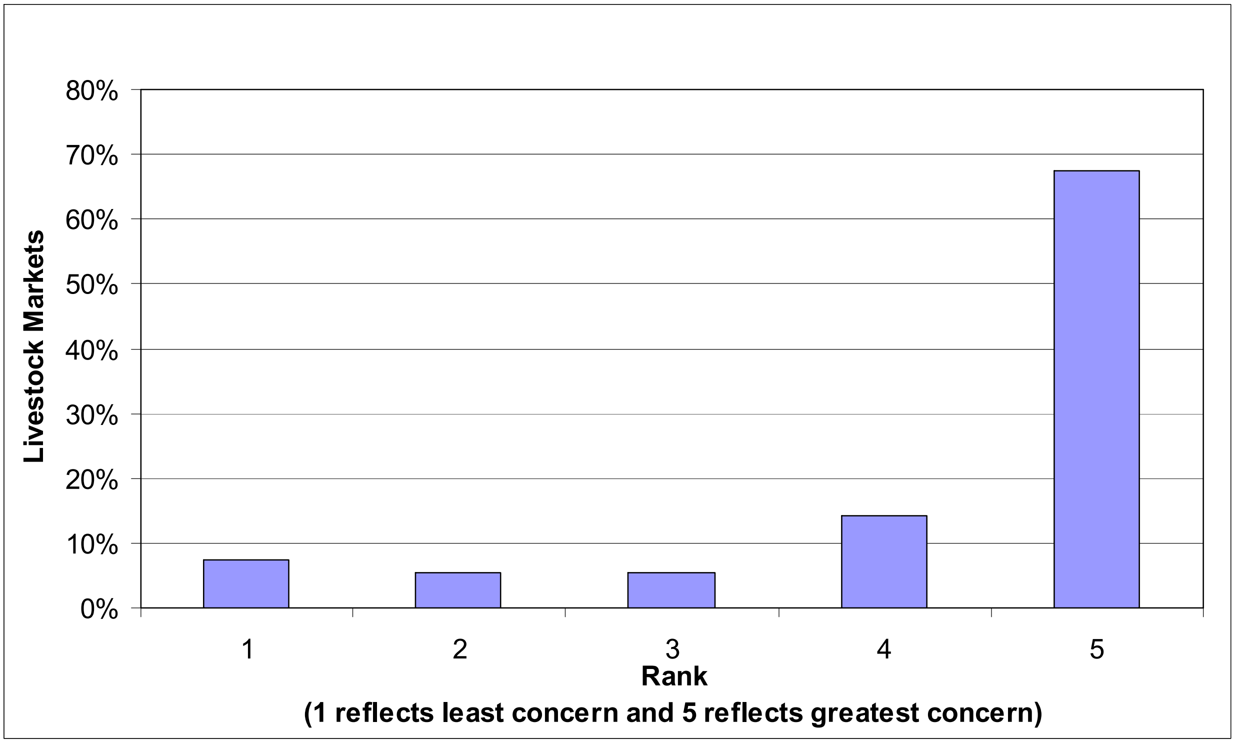
How livestock markets view the NAIS is also important because this illustrates general feelings of the program among the auction market industry. Figure 3.4 shows how auction market operators view the overall impact of the NAIS on their businesses. Approximately half of livestock market operator respondents view the NAIS as a *threat* to their businesses. Only 20% view it as an *opportunity* and 30% view it as *neither a threat nor an opportunity*. To gain support for the NAIS, addressing concerns of those that perceive the NAIS as a *threat* to their business will be critical.

Figure 3.4 Livestock Market View of the NAIS Among Survey Respondents



Most livestock markets surveyed were highly concerned about the speed of sale being adversely affected if they adopted the NAIS practices such as RFID tag use (figure 3.5). In fact, 82% of livestock market operators were highly concerned (response of 4 or 5). Only 5% of respondents answered with a moderate level of concern (response of 3) and 13% of respondents were not concerned (response of 1 or 2). However, 79% of livestock markets that have installed RFID reader systems have not experienced a change in sale speed since its installation (Bolte et al., 2007)

Figure 3.5 Concern of Impact on Speed of Sale Among Survey Respondents (Average 4.29)



3.4 Results

Ordered logit models were used to estimate the parameters in equations (5) through (9) to determine how the different explanatory (independent) variables relate to the probability the survey respondent indicated a particular knowledge level, concern, or view of the NAIS. Model estimation results are reported in tables 3.4 through 3.8 for equations (5) through (9), respectively. Changes in probabilities associated with a one-unit change in each explanatory variable were calculated and are referred to as marginal probabilities, based on equation (4). Marginal probabilities, reported in tables 3.4 through 3.8, sum to zero across rows because as the probability of one response category increases, all others must decrease collectively by that same amount. Binary variables do not have marginal probabilities as they only take on values of one or zero. Thus, the probabilities, based on equation (3), as binary variables change from 0 to 1 are presented in tables 3.4 through 3.8. The probabilities associated with changes in the binary variables were calculated by holding continuous variables at their average values and discrete variables at their most common response.

3.4.1 Knowledge of the NAIS Program Standards

Respondent knowledge of the NAIS standards varied across auction markets (figure 3.1), though the most common answer was a 7 (1 = no knowledge to 9 = extreme knowledge). Estimated impacts of factors hypothesized to be related to the level of knowledge are presented in table 3.4. Livestock market managers that plan to offer a RFID tagging service feel more knowledgeable about the NAIS program standards than those that are not planning to add a RFID tagging service if the NAIS were implemented. Holding other factors constant, the probability that an auction market survey respondent planning to add a tagging service indicated a high degree of knowledge of the NAIS standards (response of 7 or higher) was about 55%. In contrast, those that do not plan to add a tagging service have a probability of 37% of having a response of 7 or higher. Stated knowledge about the NAIS program standards was not related to whether the auction market had registered its premises, region of the country the market was located relative to the Midwest, the diversity of livestock sold at the market, RFID adoption, or the percentage of cattle that the auction market sells that have any type of identification tag.

Operators of livestock markets that sell greater volumes of livestock annually are likely to have more knowledge of the NAIS standards (response of 7 or higher) than operators of markets that sell fewer head of livestock annually. Figure 3.6 shows the probability of responses of 7 or greater (high knowledge), 3 or lower (low knowledge), and 4-6 (moderate knowledge) by size of livestock market. The probability of a livestock market operator having a high level of knowledge (7-9) increases as the size of the facility increases. Likewise, the probability of a livestock market manager having little to no knowledge (1-3) or only moderate knowledge (4-6) increases as livestock markets get smaller.

Figure 3.6 Probability of a Livestock Market's Level of Knowledge of the NAIS Program Standards Based on Annual Livestock Sales

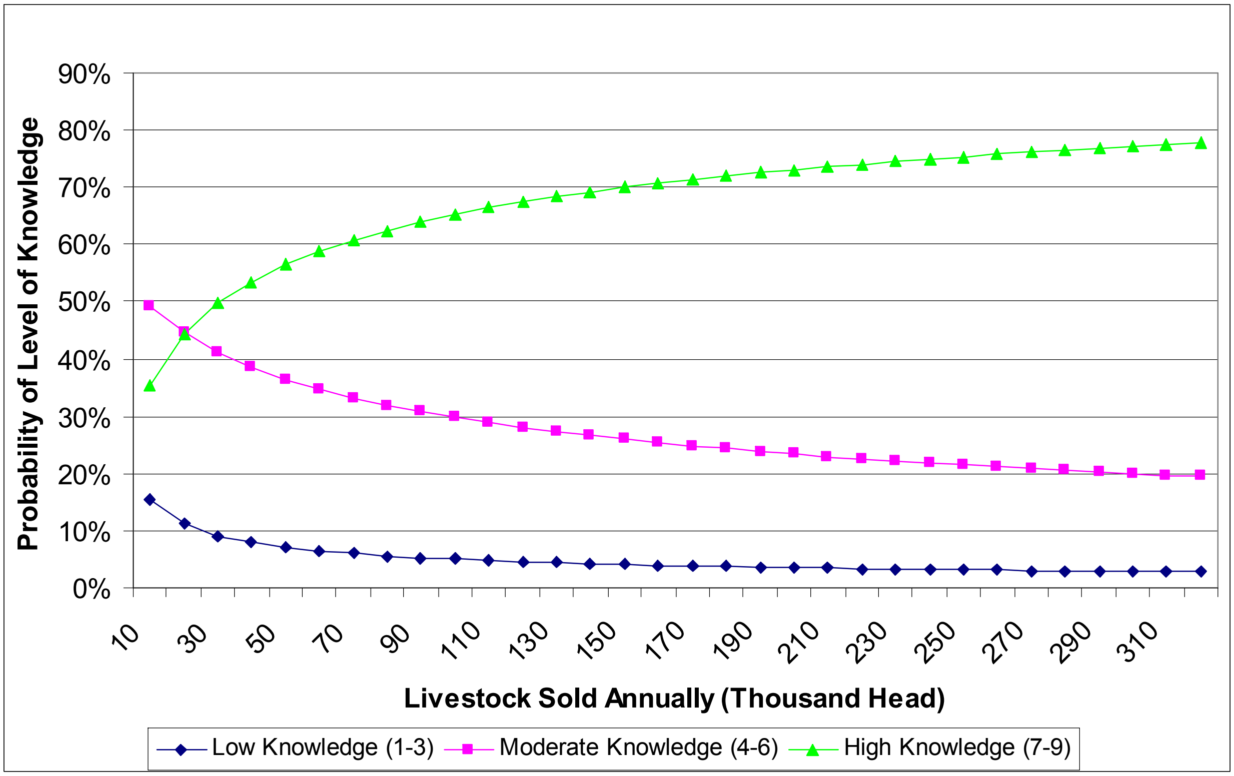


Table 3.4 Ordered Logit Estimates for Response to Statement: Rate your knowledge of the NAIS, regarding program standards (1=no knowledge to 9= extremely knowledgeable)

Variable	Parameter Estimate[1]	P-Value	1	2	3	4	5	6	7	8	9
Intercept	-2.0697	0.2931					**Probabilities**				
Tagging = 1	0.7259	0.0123	0.0078	0.0254	0.0434	0.0833	0.1505	0.1449	0.3731	0.0972	0.0745
Tagging = 0	Default		0.0159	0.0503	0.0801	0.1359	0.1996	0.1515	0.2756	0.0537	0.0375
RFID = 1	0.6818	0.1332	0.0039	0.0131	0.0232	0.0475	0.0976	0.1117	0.4122	0.1535	0.1372
RFID = 0	Default		0.0078	0.0254	0.0434	0.0833	0.1505	0.1449	0.3731	0.0972	0.0745
premises=1	0.1723	0.5559	0.0078	0.0254	0.0434	0.0833	0.1505	0.1449	0.3731	0.0972	0.0745
premises=0	Default		0.0092	0.0300	0.0505	0.0947	0.1640	0.1498	0.3533	0.0851	0.0634
NE	-0.5893	0.3102	0.0139	0.0443	0.0718	0.1253	0.1925	0.1532	0.2959	0.0604	0.0427
SE	-0.5061	0.1664	0.0128	0.0410	0.0671	0.1190	0.1875	0.1535	0.3080	0.0648	0.0463
SW	-0.4025	0.3193	0.0116	0.0372	0.0615	0.1112	0.1807	0.1533	0.3228	0.0707	0.0510
NW	0.2589	0.6466	0.0060	0.0198	0.0344	0.0679	0.1297	0.1343	0.3962	0.1173	0.0944
Midwest/Unknown	Default		0.0078	0.0254	0.0434	0.0833	0.1505	0.1449	0.3731	0.0972	0.0745
							Marginal Probabilities				
Herfin	0.0364	0.5976	-0.0003	-0.0009	-0.0014	-0.0023	-0.0029	-0.0012	0.0039	0.0027	0.0025
Cattid	0.0151	0.9214	-0.0001	-0.0004	-0.0006	-0.0010	-0.0012	-0.0005	0.0016	0.0011	0.0010
ln*(lvstk)*	0.5337	0.0021	-0.0041	-0.0130	-0.0206	-0.0339	-0.0425	-0.0181	0.0565	0.0391	0.0368

Log-Likelihood Function = -341.8824 Number of Observations = 183

[1]Parameter estimates for "limits" with p-values in parentheses: Limit 2: 1.4776 (0.0042), Limit 3: 2.3598 (<.0001), Limit 4: 3.1902 (<.0001), Limit 5: 4.0509 (<.0001), Limit 6: 4.6700 (<.0001), Limit 7: 6.4232 (<.0001), Limit 8: 7.3698 (<.0001).

3.4.2 Knowledge to Adopt the NAIS Practices

Results of the model explaining factors related to auction market respondent understanding of what the facility would need to do to adopt the NAIS practices (figure 3.2) are reported in table 3.5. Livestock market operators that indicate they would likely add a RFID tagging service in the future are 36% probable to admit high level of knowledge (response of 7-9) of how to adopt the NAIS practices; whereas the operator is only 19% probable of having a high level of knowledge at facilities where RFID tagging services are not likely to be offered, holding all other variables constant. Survey respondents that have adopted RFID reader systems have 62% probability of high knowledge (response of 7-9), and respondents that have not adopted RFID reader systems have 36% probability of high knowledge (response of 7-9), all else constant. Statistically unrelated to operator knowledge of the NAIS were whether the market had registered its premises, auction facility location compared to the Midwest, diversity of livestock sold by the market, and percentage of cattle the market sold that had an identification tag.

Figure 3.7 illustrates that livestock markets that sell more livestock annually are more likely to have a greater level of understanding of how to adopt the NAIS practices. Smaller livestock markets, selling fewer livestock, are more likely to have moderate or little understanding of how to adopt the NAIS practices.

Figure 3.7 Probability of a Livestock Market's Level of Understanding of How to Adopt the NAIS Practices Based on Annual Livestock Sales

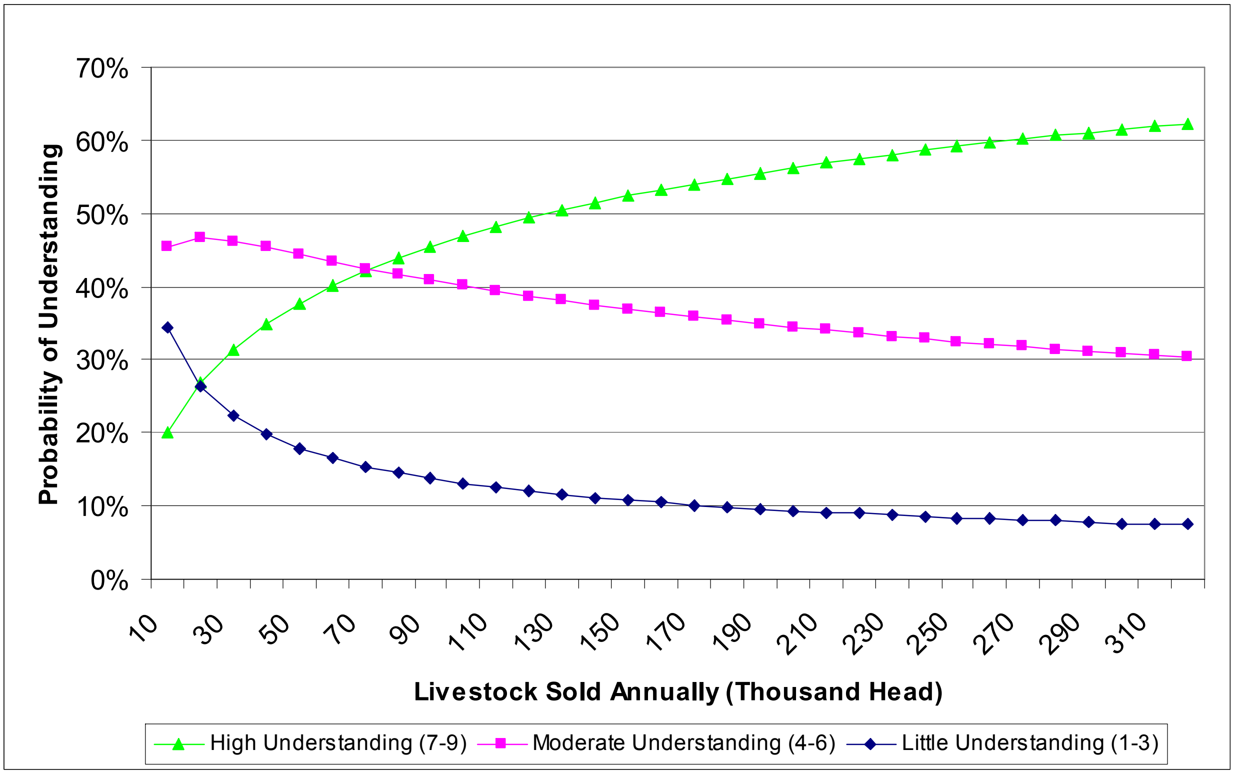


Table 3.5 Ordered Logit Estimates for Response to Statement: Rate your level of understanding of what this facility needs to do to adopt the NAIS practices (1=do not understand to 9= completely understand)

Variable	Parameter Estimate[1]	P-Value	1	2	3	4	5	6	7	8	9
Intercept	-4.825	0.011					**Probabilities**				
tagging = 1	0.854	0.003	0.050	0.047	0.095	0.095	0.167	0.188	0.196	0.094	0.068
tagging = 0	Default		0.110	0.091	0.157	0.128	0.176	0.147	0.116	0.046	0.030
RFID = 1	1.068	0.014	0.018	0.018	0.040	0.046	0.101	0.159	0.258	0.185	0.175
RFID = 0	Default		0.050	0.047	0.095	0.095	0.167	0.188	0.196	0.094	0.068
premises=1	0.160	0.584	0.050	0.047	0.095	0.095	0.167	0.188	0.196	0.094	0.068
premises=0	Default		0.058	0.053	0.106	0.103	0.173	0.184	0.181	0.083	0.058
NE	0.673	0.251	0.026	0.026	0.056	0.062	0.128	0.180	0.247	0.150	0.125
SE	-0.185	0.598	0.059	0.054	0.108	0.104	0.174	0.183	0.178	0.082	0.057
SW	-0.270	0.519	0.064	0.058	0.114	0.108	0.176	0.180	0.170	0.076	0.053
NW	0.412	0.466	0.034	0.032	0.070	0.074	0.145	0.188	0.231	0.127	0.099
Midwest/Unknown	Default		0.050	0.047	0.095	0.095	0.167	0.188	0.196	0.094	0.068
							Marginal Probabilities				
herfin	0.103	0.121	-0.005	-0.004	-0.007	-0.005	-0.004	0.002	0.010	0.007	0.007
cattid	0.095	0.513	-0.005	-0.004	-0.006	-0.005	-0.004	0.002	0.009	0.007	0.006
ln*(lvstk)*	0.542	0.002	-0.026	-0.022	-0.037	-0.027	-0.024	0.010	0.051	0.039	0.034

Log-Likelihood Function = -371.91536 Number of Observations = 183

[1]Parameter estimates for "limits" with p-values in parentheses: Limit 2: 0.709 (0.000), Limit 3: 1.507(<.0001), Limit 4: 2.034 (<.0001), Limit 5: 2.760 (<.0001), Limit 6: 3.530 (<.0001), Limit 7: 4.588 (<.0001), Limit 8: 5.565 (<.0001).

3.4.3 Understanding of Costs Necessary to Adopt the NAIS

Livestock market operators overall showed a wide range of understanding of costs associated with adopting the NAIS (figure 3.3). Table 3.6 reports results of estimating equation (7) to determine factors related to knowledge of costs of adoption. Livestock market managers that plan to offer a RFID tagging service in the future have a 32% probability of responding with a 7 or higher, whereas facilities that do not plan to offer a tagging service in the future have only a 17% probability of responding with a 7 or higher. Livestock market operators that have RFID reader systems in place are more likely to be more knowledgeable (60% probability of responding with a 7 or higher) of the NAIS costs than those auction market respondents that do not currently use RFID reader systems (32% probability of responding with a 7 or higher). Unrelated to operator understanding of costs associated with adopting the NAIS included whether the market had registered its premises, auction facility location compared to the Midwest, diversity of livestock sold by the market, percentage of cattle the market sold that had an identification tag, and auction market sales volume.

Table 3.6 Ordered Logit Estimates for Response to Statement: Rate your level of understanding of costs you will incur to adopt the NAIS at this facility (1=do not understand to 9= completely understand)

Variable	Parameter Estimate[1]	P-Value	1	2	3	4	5	6	7	8	9
Intercept	-1.443	0.448	**Probabilities**								
tagging = 1	0.814	0.004	0.075	0.083	0.109	0.092	0.135	0.190	0.164	0.099	0.052
tagging = 0	Default		0.156	0.143	0.153	0.107	0.130	0.142	0.096	0.049	0.024
RFID = 1	1.174	0.007	0.025	0.031	0.046	0.046	0.084	0.169	0.233	0.214	0.151
RFID = 0	Default		0.075	0.083	0.109	0.092	0.135	0.190	0.164	0.099	0.052
premises=1	0.272	0.355	0.075	0.083	0.109	0.092	0.135	0.190	0.164	0.099	0.052
premises=0	Default		0.097	0.102	0.126	0.100	0.138	0.178	0.140	0.079	0.040
NE	-0.727	0.237	0.144	0.137	0.150	0.107	0.132	0.149	0.103	0.053	0.026
SE	-0.411	0.239	0.110	0.112	0.134	0.103	0.138	0.170	0.129	0.070	0.035
SW	0.318	0.456	0.056	0.065	0.089	0.080	0.126	0.196	0.191	0.126	0.070
NW	-0.280	0.624	0.097	0.102	0.126	0.100	0.138	0.178	0.140	0.079	0.040
Midwest/Unknown	Default		0.075	0.083	0.109	0.092	0.135	0.190	0.164	0.099	0.052
			Marginal Probabilities								
herfin	0.079	0.249	-0.005	-0.005	-0.005	-0.003	-0.002	0.003	0.007	0.006	0.004
cattid	0.219	0.133	-0.015	-0.014	-0.014	-0.007	-0.004	0.007	0.019	0.017	0.011
ln*(lvstk)*	0.185	0.279	-0.013	-0.012	-0.012	-0.006	-0.004	0.006	0.016	0.015	0.009

Log-Likelihood Function = -378.60854 Number of Observations = 183

[1]Parameter estimates for "limits" with p-values in parentheses: Limit 2: 0.839(<.0001), Limit 3: 1.499(<.0001), Limit 4: 1.928(<.0001), Limit 5: 2.483(<.0001), Limit 6: 3.280(<.0001), Limit 7: 4.233(<.0001), Limit 8: 5.407(<.0001).

3.4.5 Perception of the NAIS Impact on Business

Livestock market operators hold diverse perceptions regarding whether the NAIS represents a *threat* or an *opportunity* to their operations (figure 3.4). Factors related to these perceptions are reported in table 3.7. Livestock market operators that have RFID reader systems in place have a 54% probability of perceiving the NAIS as an *opportunity* for their businesses; while livestock market operators that do not have RFID reader systems in use have only a 22% probability of thinking of the NAIS as an *opportunity* for their businesses. Also, livestock market managers that have registered their premises have a 22% probability of perceiving the NAIS as an *opportunity* for their businesses compared to livestock market operators that have not registered their premises only having a 14% probability of thinking of the NAIS as an *opportunity*. Livestock markets located in the Northeast region have a 53% probability of viewing the NAIS as an *opportunity* compared to a probability of less than 25% for other regions.

Table 3.7 Ordered Logit Estimates for Response to Statement: Is the NAIS a *threat* or *Opportunity* to your business? (1 = threat, 2 = neither threat or opportunity, 3 = opportunity)

Variable	Parameter Estimate[1]	P-Value	1	2	3
Intercept	-3.345	0.125		Probabilities	
tagging = 1	0.114	0.714	0.411	0.367	0.221
tagging = 0	Default		0.439	0.359	0.202
RFID = 1	1.399	0.005	0.147	0.318	0.535
RFID = 0	Default		0.411	0.367	0.221
premises=1	0.568	0.078	0.411	0.367	0.221
premises=0	Default		0.552	0.309	0.139
NE	1.368	0.028	0.151	0.322	0.528
SE	-0.031	0.938	0.419	0.365	0.216
SW	-0.772	0.111	0.602	0.282	0.116
NW	0.120	0.843	0.383	0.375	0.243
Midwest/Unknown	Default		0.411	0.367	0.221
				Marginal Probabilities	
herfin	0.041	0.588	-0.010	0.003	0.007
cattid	-0.164	0.317	0.040	-0.011	-0.028
ln*(lvstk)*	0.266	0.174	-0.064	0.019	0.046

Log-Likelihood Function = -176.26663 Number of Observations = 183

[1]Parameter estimate for "limit" with p-value in parentheses: Limit 2: 1.617 (<.0001)

3.4.6 Speed of Sale Concerns

Most livestock market managers surveyed were highly concerned about speed of sale being adversely affected if they adopted the NAIS practices such as RFID tag use (figure 3.5). Factors related to these perceptions are reported in table 3.8. While managers of livestock markets from the Northeast region have the lowest probability of concern among regions, managers in this region still have a 53% probability of being highly concerned (response of 4 or 5) about sale speed being adversely affected by adopting the NAIS. Figure 3.8 shows that operators of all sizes of livestock markets have a probability greater than 70% of being highly concerned (response of 4 or 5) of sale speed being slowed if they adopt the NAIS practices. Furthermore, the larger the auction market, the more highly concerned the operator is that adopting the NAIS practices could slow down speed of commerce. This is logical as larger volume markets must keep cattle moving through the sale ring relatively quickly to not have overly lengthy sale days that could alienate customers. With these high levels of concern, adoption of the NAIS practices by livestock markets must focus on ways to ensure that speed of commerce is not adversely affected by the NAIS adoption.

Figure 3.8 Probability of a Livestock Market's Level of Concern of Sale Speed Being Adversely Impacted by the NAIS

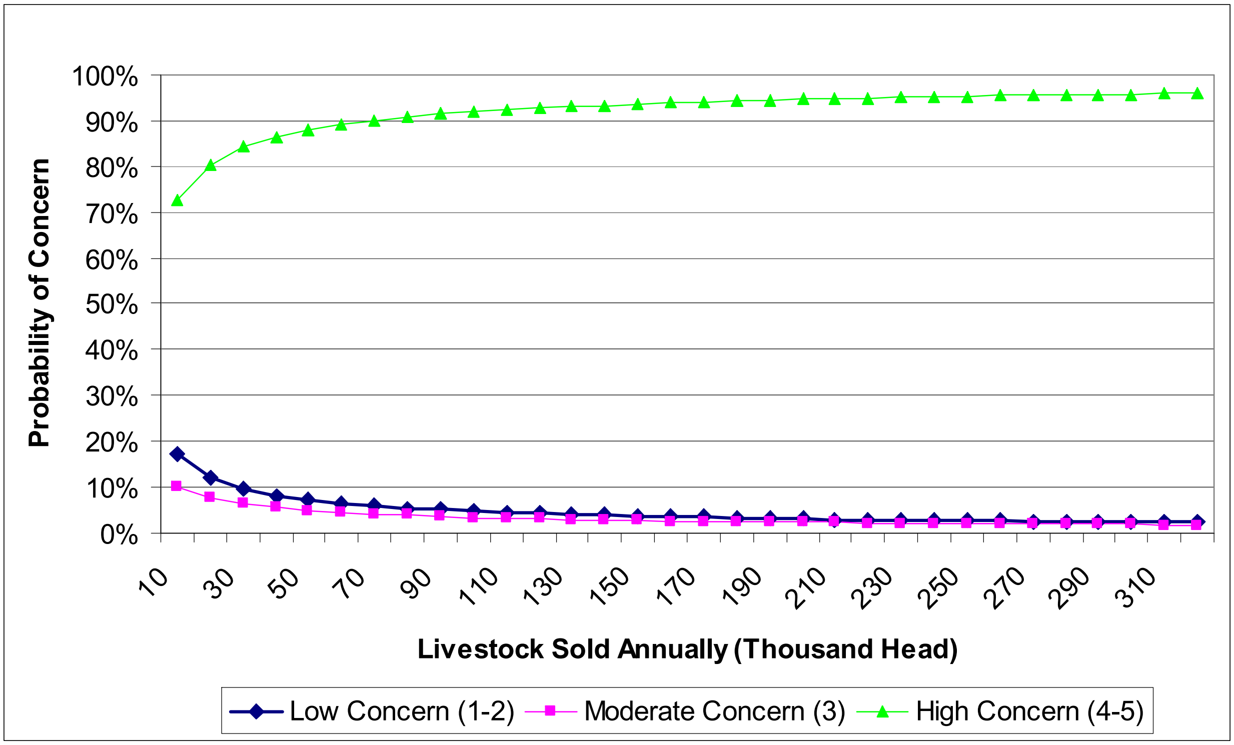


Table 3.8 Ordered Logit Estimates for Response to Statement: Concern of speed of sale being adversely impacted by the NAIS adoption (1 = low concern to 5 = high concern)

Variable	Parameter Estimate[1]	P-Value	1	2	3	4	5
Intercept	-3.120	0.181			**Probabilities**		
tagging = 1	-0.364	0.311	0.039	0.039	0.053	0.144	0.726
tagging = 0	Default		0.027	0.028	0.039	0.114	0.792
RFID = 1	-0.653	0.230	0.072	0.068	0.084	0.197	0.579
RFID = 0	Default		0.039	0.039	0.053	0.144	0.726
premises=1	-0.418	0.257	0.039	0.039	0.053	0.144	0.726
premises=0	Default		0.026	0.027	0.037	0.110	0.801
NE	-1.780	0.011	0.192	0.141	0.138	0.221	0.308
SE	-0.643	0.149	0.071	0.067	0.084	0.197	0.582
SW	0.322	0.572	0.028	0.029	0.040	0.117	0.785
NW	-0.042	0.950	0.040	0.040	0.054	0.148	0.717
Midwest/Unknown	Default		0.039	0.039	0.053	0.144	0.726
					Marginal Probabilities		
herfin	0.083	0.317	-0.003	-0.003	-0.003	-0.007	0.017
cattid	-0.305	0.076	0.011	0.011	0.013	0.026	-0.061
ln*(lvstk)*	0.629	0.004	-0.023	-0.022	-0.026	-0.054	0.125

Log-Likelihood Function = -170.54755 Number of Observations = 183

[1]Parameter estimates for "limits" with p-values in parentheses: Limit 2: 0.741 (0.002), Limit 3: 1.318 (<.0001), Limit 4: 2.244 (<.0001).

3.5 Conclusions and Implications

In order to determine how individual characteristics of livestock markets relate to levels of knowledge, views, and concerns of the NAIS, a statistical modeling procedure referred to as ordered logit models was used. The purpose of the analysis was to determine whether there are systematic characteristics of auction markets that relate to survey respondent answers to particular questions. The systematic factors found using this procedure can be used to better target information dissemination programs.

Livestock market operators that indicated they currently have, or plan to add a RFID tagging service in the future at their facilities, are likely to be more knowledgeable about the NAIS program standards, how to adopt the NAIS practices, and the probable costs involved with adoption of the NAIS. Also, managers of facilities that sell a large volume of livestock annually tend to better understand how to adopt the NAIS practices and are more knowledgeable about the NAIS program standards than operators of small-volume facilities. Finally, managers of facilities that have operating RFID reader systems better understand how to adopt the NAIS practices and the costs associated with adopting the NAIS. This suggests smaller auction market operators are an important target for information dissemination, as well as facilities that do not plan to add a RFID tagging service in the future, or facilities that do not currently have operating RFID reader systems.

Livestock market operators that have operating RFID reader systems as well as those that have registered their premises are more likely to perceive the NAIS as an *opportunity* to their businesses than livestock markets that have not completed these activities. Auction market managers that see *opportunities* with having electronic animal identification systems have been early adopters. Markets that have not adopted electronic animal identification information technology will need to have their perceptions changed regarding potential value before they are likely to adopt.

Livestock market managers tend to be highly concerned about adoption of individual electronic animal identification systems adversely impacting sale speed. In fact, the more volume the auction sells, the greater the manager's concern about animal identification systems slowing speed of commerce. However, the impact on the speed of sale for those livestock markets that have already adopted electronic animal identification and tracking systems is generally less than the perceived impact on speed of sale of those that have not adopted this technology.

If a goal is to have the NAIS become more broadly adopted by the livestock market industry, more information about the program is needed for livestock market operators. Most livestock market operators are only moderately knowledgeable of the program standards, costs, and adoption needs. Also, concerns of the NAIS and electronic animal identification systems need to be addressed. Finally, in order for livestock market managers to want to comply with the NAIS, they would need to perceive it as more of an *opportunity* for their businesses, and less of a *threat*.

CHAPTER 4 - RFID Technology Adoption

Recently there has been growing interest in adopting electronic animal identification services at livestock markets. Livestock markets could benefit from electronic animal identification systems because these systems would allow individual animal identification tags (most likely RFID tags) to be read at the speed of commerce, and be less likely to slow the speed of livestock market sales. The objective of this analysis was to determine how individual characteristics of livestock markets related to RFID technology adoption, a statistical modeling procedure referred to as a binary logit model was used. The purpose of this analysis was to determine whether systematic characteristics of auction markets related to survey respondents RFID technology adoption rates. If there were systematic factors related to responses of specific questions, this knowledge could be used to better target information dissemination programs.

4.1 Previous Research

Because it is such a new program, little research has been completed on RFID technology adoption among livestock market operators. However, binary logit models have been used in similar circumstances to determine the probability of participation in a program or industry activity. The discussion below highlights a few selected studies that have used this technique.

Capps, Randall, and Kramer estimated factors affecting participation of families nationwide in the Food Stamp Program based on residential location, source of income, and household age distribution. Because the dependent variable is discrete (did or did not participate), the study also considered differences in probit and logit models. Both of these models are qualitative dependent models. The study found minimal differences between probit and logit models. Data used were from the Bureau of Labor Statistics Consumer Expenditure Diary Survey. The researchers determined demographic attributes of the most and least likely households to participate in the Food Stamp Program.

A study by Gyawali et al. investigated the factors affecting participation in the Conservation Reserve Program by limited resource farmers in Alabama. The researchers used a binary logit model to analyze data collected from a survey mailed to limited resource farmers in Alabama. Gender, age, race, education, occupation, acres, and other factors were used in the model as explanatory variables. Many of the explanatory variables were significant in determining the probability of participation in the Conservation Reserve Program.

Bragg and Dalton used a binary logit model to discover why dairy producers were exiting the dairy industry. The researchers realized low milk prices could be a primary reason for industry exit but believed other factors could also be important. Data were collected from a survey sent to dairy producers in Maine. Three categories of variables were used as explanatory variables including demographics, efficiency, and opportunity costs. Many of the variables were statistically significant in affecting the probability of a dairy farmer exiting dairy farming.

These three research articles used binary logit models to discover the probability and significant explanatory variables of an individual/household participating in an industry or program. All three procedures are similar to the procedures used in finding the probability and significant explanatory variables of livestock markets adoption of RFID technology. Thus, they provide a foundation for the modeling approach used in this study.

4.2 Empirical Model

In this analysis, a binary logit model was used to determine factors affecting the probability that a livestock market had installed RFID reader equipment. A binary dependent variable was used and defined as $y_i = 1$ if the livestock market operator had adopted RFID technology and $y_i = 0$ if the livestock market operator had not adopted RFID technology. An empirical representation of the binary logit model is (Greene, 1997):

$$(10)\quad \text{Prob}(y_i = 1) = F(x, \beta),$$

where the x's are explanatory variables and β's are parameters to be estimated. The i refers to individual livestock auction markets. Define:

$$(11)\quad \begin{array}{l} E(y_i \mid x) = F(x, \beta) \\ F(x, \beta) = \beta' x \end{array}$$

then the regression model can be estimated as:

$$(12)\quad y_i = E(y_i \mid x) + (y_i - E(y_i \mid x)) \\ = \beta' x + \varepsilon .$$

The error, ε, is logistically distributed; therefore, the probability of $y_i = 1$ can be denoted as:

$$(13)\quad \text{Prob}(y_i = 1) = \frac{1}{1 + \exp(-\beta' x)} .$$

The marginal effects can be calculated by:

$$(14)\quad \frac{\partial E(y_i \mid x)}{\partial x} = \frac{\exp(\beta' x)}{(1 + \exp(\beta' x))^2} * \beta .$$

The following equation was estimated to determine how individual factors affected the probability of a livestock market installing RFID reader equipment (subscript *i* is dropped for notational convenience):

$$(15)\quad RFID = \begin{array}{l} \beta_0 + \beta_1 herfin + \beta_2 cattid + \beta_3 \ln(lvstk) + \beta_4 tagging + \beta_5 premises + \beta_6 NE + \beta_7 SE \\ + \beta_8 SW + \beta_9 NW + e, \end{array}$$

where all variables are defined in table 3.1. The explanatory variables were included because they were hypothesized to have an effect on the dependent variable (i.e., whether or not RFID equipment had been installed).

The concentration of species sold (*herfin*) and number of livestock sold annually (ln*(lvstk)*) were expected to have an effect on livestock market operator's RFID adoption practices. Such that, as concentration or annual sales increased operators may be more willing to adopt RFID read systems. The percentage of cattle sold at a facility with any type of identification tag (*cattid*) (excluding market back tags) was expected to influence livestock market manager's RFID technology adoption. Areas where more cattle are tagged may be areas of quicker technology adoption. Whether a livestock auction market operator planned to add a RFID tagging service (*tagging*) or had registered their premises (*premises*) was also expected to impact an operator's technology adoption. A livestock market that had registered its premises would be more likely to have adopted RFID technology. Region (*NE*, *SE*, *SW*, and *NW*) was also included in the model to determine if auctions located in different areas of the country differed in adoption rates of RFID technology.

4.3 Data

The data used in this analysis were from the national survey of livestock market operators discussed in chapter 2. A section of the survey asked livestock market operators if they had adopted RFID technology. Table 3.2 contains summary statistics on the data used in the empirical model and table 3.3 provides correlation coefficients of the explanatory variables. All correlation coefficients between explanatory variables are less than 0.26 in absolute value.

Only 14% of livestock market survey respondents had installed electronic animal identification systems, all of which were RFID tag reading systems. Livestock markets that adopted RFID reader systems ranged in size from 13,000 to 275,000 head of cattle sold annually. Figure 4.1 shows livestock market survey respondents categorized by size of facility that have and have not adopted RFID reader systems. There were 72 livestock market respondents that sold between 25,000 and 50,000 head of cattle annually, but only 10 (13.9%) of the facilities have adopted RFID technology. Twenty percent of facilities that sold 50,000 to 100,000 head of livestock annually and 60% of facilities that sold 150,000 or more head of livestock annually have adopted RFID technology. Generally speaking, higher percentages of livestock markets have adopted RFID technology as annual cattle sales among livestock markets increase.

Figure 4.1 Survey Respondents with RFID Reader Systems Installed by Size of Livestock Market

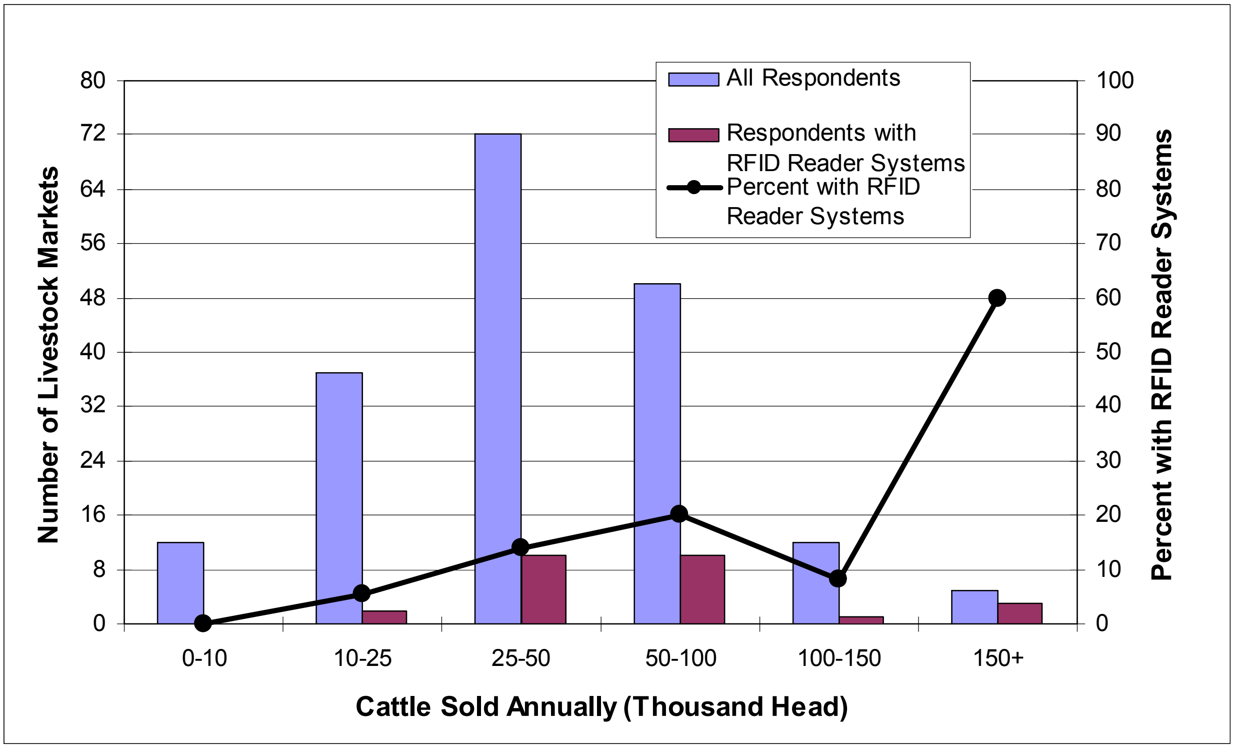
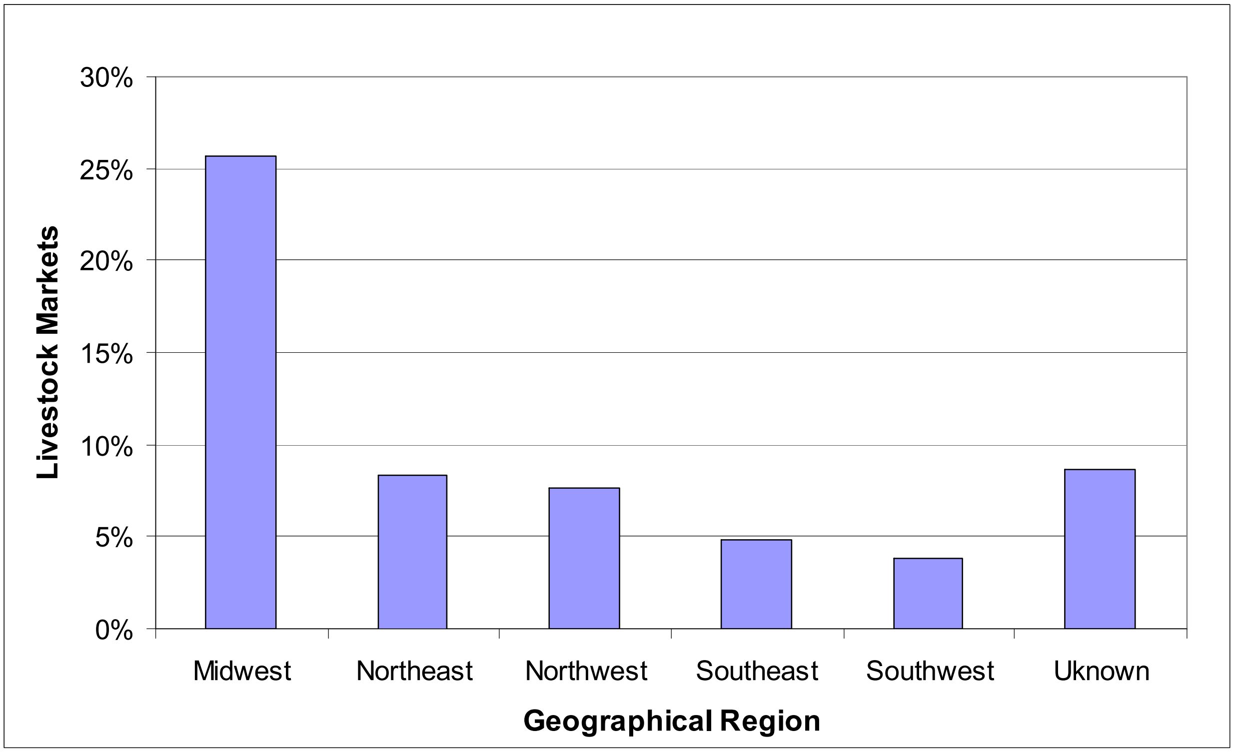


Figure 4.2 shows the percentage of livestock markets in each region that have adopted RFID reader systems. In the Midwest region, 26% of livestock market respondents have adopted RFID technology; whereas less than 10% of respondents in the other regions have adopted RFID technology. Many of the livestock markets from the Midwest region that had RFID readers installed were from Kansas and Michigan. All of the Kansas livestock markets with RFID readers installed participated in a pilot study (Bolte et al., May 2007), in which RFID readers were installed and evaluated in terms of cost and performance. Michigan livestock markets had RFID reader systems installed because the state has a mandatory cattle identification program implemented to facilitate tuberculosis eradication. Thus, the relatively high adoption rate in the Midwest region somewhat overstates the adoption rate in the region as a whole given the circumstances for Kansas and Michigan.

Figure 4.2 Percent of Respondents in Each Region That Have Adopted RFID Technology



4.4 Results

A Binary logit model was used to estimate the parameters in equation (15) to determine how the different explanatory (independent) variables relate to the probability of a livestock market operator adopting RFID technology. Model estimation results are reported in table 4.1. Changes in probabilities associated with a one-unit change in each explanatory variable were calculated and are referred to as marginal probabilities, based on equation (14). Marginal probabilities were calculated based on the average or most common survey respondent responses with respect to a one unit change in each explanatory variable. Binary variables in the model do not have marginal probabilities because they only take on values of one or zero, so the probabilities as binary variables change from 0 to 1 are presented in table 4.1 and were calculated using equation (13). The probabilities associated with changes in the binary variables were calculated by holding all other variables at their average values if a continuous variable or most common response if a binary variable.

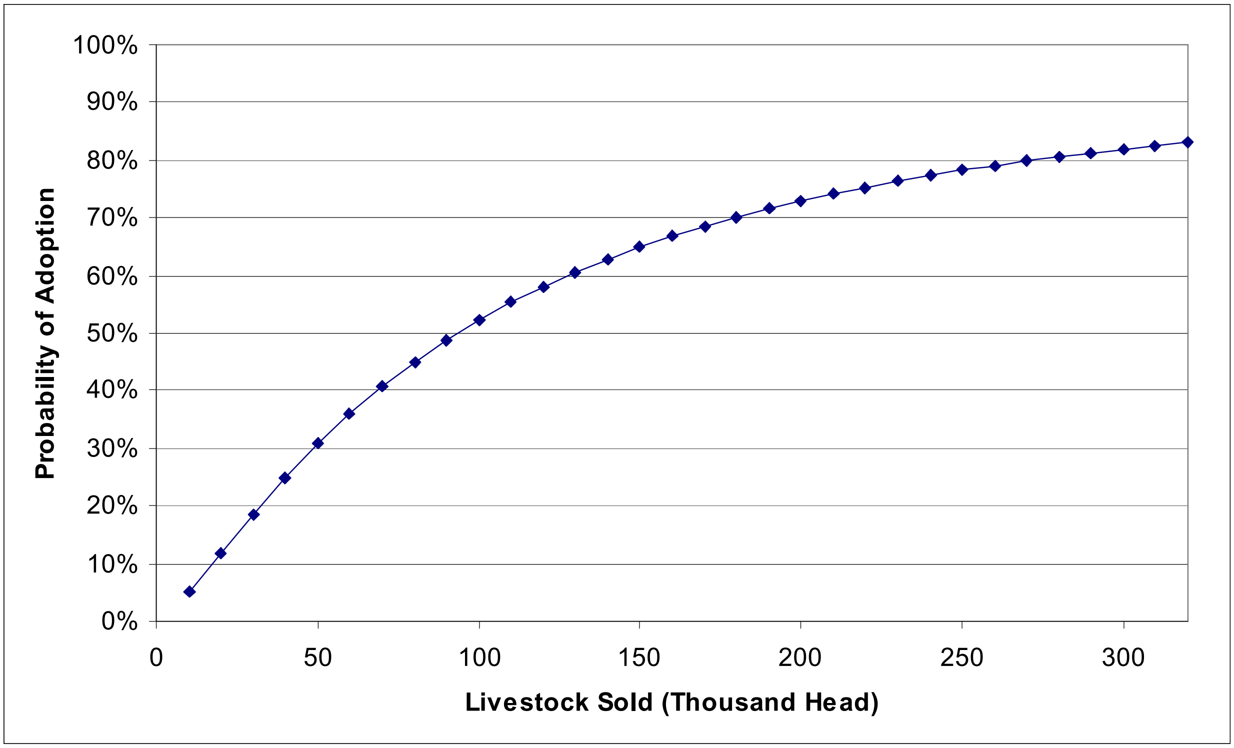
Table 4.1 Binary Logit Estimates for the Probability of RFID Reader Equipment Adoption for a Livestock Market (1 = RFID Adoption, 0 = No RFID Adoption)

Variable	Parameter Estimate	P-Value	0	1
Intercept	-43.461	<.0001	**Probabilities**	
tagging = 1	1.182	0.055	0.732	0.268
tagging = 0	Default		0.899	0.101
premises = 1	27.026	<.0001	0.732	0.270
premises = 0	Default		1.000	0.000
NE	-0.734	0.557	0.851	0.149
SE	-1.414	0.135	0.918	0.082
SW	-1.859	0.109	0.946	0.054
NW	-1.152	0.359	0.896	0.104
Midwest/Unknown	Default		0.732	0.268
			Marginal Probability	
Herfin	-0.003	0.980	-0.001	
Cattid	0.417	0.140	0.082	
ln*(lvstk)*	1.299	0.005	0.255	

Log-Likelihood Function = -43.54311 Number of Observations = 185

Facilities that have registered their premises are 27% probable to have adopted RFID; those that have not registered their premises are 0% probable of RFID adoption. Also, facilities that plan to offer a RFID tagging service in the future are 27% probable of adopting RFID technology; those that do not plan to add a RFID tagging service in the future are only10% probable of RFID adoption. As livestock markets increase in size, the probability of RFID adoption also increases. Figure 4.3 shows that the probability of a livestock market operator adopting RFID technology increases, at a decreasing rate, as livestock market size, as measured by livestock sold annually, increases. A facility that sells 320,000 head of livestock annually has an 83% probability of adopting RFID technology; however, a facility that sells only 10,000 head of livestock annually has only a 5% probability of adopting this technology. Other items, such as species concentration and geographical region were found to not influence RFID technology adoption among livestock market operators.

Figure 4.3 Probability of a Livestock Market Adopting a RFID Reader System



4.5 Conclusions and Implications

A small percentage of livestock market respondents have adopted RFID technology. A binary logit model was used to determine systematic characteristics of auction markets that have adopted RFID technology. Facilities where premises are registered are more likely to adopt RFID technology than facilities that have not registered their premises. Large-volume markets are more likely to adopt RFID reader systems than small-volume markets. Also, facilities that plan to offer a RFID tagging service in the future are more likely to adopt RFID technology than facilities not planning to add a RFID tagging service. In the future, there may be more differences in the types of customers and cattle that will attend different livestock markets. Producers of cattle in certification programs that require electronic individual animal identification, source, and/or age verification will most likely be attracted to facilities that provide RFID reader systems.

CHAPTER 5 - RFID and Tagging Service Investments

This section reviews capital outlays (investments) and annual expenses livestock market respondents expect to incur if they were to offer cattle RFID tagging services to their customers. In addition, the necessary investment and annual expenses associated with adopting electronic animal identification reader systems in livestock auction markets are estimated. Annual average total costs and cost functions are formulated for both investments and economies of scale are evaluated.

Based on conversations with livestock market managers, some are concerned that producers will not participate in the NAIS or marketing programs that use RFID technology even if the auction market installed RFID reader systems. As such, these managers deem the purchase of RFID equipment as an unnecessary expense for equipment that may have little or no use. This concern has likely increased with the NAIS becoming explicitly voluntary. Also, some market operators are concerned that producers will expect livestock markets to offer tagging services if RFID equipment is available for use. Many livestock market operators are also concerned about the investment required to adopt an electronic animal identification system and how this investment would affect their businesses. All of the livestock markets surveyed that had adopted electronic animal identification systems used RFID technology.

5.1 Previous Research

There has been little to no research on the costs of RFID technology adoption for livestock auction markets. However, there has been research conducted on the presence of economies of size in the livestock auction market industry. RFID is a new technology to the agriculture industry similar to the introduction of precision agriculture technology or the no-till drill in farming. Research on other new technologies can reveal what may occur with a new technology in the livestock auction market industry.

McLemore, Whipple, and Spielman evaluated economies of size in the Tennessee livestock auction market industry. The frontier function and ordinary least squares (OLS) methods were used to estimate the long run average total cost (LRATC) function. The two methods were used and outcomes compared to determine the optimum approach. The frontier function estimate of the LRATC used an envelope curve fitted below the points in a scatter plot of average total costs versus volume. The OLS estimate of the LRATC fitted a curve lying near the means of the average total costs for each volume size.

The study used accounting records from the Packers and Stockyards Administration Form 130 from 1978 and 1980 to determine actual average total costs for Tennessee livestock markets. Both methods found evidence of economies of size in the Tennessee livestock market industry. However, the two functions suggested different LRATC curves. The OLS method found substantial economies of size as output level increased, up to large volumes of output. The frontier function estimate revealed economies of size to be important only at small output levels. The researchers determined the OLS estimate is an appropriate approach for estimating short run average costs. Whereas, the frontier function approach provides a more theoretical LRATC curve, since it is associated with the envelope theorem, but the estimated error may be more probable of producing a mis-estimation of the LRATC function in a few observations. The article also pointed out other studies that found economies of size in livestock auction markets (Wootan and McNeely; Grinnell and Shuffett; Grimes and Cramer; Wilson and Kuehn).

Gandonou and Dillon studied the financial risk of adopting precision agriculture among farmers. The researchers point out there are many ways to reduce farming risks; primarily, crop insurance, debt reduction, diversification, forward contracts, and the continuous adoption of new and more efficient technologies. Precision agriculture is a technology that can be adopted among farmers to better control the production process. This study's objective was to determine the financial risk related to investment of precision agriculture of a hypothetical farm in Henderson County, Kentucky that produced corn and soybeans. A mathematical programming model was used to model the production environment and three different precision farming scenarios. The first scenario forced the farmer to invest in precision agriculture equipment and was not allowed to irrigate. The second, made the farmer invest in irrigation technology and not precision agriculture. The last scenario allowed the producer to invest in both technologies. Producer's net worth and debt was highest in the last scenario. The study's results were that investment in precision agriculture and/or irrigation improved the farm's financial situation.

Epplin et al. estimated production costs and economies of size of conventional tillage versus no-till wheat production in Northwest Oklahoma. In the Prairie Gateway (most of the

Southern Great Plains) less than three percent of wheat farms used no-till production methods (Ali, 2002). Earlier studies determined the reduction in tillage costs did not offset the increase in herbicide costs when using no-till. However, there has been a significant price decrease in the cost of the herbicide, glyphosate, used in conjunction with no-till. Economies of size in average machinery investments were evident across a range of farm sizes when no-till was used. The reduced price of the herbicide has improved the economics of no-till relative to conventional tillage methods.

Since economies of size were evident in livestock auction markets in other studies it is probable that economies of size may be related to RFID tagging service investments and/or RFID technology adoption among livestock markets as well. Commonly a new technology, such as no-till farming and precision agriculture carry financial risk; such is the case for RFID tagging service and RFID technology investments in livestock markets. However, over time these new technologies often are financially beneficial to businesses.

5.2 Tagging Service Investment

5.2.1 Empirical Model

This analysis determines the investments livestock auction markets offering a RFID tagging service to customers may experience. Livestock market respondents indicating they would provide tagging services were asked to estimate the required investment, annual expenses, and expected use of the service. The investment is a "one-time" capital outlay that included things such as a squeeze chute, new pens, etc. The additional annual expenses included things such as operating labor. Expected use is the number of livestock expected to use the new tagging service annually. Other potentially important costs of a RFID tagging service, such as costs of animal shrink and increased risk of animal and employee injury, could not be calculated with the available data.

An empirical representation of the model is given in equation 16 (Olsen, 2004):

$$(16) \quad Y_i = \frac{\left[\dfrac{rA_i}{1-(1+r)^{-N}}\right] + B_i}{C_i},$$

where the subscript *i* refers to individual livestock markets, *Y* is the estimated annualized average total cost of offering a RFID tagging service (based on data provided from livestock market respondents), *A* is the estimated total investment cost, *B* is the estimated annual expense, *C* is the expected annual livestock use (head of livestock), *r* is the annual interest rate, and *N* is the useful life of the investment in years.

A trend line was formulated as a function generalizing the annualized average total costs of offering a RFID tagging service across livestock market size. The trend line is estimated to allow greater economies of scale up to a certain size of operation and to have constant economies of scale for firms beyond size *d* where *d* is a parameter to be estimated. The generalized cost function was estimated using the following two-regime switching regression:

$$(17)\quad \begin{aligned} Y_i &= \beta_0 + \beta_1 \ln(C_i) + e_i \quad C < d \\ &= \alpha_0 + e_i \quad C \geq d \\ &\textit{subject to}: \\ &\beta_0 + \beta_1 \ln(C_i) = \alpha_0 \ \textit{when}\ C = d \end{aligned},$$

where *Y* is $\beta_0 + \beta_1 \ln(C_i)$ or α_0, *C* is the number of head that use the service, *d* is the number of head at which the regression regime switches from greater economies of scale to constant economies of scale, and *e* is the error and parameters β_0, β_1, and α_0 were estimated by minimizing the sum of errors squared:

$$(18)\quad \textit{MINIMIZE} \sum (e_i)^2 = \sum \left[\hat{Y}_i - Y_i \right]^2 .$$

Other functional forms were evaluated to discover the optimum generalized cost function. However, the above non-linear functional form was chosen as it allows for diminishing costs per head as livestock market size increases up to a certain livestock market size and the functional form does not allow predicted tagging service costs to become negative. Other functional forms evaluated included:

$$(19)\quad Y_i = \beta_0 + \beta_1 C_i + e_i \ \text{(Linear)}$$

$$(20)\quad Y_i = \beta_0 + \beta_1 C_i + \beta_2 C_i^2 + e_i \ \text{(Quadratic)}$$

(21) $Y_i = \beta_0 + \beta_1 \ln(C_i) + e_i$ (Semi-log)

(22) $Y_i = \beta_0 C_i^{-\beta_1} + e_i$ (Power)

Equation 17 offered the function with the highest R-squared value and did not allow tagging costs to become negative. All variables are defined in table 5.1 and summary statistics of the variables are reported in tables 5.2 and 5.3.

Table 5.1 Variable Definitions of Empirical Model Describing Cost of Offering a RFID Tagging Service

Variable	Definition
Y	Annualized average total cost estimate of offering a RFID tagging service, based on data provided from livestock market respondents.
$\hat{Y}_i$	Predicted annualized average total cost of offering a RFID tagging service.
A	Estimated investment needed to offer a RFID tagging service.
B	Estimated annual expense of offering a RFID tagging service.
C	Expected number of livestock that will use the RFID tagging service.
N	Useful life of the investment (years).
r	Annual interest rate applied to the investment.
e	Random error
β,α	Parameters to be estimated through the modeling procedure.

Table 5.2 Summary Statistics of Variables Used in Empirical Model Describing Cost of Offering a RFID Tagging Service[1]

Variable	Mean	Maximum	Minimum	Standard Deviation
A	$43,651	$500,000	$0.00	$77,154
B	$28,138	$200,000	$0.00	$31,195
C	23,130	128,930	200	21,615

[1] One outlier removed from summary statistics.

Table 5.3 Summary Statistics of Estimated Annualized Average Total Cost of Offering a RFID Tagging Service[1]

Variable	Mean	Maximum	Minimum	Standard Deviation
Y [2]	$3.21/head	$61.49/head	$0.00/head	$7.93/head
Y [3]	$3.39/head	$61.99/head	$0.00/head	$8.16/head

[1] One outlier removed from summary statistics.
[2] *Y* evaluated at an 8% interest rate and 10 year useful life per head of livestock expected to use the tagging service. Value determined by using the equation (16) definition of *Y*.
[3] *Y* evaluated at a 15% interest rate and 10 year useful life per head of livestock expected to use the tagging service. Value determined by using the equation (16) definition of *Y*.

5.2.2 Data

The data used in this analysis were from a national survey of livestock market operators. The data collected from the survey are summarized in chapter 2. A section of the survey asked livestock markets if they would offer a RFID tagging service when NAIS is fully implemented and questions relating to offering the service. When the survey was constructed the authors envisioned the statement of the NAIS being “fully implemented” in the survey instrument to refer to mandatory NAIS at the federal level. However, during the time the surveys were mailed to the livestock market operators, USDA announced that the NAIS would remain voluntary (at the federal level). Therefore, some livestock market survey respondents may have perceived the NAIS being “fully implemented” as a federal mandatory program while others may have perceived “fully implemented” as a voluntary NAIS. Therefore, the term “fully implemented” could have been interpreted by livestock market respondents differently.

Fifty-five percent of livestock auction market managers stated they would provide a RFID tagging service for customers if the NAIS were fully implemented (figure 5.1). There was variation in the responses pertaining to adding a tagging service based on region. Table 5.4

shows that most livestock market respondents from the Northeast and Northwest regions plan to add a tagging service at their facilities if the NAIS were fully implemented. These two regions also exhibited the least "uncertain" responses. In the Midwest, Southeast, Southwest, and Unknown regions about half of livestock market respondents would add a tagging service at their location if the NAIS were fully implemented.

Figure 5.1 Livestock Market Operators Response to the Question: When the NAIS becomes fully implemented will this facility provide a tagging service for customers, providing them an alternative to tagging on their farm/ranch?

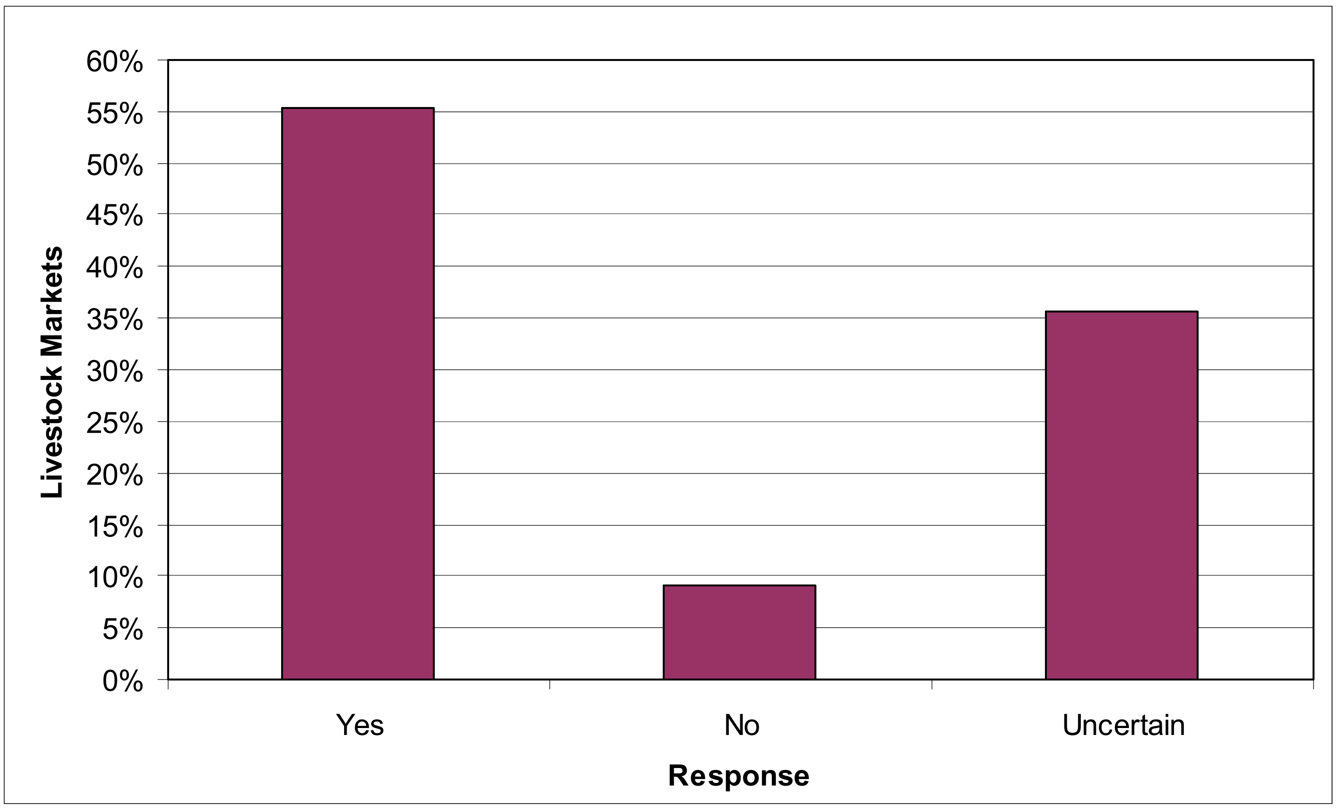


Table 5.4 Tagging Service Addition Based on Geographical Region Among Survey Respondents

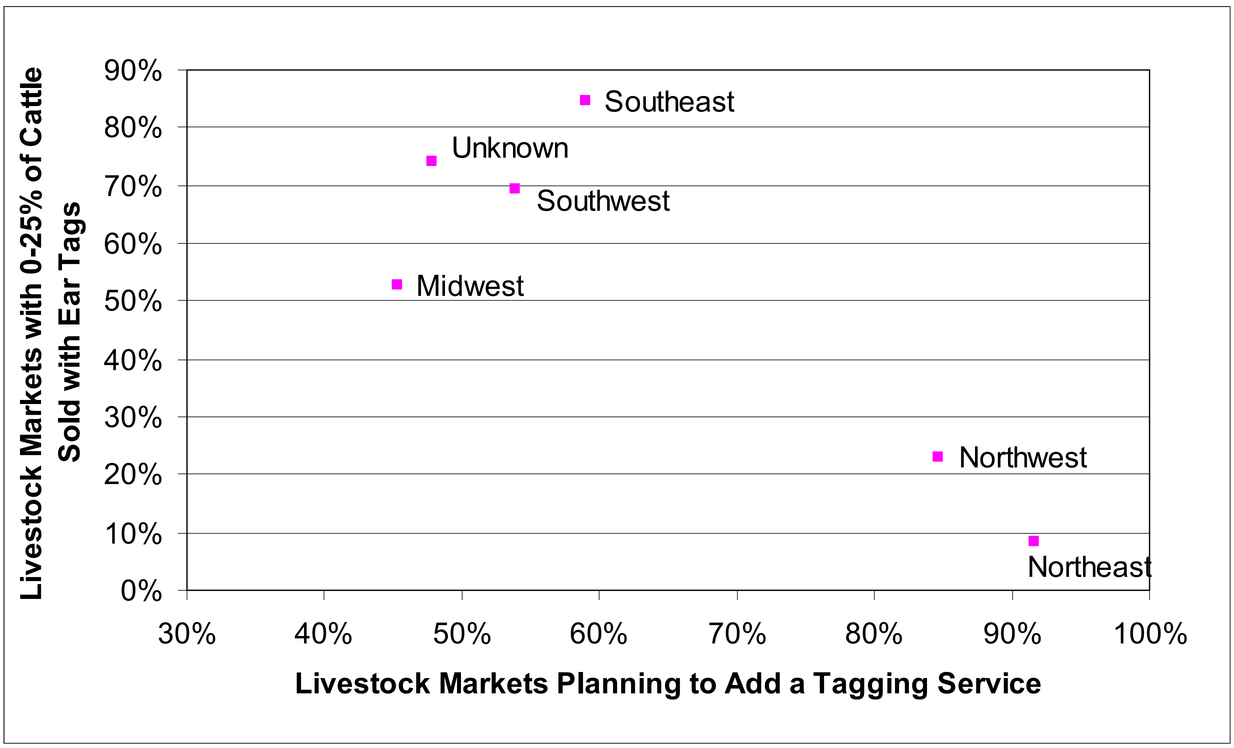
	Geographical Region					
	Midwest	Northeast	Northwest	Southeast	Southwest	Unknown
Would add a tagging service	45.3%	91.7%	84.6%	59.0%	53.9%	47.8%
Would not add a tagging service	8.0%	0.0%	0.0%	10.3%	15.4%	13.0%
Uncertain	46.7%	8.3%	15.4%	30.8%	30.8%	39.1%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

In regions where fewer cattle were sold with ear tags (e.g., number tag, RFID tag, etc.) more livestock markets would be expected to offer tagging services. This was expected because if producers currently do not tag their cattle, then most likely they would not be capable or want to RFID tag their livestock if the NAIS became fully implemented. Thus, if participation through RFID tagging occurred, the livestock market could step in and offer tagging services. Table 5.5 shows the percentage of cattle sold with any type of ear tag by region. In the Northeast and Northwest regions usually greater than 25% of cattle are sold with some sort of ear tag; whereas, in the other regions usually less than 26% of cattle are sold with ear tags. The relationship between cattle sold with ear tags and tagging service addition is illustrated in figure 5.2. In the Midwest, about 53% of markets currently sell 0-25% of cattle with ear tags and 45% of Midwest auction markets would plan to add a tagging service. Livestock markets in regions where fewer cattle currently are tagged at the time of sale (Midwest, Southeast, Southwest, Unknown) are less likely to add a tagging service than livestock markets in regions where more cattle are sold that are tagged at the time of sale (Northeast and Northwest). This finding is contradictory to what was expected and points to a possible barrier to adoption (i.e., producers do not currently tag cattle and livestock markets do not plan on adding a tagging service).

Table 5.5 Percent of Cattle Sold with Ear Tags by Geographical Region Among Survey Respondents

Percent of Cattle sold with ear tags	Geographical Region					
	Midwest	Northeast	Northwest	Southeast	Southwest	Unknown
0-25%	52.7%	8.3%	23.1%	84.6%	69.2%	73.9%
26-50%	23.0%	33.3%	30.8%	10.3%	19.2%	0.0%
51-75%	13.5%	33.3%	23.1%	2.6%	3.9%	13.0%
76-100%	10.8%	25.0%	23.1%	2.6%	7.7%	13.0%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

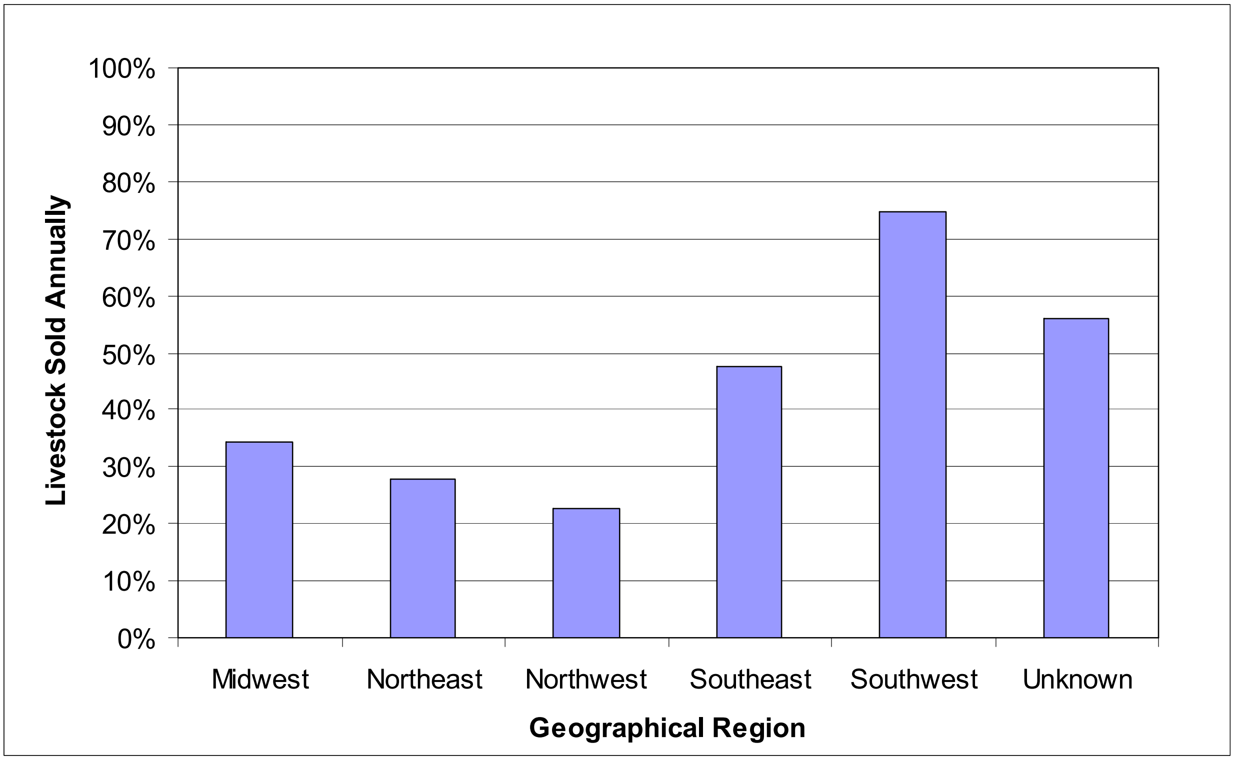
Figure 5.2 Relationship Between Percentage of Livestock Markets Selling 0-25% of Cattle with Identification Ear Tags and Percentage of Markets in the Region Planning to Add a Tagging Service When NAIS is Fully Implemented



Among livestock markets that plan to add a tagging service for their customers if the NAIS were implemented, 85% plan to charge additional fees for this service. None of the livestock market respondents surveyed specifically indicated they would not charge an added fee for this additional service, but 15% of the livestock market respondents were uncertain as to whether or not they would charge added fees. Of those reporting they would charge an additional fee for tagging livestock, the average expected fee reported was $3.34 per head (excluding the cost of the RFID tag). The maximum a livestock market anticipated charging was $20.00 per head and the minimum was $1.00 per head.

Livestock market respondents were asked to estimate the number of livestock they expected would use a RFID tagging service if the NAIS were fully implemented. On average, livestock market operators expect 23,130 head of livestock to use the service annually. However the responses ranged from 200 to 128,930 head annually (Table 5.2). Figure 5.3 depicts the responses in terms of the percentage of livestock sold annually that would be expected to use a tagging service offered by livestock markets by region. Livestock markets in the Southwest expect the highest percent of livestock sold would use a tagging service. The lowest expectations for using a tagging service were in the Northwest and the Northeast where only 23% and 28%, respectively, of livestock were expected to use the service. The Northwest and Northeast regions are where most livestock market managers planned to add a tagging service, even though only 23% and 28% of livestock would use the service. One reason for the lower expected use is because a higher percentage of cattle currently are already being tagged in these regions by producers themselves.

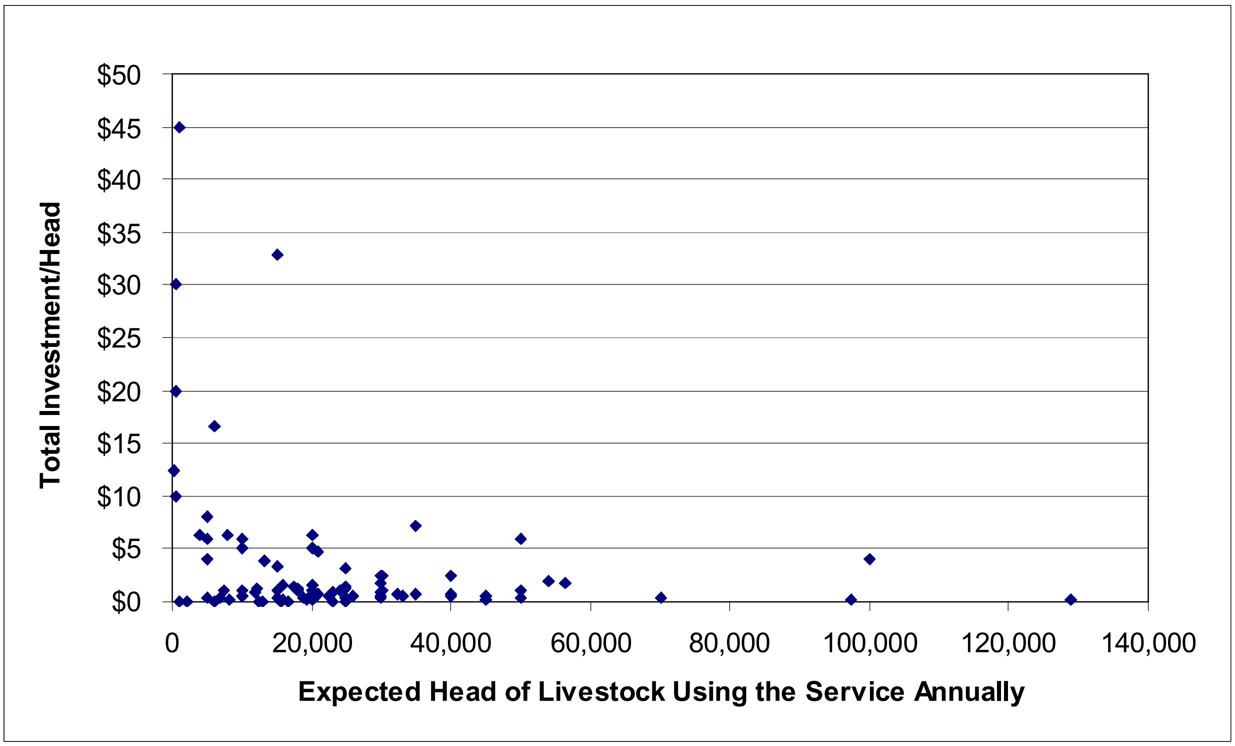
Figure 5.3 Percent of Livestock Sold Annually that are Expected to Use the Tagging Service by Region, Among Survey Respondents



A concern of livestock market operators when adding a tagging service is who would carry out this service, if it were added. Many livestock market managers have difficulty finding employees and thus were concerned about being able to find employees to perform this service. Eighty-three percent of livestock market operators would plan to use facility employees, 12% would use a third party to implement the service, and 5% were uncertain. A possible third party choice could be a local veterinarian or this could be an opportunity for startup businesses to provide custom tagging services.

Respondents were asked to estimate the annual expenses of offering a tagging service. On average, livestock markets expect to spend $28,138 annually on operating expenses and expect to invest $43,651 to set-up a tagging service (table 5.2). Most livestock markets expect the investment in a tagging service to be under $10 per head of livestock that would use the service (figure 5.4). Six of the livestock market respondents expected the investment to be over $10 per head. One livestock market operator estimated a tagging service addition at their facility would require an investment of $325 per head of livestock using the system. This market estimated that only 200 head of livestock would use a tagging service but that they would need to invest $65,000 to set-up a tagging service. The investment for this livestock market was deemed unrealistic and considered to be an outlier, thus it was excluded from figure 5.4 and removed from the analysis.

Figure 5.4 Total Investment per Head of Livestock Annually Using Tagging Service



5.2.3 Results

The empirical model used equations 16, 17, and 18 to determine the annualized average total cost estimate of offering a RFID tagging service to livestock market customers and a function outlining the average predicted annualized total cost of offering a RFID tagging service across livestock market sizes. Annualized cost estimates of RFID tagging services were calculated by amortizing the required investment over a 10-year period at interest rates of 8% and 15%. The annual expenses of adding a tagging service were added to this amortized value to arrive at an annual cost associated with adding a tagging service. An 8% interest rate was used to reflect the cost of borrowing money for an operating loan and the 15% interest rate was used to reflect the cost of borrowing money for an operating loan plus the cost of making a risky investment. In a few cases, expected use was not provided by the livestock market respondent, so 45% of annual livestock sales was used which was the average of what other livestock market operators reported. At the end of the useful life, the assumed salvage value was zero on all of the investment (i.e., they were completely depreciated from an economic standpoint).

The annualized average total cost estimates using the 8% interest rate averaged $3.21 per head of livestock expected to use the service and ranged from $0.00 to $61.49 per head (figure 5.5). The annualized average total cost estimates using the 15% rate averaged $3.39 per head and ranged from $0.00 to $61.99 per head. If the two livestock markets with the largest annualized average total cost estimates were removed from the data set the average cost per head of livestock expected to use the service would be $2.19 at the 8% interest rate and $2.34 at the 15% interest rate. The range in costs would be $0.00 to $21.19 per head for the 8% interest rate and $0.00 to $21.59 per head for the 15% interest rate. Annual cost estimates changed little with interest rates because the annual expense (i.e., operating labor) represents a much larger portion of the annual cost estimate than does the annualized investment amount.

The generalized cost function in figure 5.5 was formulated using equation 17. The predicted equation is:

$$
\begin{aligned}
&Y_i = 45.089 - 4.650\ln(C_i)\ \textit{when}\ \ C < 11{,}755 \\
&\quad = 1.508\ \textit{when}\ \ C \geq 11{,}755 \\
&\textit{subject to}: \\
&45.089 - 4.650\ln(C_i) = 1.508\ \textit{when}\ C = 11{,}755
\end{aligned}
\qquad (23)
$$

where C is the number of livestock expected to use the RFID tagging service annually. The predicted value of Y is $45.089 - 4.650\ln(C_i)$ when C is less than 11,755 head and Y is 1.508 when C is greater than or equal to 11,755 head. As expected, predicted average annual total costs of a tagging service decrease as livestock use increases up to 11,755 head. When 11,755 head of livestock or more use the service the predicted average annual total costs become constant at $1.51 per head. The R-square value for this equation was 0.274, the highest value among the functional forms tested.

In figure 5.5, economies of size are shown by a rapid decrease and flattening in the predicted average annualized total cost curve as usage of the service increases. This means that livestock markets with larger volumes of livestock using the tagging service will have a competitive advantage over livestock markets with fewer livestock using the service. However, many livestock markets using the tagging service on less than 11,755 head had cost estimates below $5 per head indicating that smaller livestock markets can compete economically with a tagging service. The expected annualized cost estimate was less than $5.00 per head for most (90%) livestock markets (figure 5.6).

Figure 5.5 Annualized Cost per Head of Livestock Using the Tagging Service (8% Return)

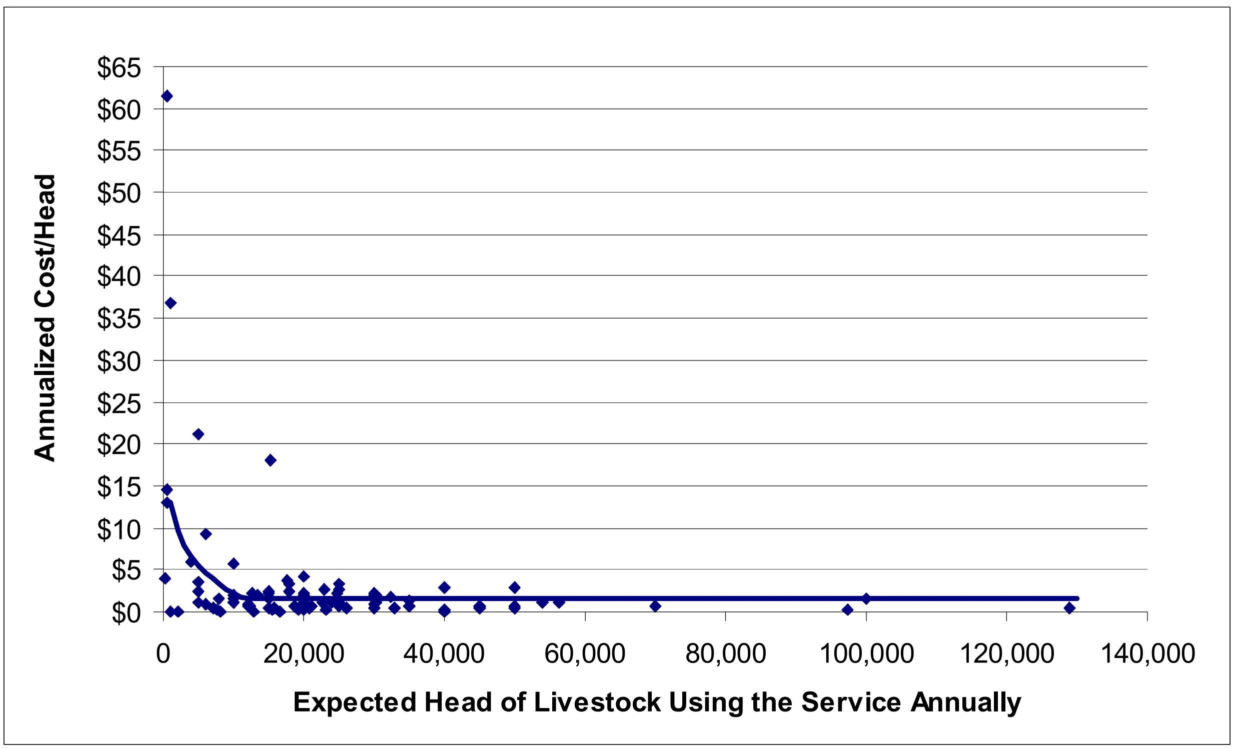
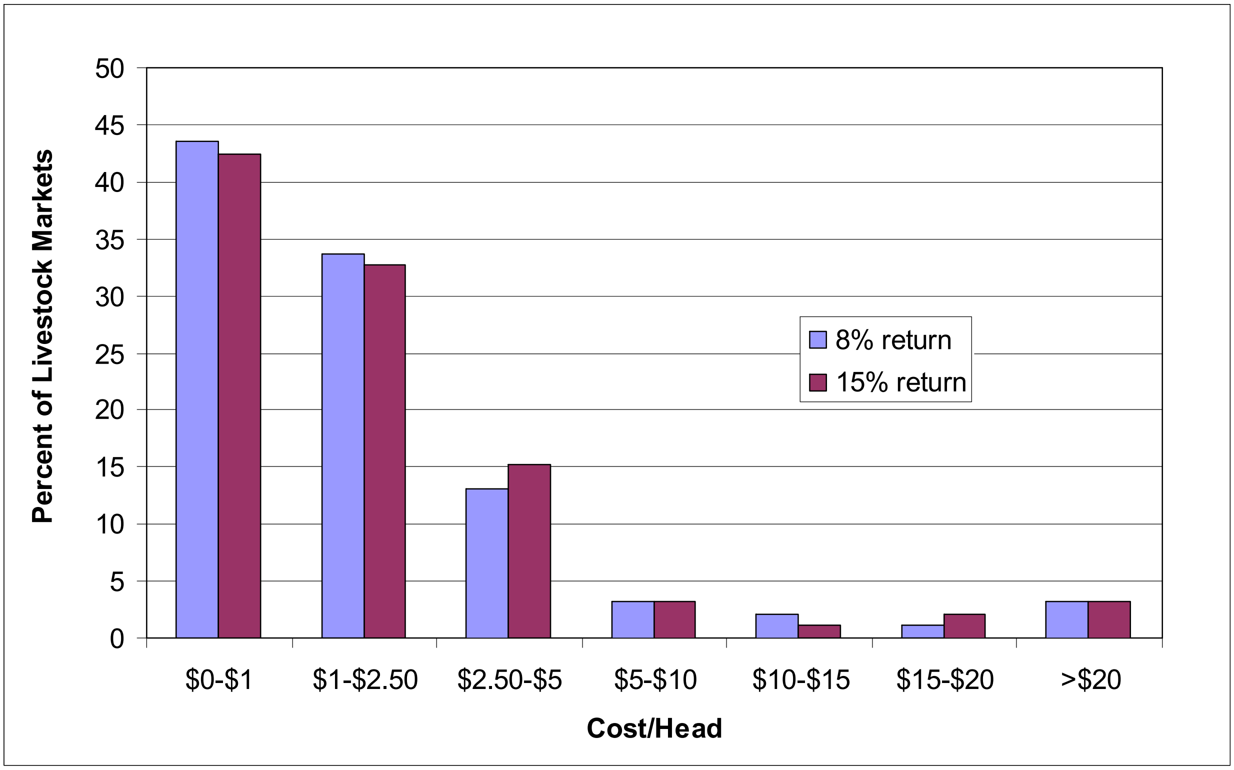


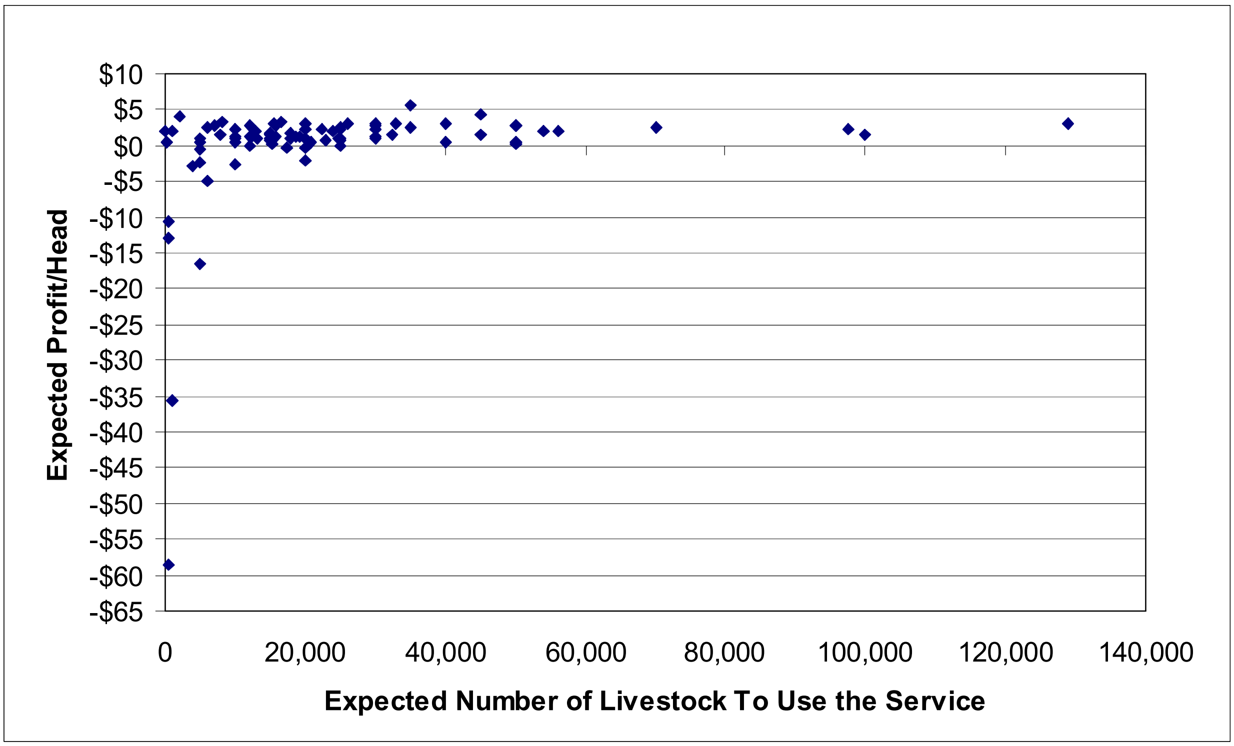
Figure 5.6 Annualized Cost Estimate per Head of Livestock Using the Tagging Service



The points along the average annualized total cost curve could be the fee livestock markets charge customers for a tagging service plus the cost of the RFID tag. When livestock market respondents were asked how much they would charge for a tagging service the average response was $3.34 per head, which is almost exactly equal to the average annual cost estimates, indicating livestock market managers would simply pass the cost of the additional service on to customers rather than trying to make this a profit center. However, if livestock markets only charge $3-$5 per head for RFID tagging when it cost them more (10% had cost estimates greater than $5 per head) they would lose money on this service.

When comparing the average annualized cost estimate per head using the 15% interest rate to what the livestock markets reported they would charge for the service, 15% of livestock markets surveyed would lose money on this service (figure 5.7) assuming the service did not increase volume by attracting new customers to the auction market. On average, livestock markets would lose $0.05 per head, including five livestock markets that would lose more than $10 per head. If a livestock market indicated that they did not know how much they would charge for a tagging service, the average $3.34 per head was used to figure profits or losses. Livestock markets that choose to provide a tagging service for their customers should consider the annualized costs associated with the service, the possible increase in customers, and what competitors charge when determining how much to charge for their service.

Figure 5.7 Expected Profit per Head for Livestock Auction Markets Offering a RFID Tagging Service by Number of Cattle Using the Service (15% Return)



5.3 RFID Investment

5.3.1 Empirical Model

This analysis determined the investments and estimated annual expenses associated with adopting electronic animal identification systems in livestock auction markets. Livestock market respondents that had installed RFID reader systems were asked to estimate the investments necessary to make their RFID readers system operational. Investments included the cost of the RFID technology, computers and software, and facility modifications. The total dollars required to get a RFID system in place does not represent the cost of technology, but rather reflects the investment required. The annual expenses of the technology are those items that occur on a regular basis and when combined with the annualized investment equals the annual cost. Both investment and annual cost values are relevant to livestock markets. Investment because it represents capital outlay required and annual cost because it represents how profits might be impacted with the adoption of this technology.

The average annual total cost estimate of adopting a RFID reader system, based on Olsen's repayment equation is:

$$(24)\quad Y_i = \frac{\dfrac{rG_i}{1-(1+r)^{-g}} + \dfrac{rH_i}{1-(1+r)^{-h}} + \dfrac{rF_i}{1-(1+r)^{-f}} + B_i(1+r15/365)}{A},$$

where the subscript *i* refers to individual livestock markets and Y_i is the average annual total cost estimate of adopting RFID readers for a livestock auction market. *G* is the total investment in the RFID technology (i.e., RFID readers, installation, and employee training costs), *H* is the total investment in facility modifications, and *F* is the total computer investment (i.e., software, computer, and software upgrade costs). The useful life of each of these investments is *g*, *h*, and *f*, respectively. *B* includes the annual expenses associated with RFID technology (i.e., equipment rental, annual technology fees, and additional labor costs). The operating expenses were assumed to be borrowed for 15 days out of each month. *r* is the annual interest rate and *A* is the head of livestock or cattle sold.

A trend line was formulated as a function generalizing the average annual total cost estimates of adopting RFID readers across different livestock market sizes. The generalized cost function was found using the following equation

(25) $Y_i = \beta_0 A_i^{-\beta_1} + e$,

where β's are parameters to be estimated by minimizing the sum of squared error, *e*.

(26) $MINIMIZE \sum (e_i)^2 = \sum \left[\hat{Y}_i - Y_i \right]^2$.

Other functional forms were evaluated to determine the generalized cost function. However, the above non-linear functional form was chosen as it allows for diminishing costs per head as livestock market size increases and the function does not allow negative predicted RFID costs. Also, the chosen equation offered the highest R-square value. Other functional forms evaluated include:

(27) $Y_i = \beta_0 + \beta_1 A_i + e_i$ (Linear)

(28) $Y_i = \beta_0 + \beta_1 A_i + \beta_2 A_i^2 + e_i$ (Quadratic)

(29) $Y_i = \beta_0 + \beta_1 \ln(A_i) + e_i$ (Semi-log)

(30) $Y_i = \beta_0 \exp(\beta_1 A_i) + e_i$ (Exponential)

(31) $\ln(Y_i) = \beta_0 \ln(A_i) + e_i$ (Log-log)

The linear, quadratic, semi-log, exponential, and log-log functions evaluated all provided R-square values below the R-square value of the power function displayed in equation 25. All variables are defined in table 5.6 and summary statistics of the variables are reported in tables 5.7 and 5.8.

Table 5.6 Variable Definitions for Model Describing Cost of Adopting RFID Technology

Variable	Definition
Y	Annualized average total cost estimate of adopting a RFID reader system, based on data provided from livestock market respondents with functional RFID reader systems.
$\hat{Y}_i$	Predicted annualized average total cost of adopting a RFID reader system.
A	Head of livestock or cattle sold.
B	Estimated annual expenses associated with RFID technology adoption.
G	Estimated investment in RFID reader system. Includes investment in the technology, installation, and employee training.
H	Estimated investment in facility modifications. Includes investment in all facility modifications (labor and materials) made to facility to adopt RFID technology.
F	Estimated investment in computers. Includes investments in computers, software, and software upgrades required for RFID adoption.
g	Useful life of RFID reader system investment (G) (years).
h	Useful life of facility modification investment (H) (years).
f	Useful life of computer investment (F) (years).
r	Annual interest rate applied to the investment.
e	Random error
β's	Parameters to be estimated through the modeling procedure.

Table 5.7 Summary Statistics for Model Describing Cost of Adopting RFID Technology[1]

Variable	Units	Mean	Maximum	Minimum	Standard Deviation
A^2	Head	75,726	275,000	13,000	63,950
B^3	\$/Year	3,263	31,200	0	7,465
G	\$	12,965	60,094	0	13,192
H	\$	2,353	10,250	0	3,314
F	\$	5,505	24,000	0	6,388

[1]Outlier removed from summary statistics, n=25.
[2]Average annual cattle sales among livestock markets with RFID technology in use.
[3]Annual expenses including rental fees which are based on 25% of annual cattle sales using the RFID readers.

Table 5.8 Summary Statistics of Estimated Average Annual Total Cost of Adopting RFID Technology[1]

Variable	Units	Mean	Maximum	Minimum	Standard Deviation
Y^2	\$/Head	0.76	4.02	0.14	0.82
Y^3	\$/Head	0.19	1.01	0.04	0.20
Y^4	\$/Head	0.83	4.15	0.16	0.84
Y^5	\$/Head	0.21	1.04	0.04	0.21

[1]Outlier removed from summary statistics, n=25.
[2]Y when r = 8%, g = 3, h = 6, f = 3, and A = 25% of annual cattle sales. Value determined by using equation (24) definition of Y.
[3]Y when r = 8%, g = 3, h = 6, f = 3, and A = 100% of annual cattle sales. Value determined by using equation (24) definition of Y.
[4]Y when r = 15%, g = 3, h = 6, f = 3, and A = 25% of annual cattle sales. Value determined by using equation (24) definition of Y.
[5]Y when r = 15%, g = 3, h = 6, f = 3, and A = 100% of annual cattle sales. Value determined by using equation (24) definition of Y.

5.3.2 Data

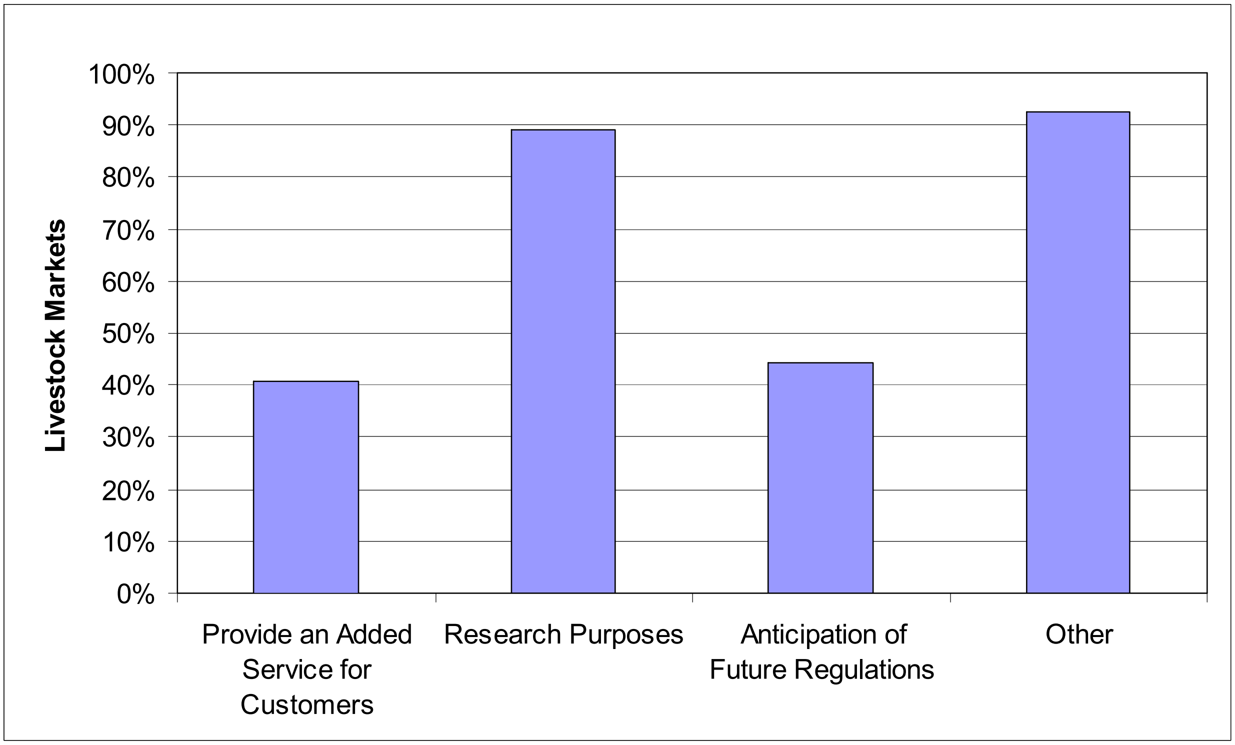
The data used in this analysis were from a national survey of livestock market operators. The data collected from the survey are summarized in chapter 2. A section of the survey asked livestock markets if they had adopted a RFID reader system and the costs of adoption. Twenty-six (14%) survey respondents had installed electronic animal identification systems; data used in this section are from those respondents.

Livestock markets that adopted RFID reader systems ranged in size from 13,000 to 275,000 head of cattle sold annually. Figure 4.1 shows livestock market survey respondents divided by size of facility that have and have not adopted RFID reader systems. No livestock markets that sold less than 10,000 head of cattle annually had adopted RFID technology, and only two (5.4%) livestock markets that sold between 10,000 and 25,000 head annually had RFID systems in place. Of livestock auction markets that sold between 25,000 and 50,0000 and between 50,000 and 100,000 head of cattle annually, only 13.9% (10) and 20% (10), respectively, had installed RFID reading equipment. Among facilities that sold 100,000 to 150,000 head of cattle annually only one (8.3%) facility had adopted this technology and three (60%) had adopted among facilities that sold over 150,000 head of cattle annually.

Twenty-six percent of livestock market respondents from the Midwest region have adopted RFID reader systems and less than 10% of respondents from the other regions have adopted this technology (figure 4.2). Many of the facilities in the Midwest region that had adopted RFID technology were from Kansas or Michigan. All of the Kansas facilities, with RFID readers installed, were participants in a pilot study. This pilot study required RFID readers be installed and evaluated in terms of performance and costs. Michigan livestock markets had RFID reader systems in place because the state has a mandatory cattle identification program implemented to facilitate the eradication of tuberculosis.

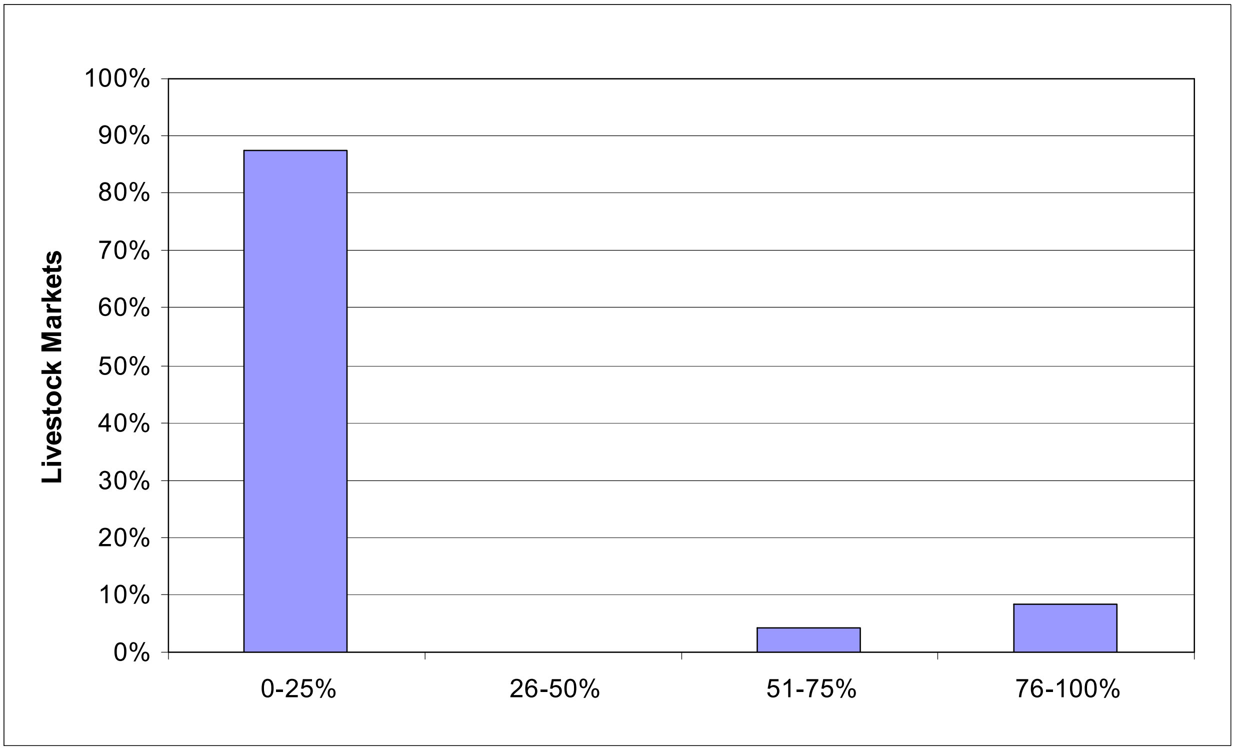
When asked reasons an electronic animal identification reader system was installed, 89% of respondents indicated it was for research purposes. Only 41% claimed they installed a reader system to provide an added service for customers and 44% did so in anticipation of future regulations. Ninety-three percent of the livestock markets identified “other” reasons for why they installed a reader system (figure 5.8). Common responses for “other” reasons included participation in a grant where part of the reader system was paid for, to increase the value of cattle, to couple with a Quality Systems Assessment (QSA) program, or because of a mandatory animal identification program in their state of origin. Almost three-fourths (73%) of livestock markets that adopted electronic reader technology were participants in a grant which paid for part of the costs of adopting an electronic reader system. Perhaps early adopters of RFID technology did so because of the cost-share program.

Figure 5.8 Reason for RFID Technology Installation Among Survey Respondents



Most facilities (88%) indicated 0-25% of cattle sold annually at the facility used the reader systems by being scanned and recorded (figure 5.9). Four percent of the markets indicated using the reader system on 51-75% of cattle sales and 8% of livestock markets scanned and recorded 76-100% of annual cattle sales with the reader system. Livestock markets located in Michigan had 76-100% of cattle sales utilizing the reader systems because individual animal identification for cattle is mandatory in the state.

Figure 5.9 Percent of Cattle Using the RFID Readers Among Survey Respondents



The annualized cost of RFID adoption is the summation of the annualized investments and annual expenses. Items that reflected one-time expenditures are classified as investments in this analysis, this included total RFID equipment investment, total facility modification investment, and total computer investments.[1] Items considered annual expenses included equipment rental, annual technology fees, and operating labor.[2] Other potential costs of RFID, such as the cost of slowing down the speed of a sale, could not be estimated with the data available.

The total RFID equipment investment included the total cost of RFID technology installation and equipment charged to the livestock auction market by the company selling the system to the facility. This investment also included the cost of any labor provided by livestock

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[1] Investment is conditional on the time of purchase. For example, livestock markets that purchased the RFID equipment five years ago may have paid more than livestock markets that adopted RFID technology one year ago because the price of the technology may have decreased over time.

[2] Annual expenses reported are conditional on the number of RFID tagged livestock using the reader system. For example, operating labor costs may increase as RFID tagged cattle sales increase at a livestock market, because more time may be required to read more cattle.

market employees to install the RFID reader system and the cost of employee training. The average cost of total RFID equipment investments was $12,965 among facilities that had adopted RFID technology (Table 5.7).

Total facility modification investments included the cost of contractor labor and materials and the cost of materials and labor supplied by the livestock market to modify the facility in preparation for installment of the RFID reader system. Table 5.7 shows that the average facility modification investment was $2,353.46. The maximum was $10,250.00 and the minimum was $0.00.

Total computer investments included investments in new computers, new software, and upgrades in software made necessary through the adoption of RFID technology. The average livestock market invested $5,505.46 in this category; one facility spent $24,000.00 and seven facilities spent no extra funds on this investment (table 5.7).

Equipment rental fees, increased annual technology fees, and operating labor were included in the annual expenses required for RFID adoption. Equipment rental costs only applied to two livestock markets that rented a RFID reader system. This rental fee was based on a fee per month and a fee per RFID tag reading. The increase in annual technology fees only applied to three livestock markets. This fee was an increase in the annual technology support fees charged to the livestock market by their respective clerking software companies. This increase in technology support fees was due to the installation of a RFID system. Operating labor expenses accounted for the additional labor needed to run a RFID reader system. On average, livestock market respondents spend $3,263.40 annually to run RFID readers systems. One facility spent $31,200.00 and 14 facilities had no operating expenses (table 5.7).

One large outlier in the data set was removed from the analyses. This livestock market estimated their total investment at $2.22 per head of cattle sold annually. This facility's largest capital outlays were associated with computer and software purchases. The entire expense for computer and software purchases should not be completely charged to the RFID reader system if this livestock market integrated the new software and computer into their entire business, not just the RFID reader system. Therefore, this reported RFID investment value was believed to be over-estimated and hence was removed from the analyses.

Total investments ranged from $5,250 to $64,000 and annual cattle sales ranged from 13,000 to 275,000 head among the livestock markets that installed RFID reader systems. Figure

5.10 shows the total investment made by each livestock market that had installed RFID reader systems based on annual livestock sales and figure 5.11 illustrates the total investment per head of livestock sold annually for livestock markets. The smallest investment per head of livestock sold annually was $0.10/head. Figure 5.12 shows the total investment made by each livestock market to purchase a RFID reader system based on annual cattle sales and figure 5.13 shows the total investment per head of cattle sold annually (as opposed to sales of all livestock as was depicted in figures 5.10 and 5.11). The smallest investment per head of cattle sold annually was $0.10 per head. Both figures 5.10 and 5.12 and figures 5.11 and 5.13 are similar, so from this point forward only the "per cattle" analysis will be used. Most of the estimated investment amounts are less than $0.50 per head of cattle or livestock sold annually at the livestock markets. The trend lines in figures 5.10 and 5.12 are linear functions and the trend lines in figures 5.11 and 5.13 are power functions fitted to the data by minimizing the sum of error squared.

Figure 5.10 Livestock Market Total Investments in RFID Reader Systems by Annual Livestock Sales

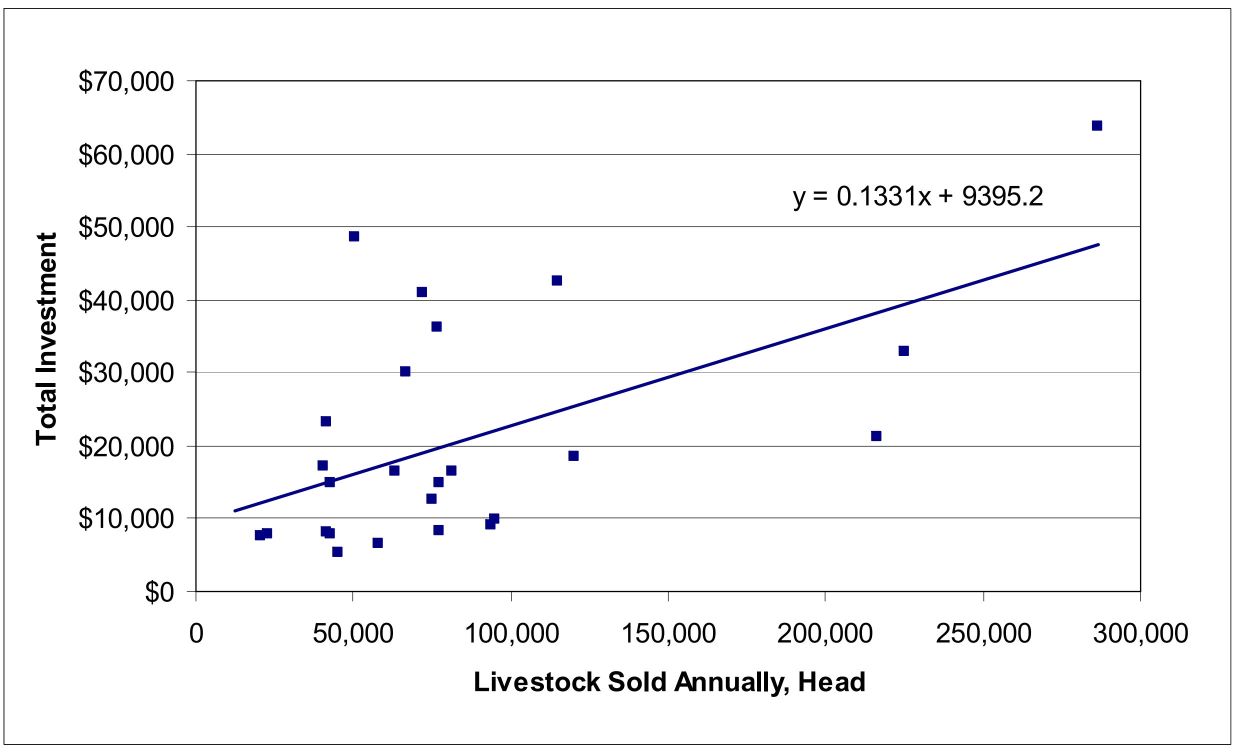


Figure 5.11 Livestock Market Total Investments per Head for RFID Reader Systems by Annual Livestock Sales

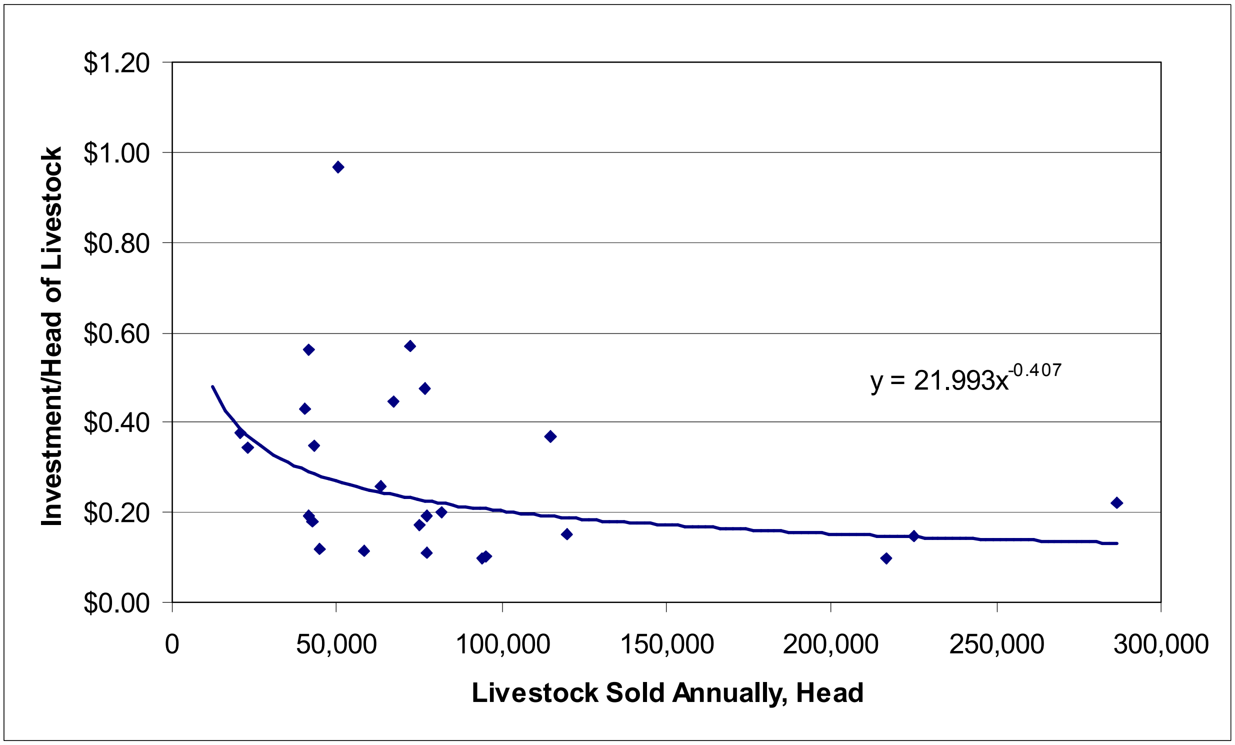


Figure 5.12 Livestock Market Total Investments in RFID Reader Systems by Annual Cattle Sales

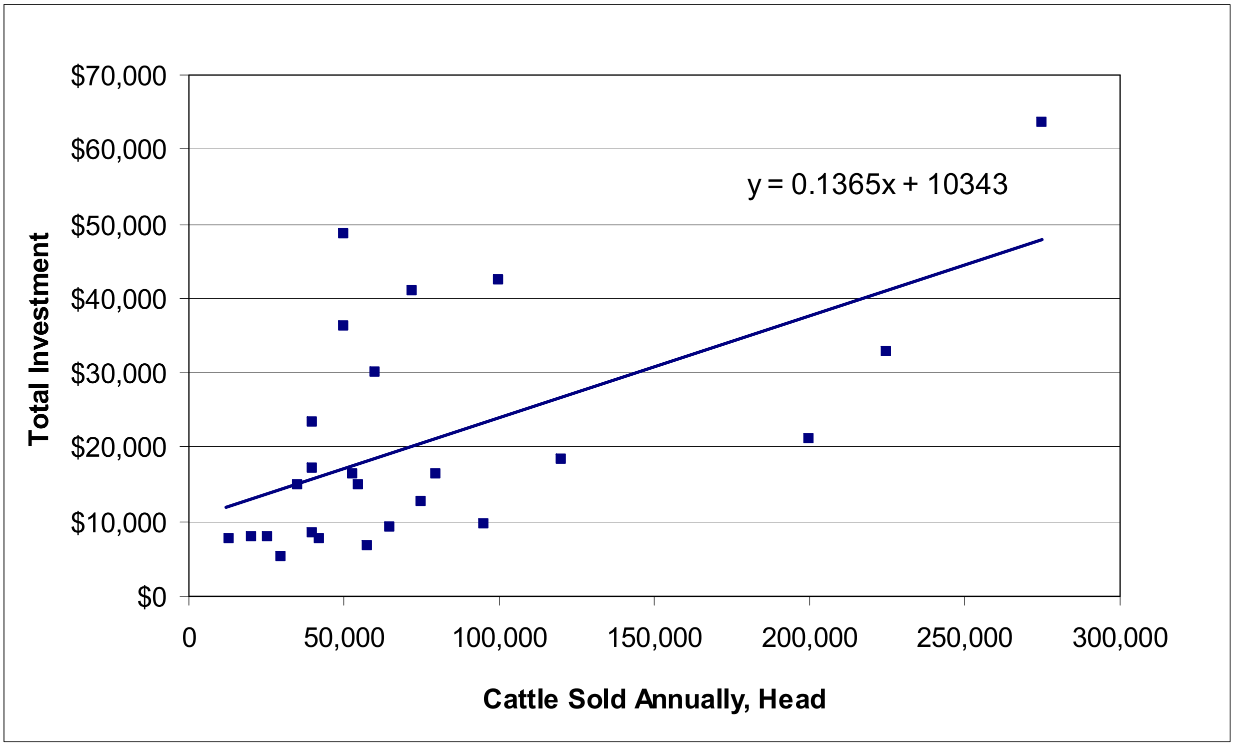
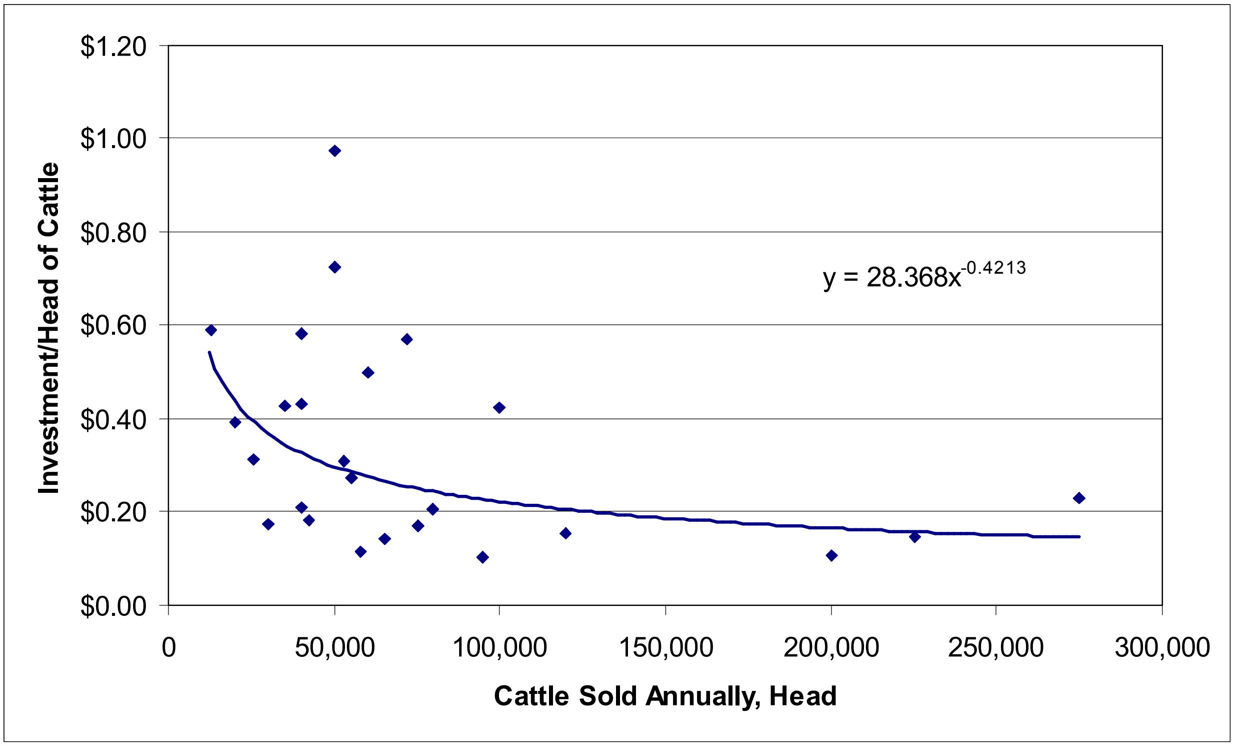


Figure 5.13 Livestock Market Total Investments per Head for RFID Reader Systems by Annual Cattle Sales



Total investment increased among livestock markets as the size of livestock markets increased. For each 1,000 head increase in annual cattle sales, total investment increased by roughly $137, as shown by the "Total Investment" trend line in figure 5.12. However, economies of size are displayed by the "Investment/Head of Cattle" trend line in figure 5.13. That is, as livestock market size increases, the investment per head of cattle decreases at a declining rate and begins to flatten out at about 150,000 head. Consequently larger livestock markets have a lower RFID system investment per head relative to smaller livestock markets.

5.3.3 Results

Annualized cost estimates of RFID reader systems were calculated by annualizing the total investment given an interest rate and number of years the system was expected to be used and adding to the annual expenses. Two rates of return were used, 8% and 15%. The 8% return was used to reflect the cost of borrowing money for an operating loan and the 15% rate was used to reflect a higher desired rate of return to account for risk. The RFID reader system was assumed to have a useful life of 3 years, the facility modifications a life of 6 years, and the computer investments (computer and software) a life of 3 years. Interest was calculated on operating costs, assuming they were borrowed for 15 days each month. It was assumed that at the end of the useful life there was no salvage value on any of the three investment categories (i.e., they were completely depreciated out from an economic standpoint).

Five livestock markets did not include the total cost of the RFID technology in their survey response. In these cases, average costs of livestock markets with similar systems and RFID companies were used. When labor cost per hour for facility modification and installation was not provided the average labor cost, $17.50 per hour, among livestock market managers that responded was used. Labor costs, included the cost of labor by livestock market employees and hired contractors for facility modifications and installation of the electronic reader system.

The annualized cost of RFID reader systems is depicted in figures 5.14 and 5.15 at an 8% return rate for different sized livestock markets. Figure 5.14 shows the annualized cost per head of cattle using the RFID reader system assuming that 25% of the cattle sold annually were using the RFID reader system. The 25% of annual cattle sales was chosen to simulate what may occur if the NAIS remains voluntary. The average annualized cost estimate per head of cattle using the system was $0.76, the maximum was $4.02, and the minimum was $0.14. The annualized cost per head of cattle using the system could be used as an estimate of the expected fee charged, given our assumptions, to owners of cattle that use the RFID reader system at a livestock market.

Figure 5.14 Livestock Market Annualized Costs per Head Based on 25% of Annual Cattle Sales (8% Return) by Head of Cattle using the System Annually

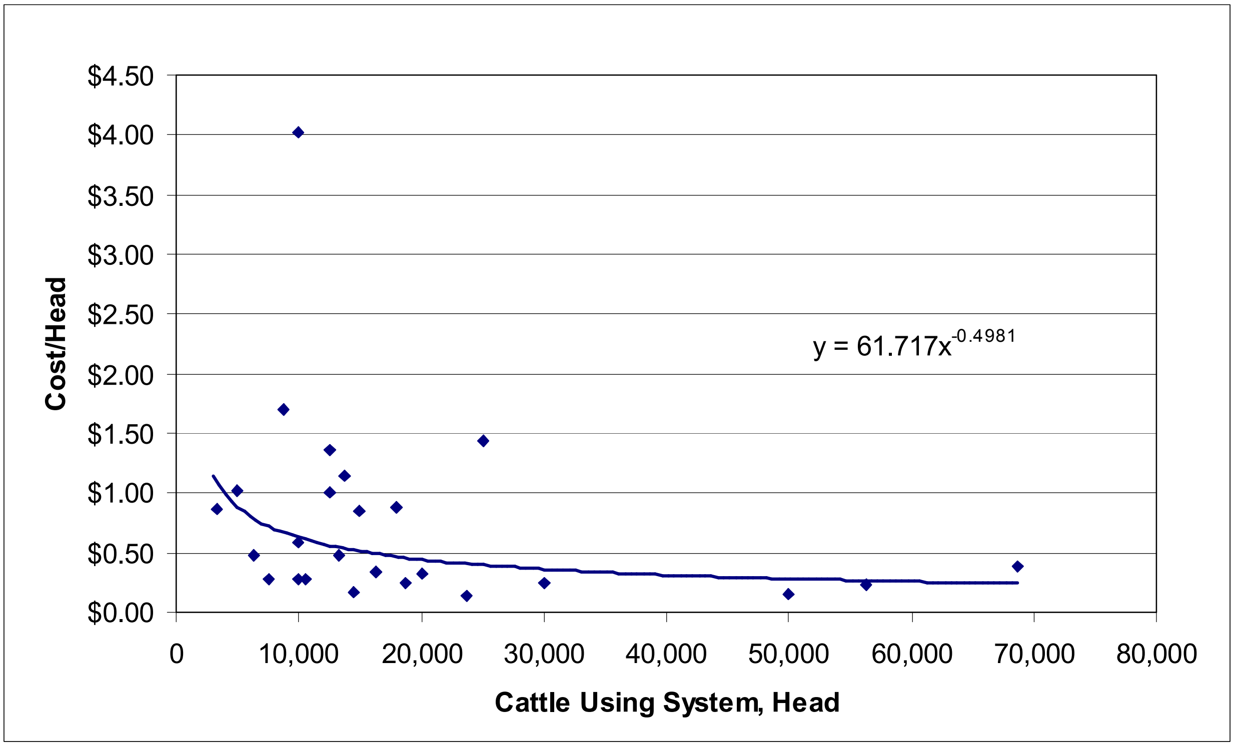
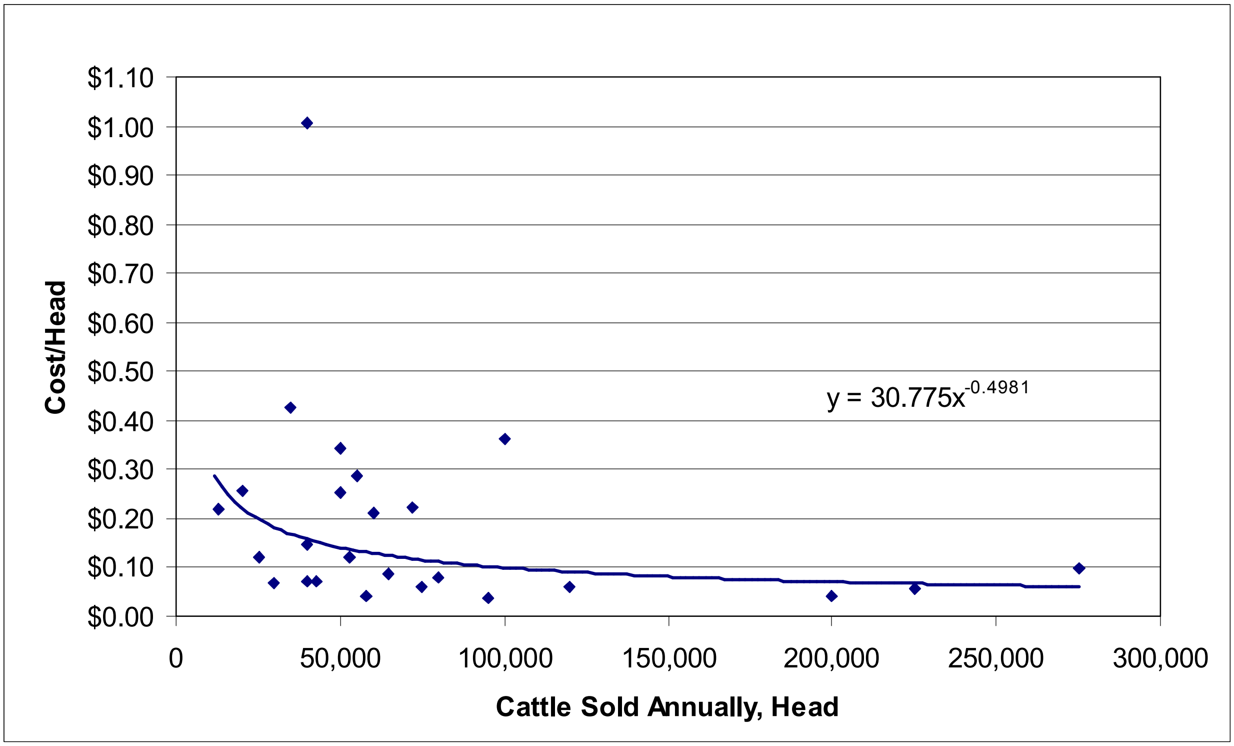


Figure 5.15 shows the annualized cost per head of cattle sold annually, where costs are allocated over 100% of cattle marketed annually. A scenario useful to livestock market operators that may choose to increase commission fees for all cattle sold at their facility after installing a reader system. This scenario also depicts what the cost might be if the NAIS were to become mandatory such that 100% of animals sold through the livestock market used the RFID system. The average annualized cost estimate per head of cattle sold was $0.19, the maximum was $1.01, and the minimum was $0.04. The estimated values in figure 5.15 are one-fourth the values depicted in figure 5.14 because the annual cost estimate was allocated over four times as many animals in this example. The exception to this was for the two livestock markets that were renting equipment and paying a fee per scan. That is, for most livestock markets the cost of owning and operating a RFID reader system is fixed and thus the more head of livestock it can be used on, the lower the cost per head. In figure 5.15 it is clear most of the annualized cost estimates per head of cattle sold fall below $0.30/head.

Figure 5.15 Livestock Market Annualized Costs per Head Based on 100% of Annual Cattle Sales (8% Return) by Head of Cattle using the System Annually



The annualized cost per head, of a RFID reader system, changes if a different rate of return is used. Figures 5.16 and 5.17 show the annualized costs of a RFID reader system by size of market given an interest rate of 15%. Figure 5.16 shows the annualized cost per head of cattle assuming the system was used on 25% of cattle sold annually (i.e., the NAIS remains voluntary – comparable to figure 5.14). On average, the annualized cost estimate was $0.83 per head of cattle using the system, the maximum was $4.15 per head, and the minimum was $0.16 per head. If the annualized cost estimate of the RFID reader system was divided by all of the cattle sold annually, the average annualized cost estimate per head of cattle sold decreased to $0.21 with maximum and minimum values of $1.04 and $0.04 per head, respectively (figure 5.17 – comparable to figure 5.15). As before, the values in figure 5.17 are one-fourth the values of the annualized cost per head of cattle in figure 5.16 because four times as many cattle are being evaluated. Once again, this indicates the economic benefit of allocating the costs over as many head as possible because most of the costs of the RFID system are fixed.

Figure 5.16 Livestock Market Annualized Costs per Head Based on 25% of Annual Cattle Sales (15% Return) by Head of Cattle Using the System Annually

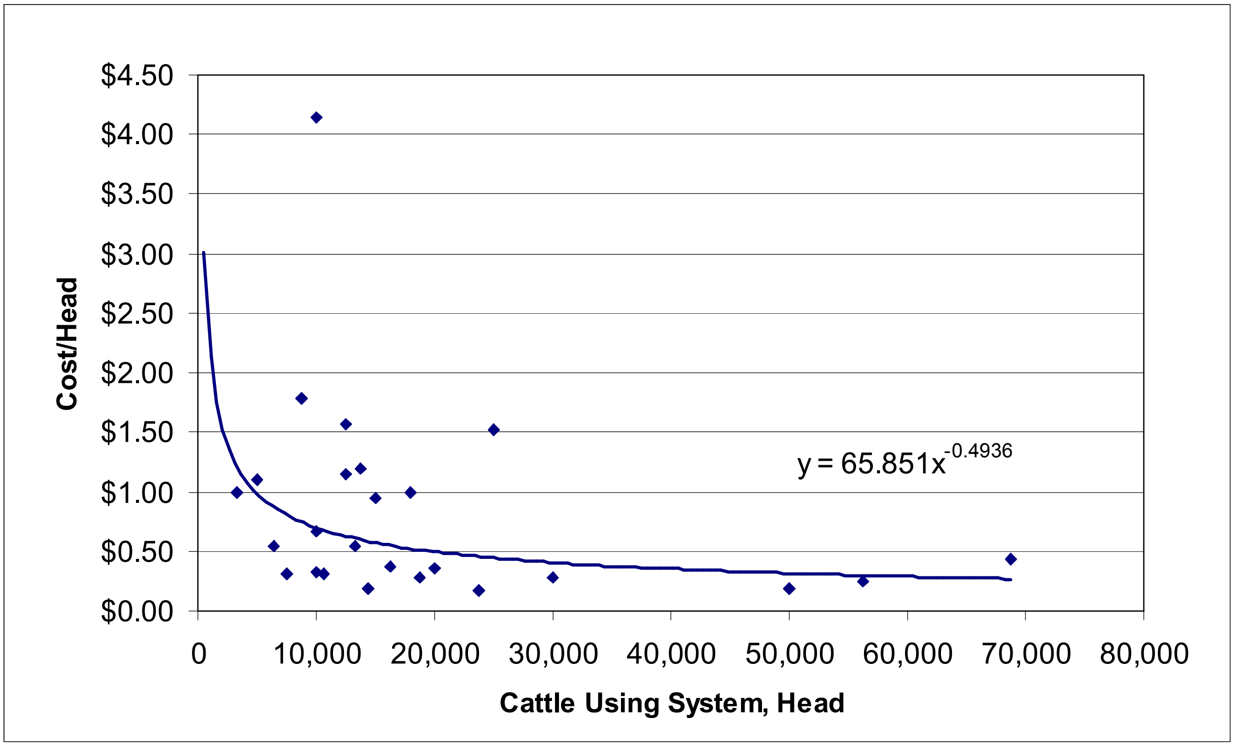
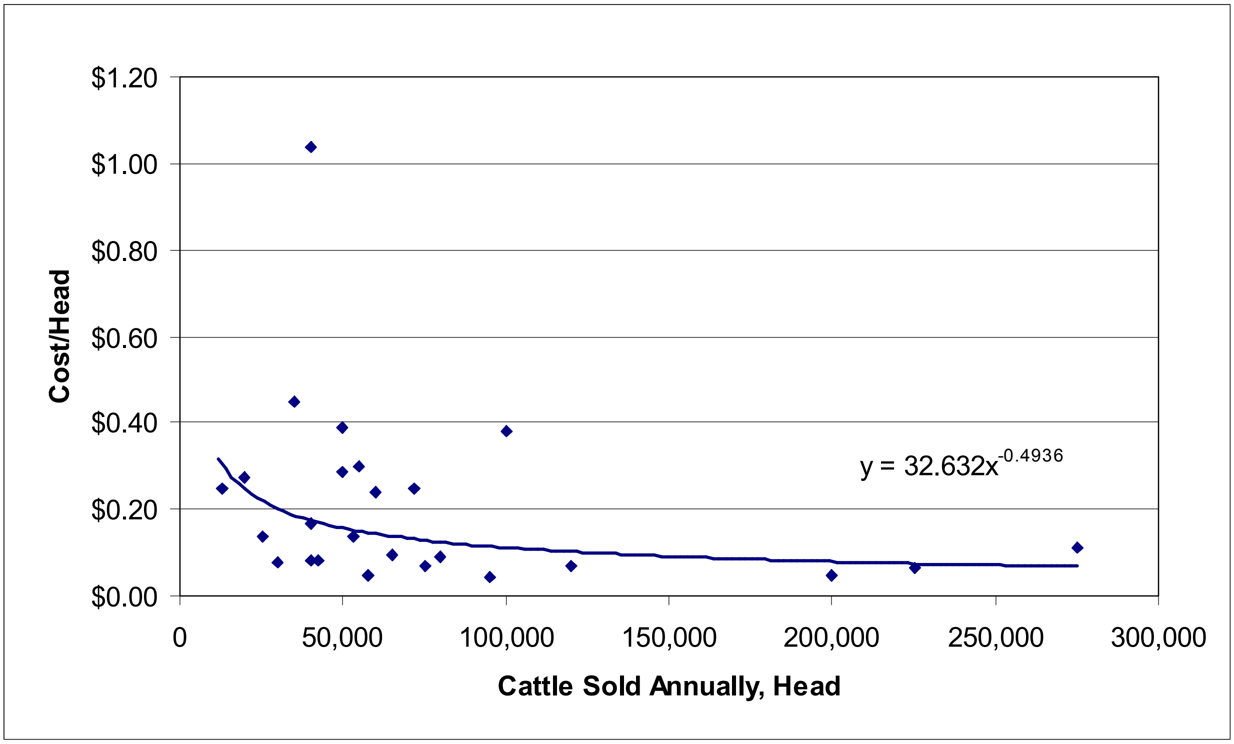


Figure 5.17 Livestock Market Annualized Costs per Head Based on 100% of Annual Cattle Sales (15% Return) by Head of Cattle Sold Annually



The generalized cost functions in figures 5.14 through 5.17 were formulated using equations 25 and 26. The estimated coefficients are in equations 32 through 35 for figures 5.14 through 5.17 respectively.

(32) $\hat{Y}_i = 61.717 A_i^{-.4981}$

(33) $\hat{Y}_i = 30.775 A_i^{-.4981}$

(34) $\hat{Y}_i = 65.851 A_i^{-.4936}$

(35) $\hat{Y}_i = 32.632 A_i^{-.4936}$

In equations 32 through 35 *A* is 100% of annual cattle sales for figures 5.15 and 5.17 and 25% of annual cattle sales for figures 5.14 and 5.16. The R-square values for equations 32 through 35 are 0.17, 0.17, 0.18, and 0.18, respectively. These R-square values were the highest values among the functional forms tested.

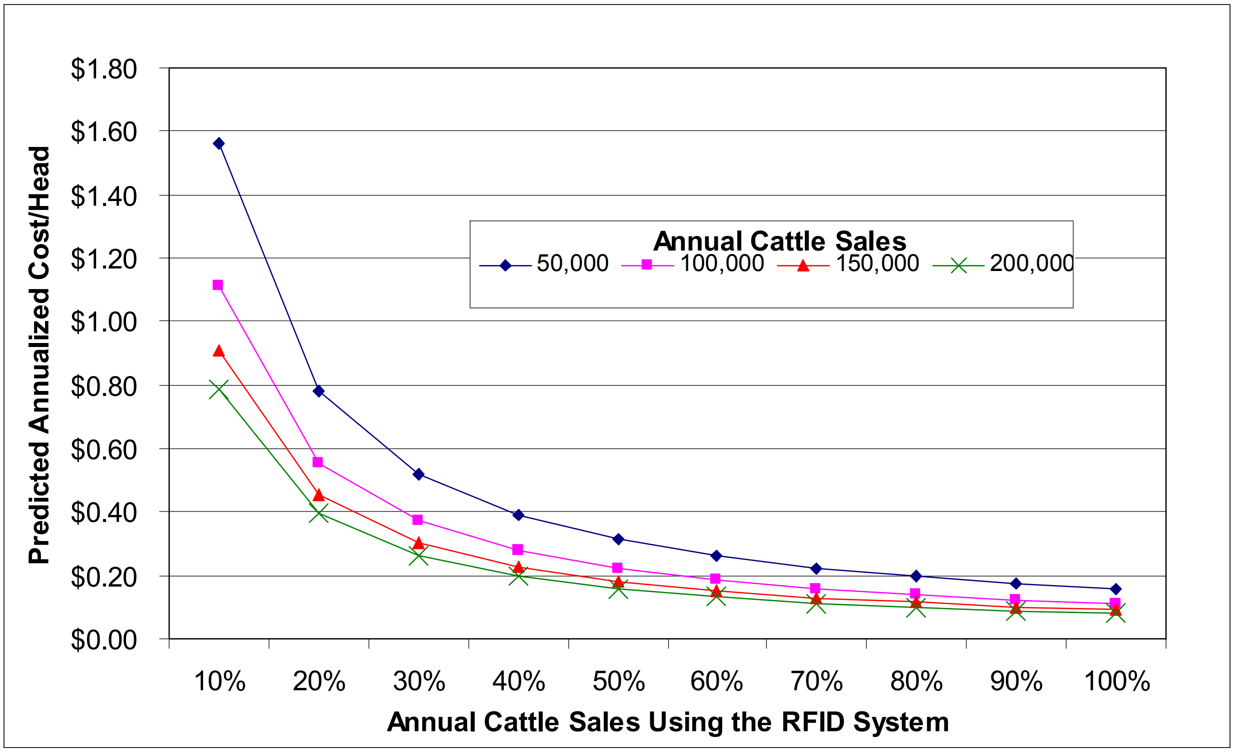
Cost estimates provided in figures 5.14 through 5.17, show that economies of scale associated with RFID adoption exist; predicted annualized cost per head decrease as the size of livestock market increases. This shows that larger livestock markets have a cost advantage relative to smaller livestock markets. These annualized costs can help livestock markets decide if they are going to charge an extra commission to all cattle sold, or only to those cattle that use the RFID reader system.

Figure 5.18 shows the predicted annualized cost per head of cattle for four different sized hypothetical livestock markets when a RFID reader system is used on varying levels of cattle. The four hypothetical livestock markets' predicted annualized costs per head were found by using the general cost function in figure 5.17 (i.e., 15% return rate). Based upon a livestock market that sells 50,000 head of cattle annually, predicted annualized costs would be $1.56 per head when 10% of cattle use the reader system and $0.16 per head when 100% of cattle use the system. A livestock market that sells 100,000 head of cattle annually could expect predicted annualized costs of $1.11 per head when 10% of cattle use the system and $0.11 per head when 100% of cattle use the system. When the predicted annualized costs between these two livestock markets are compared, a livestock market that sells 50,000 head of cattle annually has a predicted annualized cost per head 41% higher than a livestock market that sells 100,000 head of cattle, across all levels of cattle usage.

A livestock market that sells 150,000 head of cattle annually can expect predicted annualized costs of $0.91 per head when 10% of cattle use the system and $0.09 per head when 100% of cattle use the system. A livestock market that sells 200,000 head of cattle annually can expect predicted annualized costs of $0.79 per head when 10% of cattle use the system and $0.08 per head when 100% of cattle use the system. Predicted annual costs for a facility that sells 150,000 head of cattle annually are 15% higher than predicted annual costs for a facility that sells 200,000 head of cattle annually, across all levels of cattle usage.

There are large differences in predicted annualized costs per head when comparing different sized livestock markets; however, predicted annualized costs per head gradually decrease as more cattle use the system for each livestock market size. This means economies of size exist in this relationship; as more cattle use the RFID reader system predicted annualized costs per head decrease. Presence of economies of size means smaller livestock markets that use a reader system intensively (i.e., higher percentage of cattle sold annually) can compete with larger livestock markets that use their reader system on a smaller percentage of total cattle sales. The largest decrease in predicted annualized cost per head appears to be realized when at least 45% of cattle use the system for all four livestock markets. This shows that livestock markets wishing to invest in a RFID reader system should strive to have a minimum of 45% of cattle sales using the RFID reader system to substantially decrease predicted annualized costs per head of cattle using the system.

Figure 5.18 Four Hypothetical Livestock Market's Predicted Annualized Costs of RFID Reader Systems by Varying Levels of Cattle Using the System (15% Return)



5.4 Conclusions and Implications

This section reviewed the annualized average total costs of offering a RFID tagging service and installing a RFID reader system in livestock auction markets. Generalized cost functions were derived in both cases and economies of scale were evaluated. Fifty-five percent of respondents declared they would provide a RFID tagging service when the NAIS is fully implemented and only 14% of respondents had operating RFID reader systems.

Annualized total cost estimates of RFID tagging services were calculated by amortizing the required investment over a 10-year period at 8% and 15% interest rates. The annual expenses of adding a tagging service were added to this amortized value to arrive at an annual cost estimate associated with adding a tagging service. Most livestock markets (90%) experienced annualized cost estimates of less than $5.00 per head for a RFID tagging service.

A generalized cost function was derived to describe the predicted annualized average total cost of offering a RFID tagging service across different usage rates among livestock markets. The generalized cost function displayed economies of size. Meaning average predicted annual total costs of a tagging service decrease as livestock usage increases, up to 11,755 head. When 11,755 head of livestock or more use the service, predicted average annual total costs become constant at $1.51 per head.

Annualized cost estimates of RFID reader systems were calculated by annualizing the total investment at 8% and 15% interest rates and adding the amortized investment to the annual expenses. Interest was also calculated on operating costs, assuming they were borrowed for 15 days each month. Most auction markets had annual cost estimates associated with RFID systems of less than $0.30 per head of cattle sold annually, with large-volume markets having annual cost estimates that were less than $0.11 per head of cattle sold annually.

A generalized cost function was derived to describe the predicted annualized average total cost of adopting RFID reader systems among different sized livestock markets. The generalized cost function displayed economies of scale. Meaning larger-volume livestock markets have lower predicted costs per head when compared to smaller-volume livestock markets. However, smaller-volume livestock markets that use an electronic reader system intensively (i.e., on a high percentage of cattle sold annually) can compete cost-wise with larger-volume markets that use their reader system on a small percentage of cattle.

CHAPTER 6 - Benefits of Electronic Animal Identification

Electronic animal identification systems may benefit livestock markets that choose to install them. For example, livestock markets may find more customers (buyers and sellers) attracted to their facility because of premiums associated with RFID tagged cattle or simply because of the added RFID reader service. Premiums associated with RFID tagged cattle could result in higher valued animals sold or even an elevated reputation for a livestock market. Electronic animal identification systems must provide benefits to livestock markets that decide to install them; otherwise, it is unlikely that these businesses will adopt the services.

As demand for cattle individually identified with electronic tags increases, livestock markets that offer electronic animal identification reader systems will be able to attract more buyers and sellers. Livestock markets would probably need to advertise this service and could even offer meetings to buyers and sellers explaining what the livestock market has to offer in regard to electronic animal identification and how the reader system can benefit buyers and sellers of livestock. If livestock market customers are unable to reap the benefits of individual electronic identification of their cattle, then it is highly unlikely that RFID reader systems installed by livestock markets will be widely used by their customers.

One reason many producers are RFID tagging cattle is because of participation in preconditioning programs where RFID tags are required. Preconditioned has many different definitions in the cattle industry. In this analysis it specifically describes cattle that have been third-party verified as preconditioned. Meaning the cattle were enrolled in a specific program that required certain preconditioning standards. Usually these standards include the cattle being weaned at least three weeks prior to being sold, trained to eat from a bunk, properly vaccinated against disease, castrated, dehorned, and sometimes source and/or age verified (King and Seeger, 2005). Not all preconditioning programs require RFID tagging.

Preconditioning programs are thought to improve feedlot performance of feeder cattle (King and Seeger, 2005). The average cost of preconditioning programs is $28-63/head (King and Seeger, 2005). The use of these programs is on the rise. A study completed by King and Seeger, at Superior Livestock Auction Market noted that 3% of cattle sold were enrolled in the auction market's VAC 45 preconditioning program and 12% in the market's VAC 34 preconditioning program in 1995. By 2004, 25% and 49% of cattle sold were enrolled in the respective preconditioning programs. Also, half of livestock market operators, surveyed by the Livestock Marketing Association and Global Animal Management, currently sell cattle participating in preconditioning programs (Rutherford, 2007). Seventy-five percent of operators believe exposure to these programs is important for future competition in beef markets and 65% of operators expect to see an increase in the number of cattle enrolled in these programs (Rutherford, 2007).

Another reason producers use RFID tags is for management purposes. Cow-calf, stocker, and feedlot producers use RFID tags in order to better manage their cattle through automated, computer-based records. RFID tags are costly compared to visual identification tags; they cost approximately $2.00-$2.60 per tag. On average only 26-50% of feeder cattle, marketed at surveyed livestock markets, are identified by some type of identification tag when sold. When they are identified it is usually with a standard visual number tag costing $0.50-$0.75 a piece. However, survey results from Breiner et al. suggested that by the end of 2006 usage of RFID tags would double among cow-calf producers, the primary suppliers of feeder cattle (this survey however was completed prior to the USDA announcing NAIS would remain voluntary indefinitely).

Producers of feeder cattle need to know if there are premiums associated with RFID tagged and preconditioned animals to make better marketing decisions of their livestock. Some buyers may be willing to pay a premium for RFID tagged and preconditioned cattle. Some preconditioning programs require RFID tagged cattle. RFID tagging makes health and age/source verification records easier to track electronically. Therefore, the objective of this analysis is to quantify the economic effect of RFID tags and preconditioning programs on prices paid for feeder cattle in Kansas livestock markets. To accomplish this objective previous research will be studied, the conceptual and empirical model will be formulated, data will be explained, and the model and results will be described.

6.1 Previous Research

There has been abundant research conducted with hedonic pricing models of feeder cattle. There has also been many research papers outlining premiums received for preconditioned cattle. However, to the knowledge of the researcher there has not been an analysis on the effect of feeder cattle prices when feeder cattle are tagged with RFID tags and preconditioned.

Cole analyzed the effect of specific economic factors on the price of feeder cattle in livestock auction markets. Two models were used to estimate feeder cattle price determinants. The first model used average price paid per pound at feeder cattle sales, grade of the animal, weight class, lot size, and sex as independent variables. The second model used the same independent variables as model one, but weight was treated as a continuous variable and lot size was divided into categories. Statistically significant variables were grade, lot size (only in model one), weight (in model one), and sex.

Schroeder et al. estimated the impact of many physical characteristics on feeder cattle prices in Kansas. This study divided the data into four data sets categorized by season and weight which allowed for a more homogenous set of feeder cattle prices and characteristics for analysis. A hedonic pricing model was used with significant variables of weight, weight squared, lot size, condition, fill, breed, presence of horns, and time of sale. During different seasons buyers demanded different physical characteristics of feeder cattle.

Coatney, Menkhaus, and Schmitz looked for interdependencies between feeder cattle characteristics, when feeder cattle buyers make pricing decisions. The researchers used hedonic price functions to formulate total price impacts, indirect price impacts, and direct price impacts coupled with different characteristics of cattle. The most statistically significant direct price impacts occurred because of a change in the cattle's physical characteristics such as weight, sex, frame score, and breed. The largest indirect price impacts occurred because of seller added characteristics (i.e., vaccinations) and market factors demonstrated through the weight and frame score of the feeder cattle. The study concluded that feeder cattle sellers must be aware of direct and indirect impacts of cattle characteristics to better understand feeder cattle buyer preferences and pricing. They concluded that modeling interdependencies associated with certain characteristics of feeder cattle were important to remember.

Other studies have found premiums for third-party verified preconditioned cattle. A survey conducted by the Livestock Marketing Association and Global Animal Management indicated that livestock market operators have seen premiums up to $5.37 per hundredweight (cwt) for cattle that were age and source verified and third-party verified as preconditioned (Rutherford, 2007). Analyzing LMA-VACC and regular auction sales at the Holton Livestock

Exchange in Kansas, Dhuyvetter, Bryant, and Blasi found premiums of $4.50 to $5.50 per cwt for LMA-VACC preconditioned calves sold in the fall relative to cattle that were not preconditioned, over a five year period. King and Seeger analyzed cattle sold in the Superior Livestock Video Auctions from 1995 to 2004 and found that cattle that were in the Superior promoted VAC-45 preconditioning program brought premiums on average of $4.37 per cwt over the 10-year period. Premiums paid for VAC-45 calves in 2004 were higher than previous periods and premiums had increased each of the last five years. Lawrence and Yeboah found that some calves in the Iowa-Missouri Beef Improvement Organization's source verified and preconditioned program received premiums relative to cattle not in the program. Lighter-weight calves in the program received larger premiums perhaps because lighter-weight cattle are generally more susceptible to disease.

6.2 Empirical Model

A hedonic price model was used in this study to estimate the price differential associated with RFID tagged and preconditioned calves. The model allows internal and external characteristics to affect price. Feeder cattle characteristics (*C*) and market characteristics (*M*) influence the price (*P*) of feeder cattle. Three regressions were used to test the influence of many factors on the price of feeder cattle at three livestock markets in Kansas where data were collected. The model used is similar to the models used in Coatney, Menkhaus, and Schmitz; Lawrence and Yeboah; and Shroeder et al. The conceptual model was specified as:

$$(36) \qquad P_{it} = \sum_k V_{ikt} C_{ikt} + \sum_h R_{ht} M_{ht} \; .$$

The subscript i describes a certain lot of cattle, k describes certain physical traits, h refers to the influence of the market, and t represents the auction date. *V* and *R* reflect the marginal effect of the specific physical (*C*) and market (*M*) characteristics. This conceptual model is an expanded version of Ladd and Martin's Input Characteristics Demand Model (Ladd and Martin, 1976).

More specifically the hypothesized empirical models were:

$$P_i = b_0 + b_1 weight_i + b_2 weight_i^2 + b_3 head_i + b_4 head_i^2 + b_5 heifer_i + b_6 BCS3_i + b_7 BCS5_i + b_8 large_i + b_9 small_i + b_{10} british_i + b_{11} cont_i + b_{12} polled_i + b_{13} RFID_i + e \tag{37}$$

$$P_i = b_0 + b_1 weight_i + b_2 weight_i^2 + b_3 head_i + b_4 head_i^2 + b_5 heifer_i + b_6 large_i + b_7 small_i + b_8 british_i + b_9 polled_i + b_{10} RFID_i + e \tag{38}$$

$$P_i = b_0 + b_1 weight_i + b_2 weight_i^2 + b_3 head_i + b_4 head_i^2 + b_5 heifer_i + b_6 BCS2_i + b_7 BCS3_i + b_8 BCS5_i + b_9 large_i + b_{10} small_i + b_{11} british_i + b_{12} cont_i + b_{13} cross_i + b_{14} polled_i + b_{15} RFID_i + e \tag{39}$$

where i represents the individual lots of cattle, b's represent the regression coefficients and e is the error term. Equations 37, 38, and 39 correspond to livestock market 1, livestock market 2, and livestock market 3, respectively. The other variables in the equation above are described in table 6.1 and summary statistics are in tables 6.2 through 6.4. All variables above excluding *heifer* and *RFID* were statistically significant in Schroeder et al. The heifer variable was statistically significant in research completed by Coatney, Menkhaus, and Schmitz. The models were constructed based upon available data and significant variables from past research.

Table 6.1 Description of Variables used in Feeder Cattle Price Premiums Model

Variable	Description	Units
P	Price of feeder cattle	$/cwt
weight	Average weight of cattle in a lot	Pounds/Calf
heifer	Female calves	1 if heifer; 0 otherwise
steer	Castrated, male calves	Base
head	Number of cattle per lot	Head/Lot
BCS2	Body Condition Score 2 – Very Thin	1 if BCS2; 0 otherwise
BCS3	Body Condition Score 3 – Thin	1 if BCS3; 0 otherwise
BCS4	Body Condition Score 4 – Average	Base
BCS5	Body Condition Score 5 – Fat	1 if BCS5; 0 otherwise
large	Frame Score	1 if Large; 0 otherwise
medium	Frame Score	Base
small	Frame Score	1 if Small; 0 otherwise
british	British breeds (Angus, Shorthorn, Hereford…)	1 if British; 0 otherwise
cont	Continental breeds (Charolais, Limousin, Simmental…)	1 if Continental; 0 otherwise
cross	British-Continental breed cross	1 if Cross; 0 otherwise
Other Breed	Breed other than Continental or British (Longhorn, Brahman, Holstein…)	Base

polled	Lot of cattle has no horns	1 if Polled; 0 otherwise
Not Polled	Lot of cattle was horned, mixed or tipped	Base
RFID	RFID tagged and preconditioned	1 if RFID tagged and preconditioned; 0 otherwise

6.3 Data

Data were collected from three livestock market sales in Kansas within a three-month period (October 2006-January 2007). The three markets were located in different parts of the state; market 1 in Northeast, market 2 in North Central, and market 3 in Southeast Kansas. Data collected at each of the sales included the date, location, and time of sale. Data collected as each lot of cattle were sold included the average weight of lot, head per lot, sex, body condition score, frame score, color, breed, presence of horns, presence of RFID tag, officially preconditioned, and sale price. The same person collected data at all three sales to decrease variation in subjective variables.

Any lot of cattle that had a price lower than $40/cwt, average weight greater than 1200 pounds, or average weight less than 300 pounds was removed from the data set as they were considered to be outliers. By doing this, only cattle that were of good health, structure, and size were used in the regression. Tables 6.2 through 6.4 provide summary statistics of the data used in the models.

Each livestock market sold calves in different preconditioning programs. At market 1 the preconditioning program used was the Livestock Marketing Association's vaccinated and certified program (LMA-VACC). At market 2 the USDA Quality Systems Assessment (QSA) program was used and at market 3 a program called BoviTrax was used on preconditioned cattle. At all of the markets, all RFID tagged cattle sold were enrolled in one of the preconditioning programs. At markets 2 and 3 the only other cattle sold were non-RFID tagged, non-preconditioned. However, at market 1 there were cattle that were enrolled in the LMA-VACC program and not RFID tagged.

Table 6.2 Summary Statistics for Variables Used in Feeder Cattle Price Premiums Model for Livestock Market 1

Variable	N	Mean	Standard Deviation	Minimum	Maximum
P	161	113.940	9.150	91.000	137.000
weight	161	554.888	97.482	315.000	826.000
head	161	7.658	7.249	1.000	36.000
heifer	161	0.416	0.494	0.000	1.000
steer	161	0.584	0.494	0.000	1.000
BCS	161	4.056	0.256	3.000	5.000
BCS2	161	0.000	0.000	0.000	0.000
BCS3	161	0.006	0.079	0.000	1.000
BCS4	161	0.932	0.253	0.000	1.000
BCS5	161	0.062	0.242	0.000	1.000
large	161	0.292	0.456	0.000	1.000
medium	161	0.584	0.494	0.000	1.000
small	161	0.124	0.331	0.000	1.000
british	161	0.273	0.447	0.000	1.000
continental	161	0.031	0.174	0.000	1.000
cross	161	0.696	0.462	0.000	1.000
Other Breed	161	0.000	0.000	0.000	0.000
polled	161	0.988	0.111	0.000	1.000
Not Polled	161	0.012	0.111	0.000	1.000
RFID	161	0.832	0.375	0.000	1.000

Table 6.3 Summary Statistics for Variables Used in Feeder Cattle Price Premiums Model for Livestock Market 2

Variable	N	Mean	Standard Deviation	Minimum	Maximum
P	277	100.196	11.046	68.000	139.500
weight	277	665.570	136.006	339.000	1120.000
head	277	13.036	16.888	1.000	99.000
heifer	277	0.462	0.499	0.000	1.000
steer	277	0.534	0.500	0.000	1.000
BCS	277	4.000	0.000	4.000	4.000
BCS2	277	0.000	0.000	0.000	0.000
BCS3	277	0.000	0.000	0.000	0.000
BCS4	277	1.000	0.000	1.000	1.000
BCS5	277	0.000	0.000	0.000	0.000
large	277	0.155	0.363	0.000	1.000
medium	277	0.791	0.408	0.000	1.000
small	277	0.054	0.227	0.000	1.000
british	277	0.928	0.259	0.000	1.000
continental	277	0.072	0.259	0.000	1.000
cross	277	0.000	0.000	0.000	0.000
Other Breed	277	0.000	0.000	0.000	0.000
polled	277	0.848	0.359	0.000	1.000
Not Polled	277	0.152	0.359	0.000	1.000
RFID	277	0.090	0.287	0.000	1.000

Table 6.4 Summary Statistics for Variables Used in Feeder Cattle Price Premiums Model for Livestock Market 3

Variable	N	Mean	Standard Deviation	Minimum	Maximum
P	423	93.384	14.988	40.000	136.000
weight	423	572.017	145.094	305.000	1097.000
head	423	4.009	6.261	1.000	66.000
heifer	423	0.390	0.488	0.000	1.000
steer	423	0.551	0.498	0.000	1.000
BCS	423	3.998	0.253	2.000	5.000
BCS2	423	0.005	0.069	0.000	1.000
BCS3	423	0.019	0.136	0.000	1.000
BCS4	423	0.950	0.217	0.000	1.000
BCS5	423	0.026	0.159	0.000	1.000
large	423	0.161	0.368	0.000	1.000
medium	423	0.754	0.431	0.000	1.000
small	423	0.085	0.279	0.000	1.000
british	423	0.220	0.415	0.000	1.000
continental	423	0.097	0.296	0.000	1.000
cross	423	0.657	0.475	0.000	1.000
Other Breed	423	0.026	0.159	0.000	1.000
polled	423	0.856	0.352	0.000	1.000
Not Polled	423	0.144	0.352	0.000	1.000
RFID	423	0.073	0.261	0.000	1.000

6.4 Results

An Ordinary Least Squares regression model was used to estimate equations 37-39. This model differs from models used by other researchers because it includes a variable specifically pertaining to the presence of RFID tagged and preconditioned feeder cattle. The estimated parameters are presented in tables 6.5-6.7.

With market 1, only estimated parameters associated with *weight*, *head*, $head^2$, and *heifer* were statistically significant (table 6.5). The variables *weight*, $head^2$, and *heifer* had negative effects on the price of feeder cattle and *head* had a positive effect. This model found no significant difference between cattle that were sold with or without RFID tags. All cattle sold at this sale were preconditioned in the LMA-VACC program. The model explained 60% (adjusted R-square) of the variation in feeder cattle prices.

Table 6.5 Estimated Premiums and Discounts Associated With Feeder Cattle Characteristics at Livestock Market 1 (Standard Error in Parenthesis)

weight	-0.102	(0.047) **
weight²	0.000	(0.000)
head	0.845	(0.195)***
head²	-0.018	(0.006)***
heifer	-6.728	(0.955)***
BCS3	4.944	(5.901)
BCS5	0.279	(2.231)
large	-1.329	(1.151)
small	0.324	(1.609)
british	1.190	(1.094)
continental	1.368	(2.742)
polled	-1.608	(4.236)
RFID	1.448	(1.359)
Intercept	161.959	(13.656)***
Adjusted R^2 - 0.5981		

Significant at the 10% level *
Significant at the 5% level **
Significant at the 1% level ***

For market 2 the variables *weight*, *weight*^{2}, *head*, *head*^{2}, *heifer*, *small*, and *RFID* were statistically significant (table 6.6). The variables *weight*, *head*^{2}, *heifer*, and *small* had negative effects on the price of feeder cattle and *weight*^{2}, *head*, and *RFID* had positive effects. A statistically significant premium was paid for cattle that were RFID tagged and preconditioned. Feeder cattle that were QSA approved and RFID tagged received a premium of $2.96 per cwt compared to cattle not QSA approved or RFID tagged. For a 600 pound calf this premium would equate to $17.77 per head. The model explained 71% (adjusted R square) of the variation in feeder cattle prices.

Table 6.6 Estimated Premiums and Discounts Associated With Feeder Cattle Characteristics at Livestock Market 2 (Standard Error in Parenthesis)

weight	-0.211	(0.021)***
weight^2	0.000	(0.000)***
head	0.329	(0.060)***
head^2	-0.003	(0.001)***
heifer	-8.748	(0.723)***
large	-0.204	(1.192)
small	-6.323	(1.825)***
british	1.239	(1.425)
polled	0.694	(1.014)
RFID	2.962	(1.350)**
Intercept	192.961	(7.612)***

Adjusted R^2 - 0.7110

Significant at the 10% level *
Significant at the 5% level **
Significant at the 1% level ***

For Market 3 *weight*, *weight*^{2}, *head*, *head*^{2}, *heifer*, *BCS2*, *BCS3*, *british*, *continental*, and *polled* variables were statistically different from zero (table 6.6). The variables *weight*, *head*^{2}, *heifer*, *BCS2*, and *BCS3* had negative effects on the price of feeder cattle and the variables *weight*^{2}, *head*, *british*, *continental*, and *polled* had positive effects. There was no statistically significant difference between cattle that were RFID tagged and preconditioned versus those that were not RFID tagged or preconditioned. All cattle sold at this sale were either preconditioned in the BoviTrax program and RFID tagged or not RFID tagged or preconditioned. The model explained 36% (adjusted R square) of the variation in feeder cattle prices.

Table 6.7 Estimated Premiums and Discounts Associated With Feeder Cattle Characteristics at Livestock Market 3 (Standard Error in Parenthesis)

weight	-0.119	(0.026)***
weight^2	0.000	(0.000)***
head	1.158	(0.203)***
head^2	-0.015	(0.004)***
heifer	-6.318	(1.224)***
BCS2	-20.640	(8.700)**
BCS3	-23.562	(4.410)***
BCS5	-4.909	(3.813)
large	-0.299	(1.777)
small	-2.591	(2.162)
british	7.070	(3.944)*
continental	8.548	(4.161)**
cross	4.534	(3.817)
polled	3.825	(1.745)**
RFID	1.147	(2.383)
Intercept	131.551	(8.900)***
Adjusted R^2 – 0.3577		

Significant at the 10% level *
Significant at the 5% level **
Significant at the 1% level ***

Preconditioned and RFID tagged cattle brought a statistically significant and economically important premium at only one of the three livestock markets that were analyzed. Preconditioned and RFID tagged cattle at the first livestock market brought a premium of $1.45 per cwt when compared to cattle that were preconditioned but not RFID tagged, but the premium was not statistically significant. The second livestock market sold preconditioned and RFID tagged cattle that brought a $2.96 per cwt premium that was statistically significant when compared to cattle that were not preconditioned or RFID tagged. At the third livestock market, preconditioned and RFID tagged cattle brought a premium of $1.15 per cwt when compared to cattle that were not preconditioned or RFID tagged; however, the premium was not significantly different from zero.

6.5 Conclusions and Implications

Feeder cattle prices are dependent on many different factors. These models could have been improved if more feeder cattle at each sale had been RFID tagged and not preconditioned. Then it could have been determined with greater confidence whether RFID tagged cattle receive premiums. In this data set 100% of RFID tagged cattle were preconditioned and only at market 1 were non-RFID tagged cattle preconditioned. Consequently, if there was a premium for non-RFID tagged, preconditioned cattle it would be hard to find the value statistically significant since such a small proportion of these cattle existed in the data set.

The results of this analysis indicate that there could be a statistically and economically significant premium associated with RFID tagged, preconditioned feeder cattle at one out of three Kansas livestock markets. Previous studies have found similar significant variables in feeder cattle price models but did not evaluate a premium or discount associated with RFID tagged cattle. Future studies should investigate the above mentioned deficiencies of this study.

The RFID tagged cattle market is still somewhat thin and consistent sale premiums will depend upon buyer demand and competition for such cattle at any particular market venue. Price premiums associated with RFID tagged and preconditioned cattle and the prospects of a larger customer base are two benefits that may be achieved by livestock markets that provide electronic animal identification reader systems to their customers. This added service may position a livestock market apart from other facilities by offering additional services to their customers.

CHAPTER 7 - Conclusion

Buyers and sellers of livestock come together at livestock auction markets to discover prices in a public setting. Livestock markets may differentiate themselves by offering electronic individual animal identification and tracking services to their customers. Programs such as the National Animal Identification System (NAIS), marketing alliances, and verification programs are leading to increased use of animal identification systems. Livestock markets are a primary industry sector where animal movement and identification information can be recorded. The purpose of this project was to determine livestock market manager perceptions about animal identification systems, estimate costs of adopting animal tracking systems in auction markets, and assess benefits related to adoption of animal identification systems in auction markets. To accomplish these objectives a national survey of livestock auction markets was conducted, Kansas livestock market operators in a pilot study were interviewed, and sale day transaction data were collected. Results from completed surveys, representing 189 livestock auction markets, were reported.

Because of the important role auction markets have in being the first market for many cattle, livestock market operator knowledge, concerns, and views of the NAIS and animal identification movement tracking systems are important to understand. If livestock market operators do not understand the NAIS or animal identification systems, information may be misconstrued. Identifying concerns livestock market operators may have about electronic animal identification systems is also important in designing programs to address these issues.

Livestock market operators that plan to offer a RFID tagging service in the future were more probable to have greater knowledge of the NAIS program standards, how to adopt the NAIS practices, and costs necessary to comply with the NAIS. Auction market operators that have adopted RFID reader systems are more probable to have more knowledge of how to adopt NAIS practices and of the costs necessary to adopt the NAIS practices. Also, facilities where more livestock are sold annually are more probable to have more knowledge of the NAIS program standards and how to adopt the NAIS practices.

Those facilities that have operating RFID reader systems or have registered their premises are more likely to view the NAIS as an *opportunity* to their businesses than facilities that do not use RFID reader systems or have not registered their premises. Facilities that viewed the NAIS as an *opportunity* to their businesses were early adopters of the program. Concerns that electronic animal identification systems will adversely impact speed of sale are common among livestock market operators. Livestock markets that sell large volumes of livestock annually have greater concerns than low-volume facilities.

Most livestock market operators are only moderately knowledgeable of the NAIS standards, costs, and adoption needs. More information about the NAIS is needed for livestock market operators if it is a goal to have the NAIS become more broadly adopted by the livestock market industry. Also, concerns of electronic animal identification systems need to be addressed and livestock market operator views of how the NAIS will impact their business need to be improved.

There is growing interest in adopting electronic animal identification systems at livestock markets, though only a small percentage have done so. Livestock market operators that have registered their premises, sell larger volumes of livestock, or plan to add a RFID tagging service in the future are more likely to adopt RFID reader systems. Looking ahead, livestock markets may become more specialized in the services they offer and customers they attract. Producers selling cattle with individual animal identification would be more attracted to facilities providing RFID reader systems.

Many facilities claimed they would offer a RFID tagging service when the NAIS is fully implemented. Ninety percent of livestock market respondents would experience annualized cost estimates of less than $5.00 per head for a RFID tagging service. Economies of size are evident with tagging services. Predicted annual total costs decrease as livestock usage increases up to 11,755 head, after which point predicted annual total costs are constant at $1.51 per head.

Only 14% of respondents had functional RFID reader systems at their facilities. Most livestock markets' annual cost estimates for a RFID reader system were less than $0.30 per head of cattle sold annually. Most large-volume facilities experienced annual cost estimates of less than $0.11 per head of cattle sold annually. Economies of scale were present in the predicted annual costs of a RFID reader system. Consequently larger-volume markets had lower predicted costs per head when compared to smaller-volume markets. Despite important economies of size, smaller-volume facilities that use electronic reader systems intensively (i.e., on a higher percentage of cattle sold annually) can compete cost-wise with larger-volume markets that use their reader system on smaller percentages of cattle.

Benefits that may be associated with offering electronic animal identification services include attracting more buyers and sellers because of increased services or premiums associated with RFID tagged cattle; both ultimately benefiting the facility's reputation. Livestock markets that offer RFID reader systems will be able to attract more customers as demand for cattle individually identified with electronic tags increases. Premiums for RFID tagged and preconditioned cattle were statistically significant at one of three livestock markets in Kansas. The RFID tagged cattle market depends highly upon buyer demand and competition for such cattle at a particular livestock market facility. On the other hand, livestock markets will not invest in such systems and services if demand and utilization does not justify the investment.

Deficiencies in this study included a limited data set; especially for the sections covering the annual costs of RFID reader systems and price premiums associated with RFID tagged and preconditioned cattle. A higher response rate to the national survey sent to livestock markets would have enhanced the study. Future research could focus on a benefit-cost analysis of electronic animal identification in livestock auction markets. Also, a follow-up study in a few years could investigate changes in knowledge, concerns, views, and adoption rates associated with electronic animal identification systems and the NAIS as more educational information becomes available and changes in policy decisions occur. An updated study could also investigate the cost of adopting RFID reading equipment, to see if the costs decrease over time due to technology longevity and broaden the study to include more livestock markets that have adopted such services.

Overall, current and reliable data on investments, operating costs, reliability of technology, NAIS standards, adoption requirements, and impacts of animal identification systems on sale speed needs to be provided to livestock markets and are critical to adoption of these systems within the livestock market industry. Facilities that discover value opportunities of animal identification systems to exceed costs will be more likely to adopt such practices as long as the NAIS is a voluntary program. Consequently, more specialization and differentiation is likely across auction markets over time with a voluntary program than if the NAIS were mandatory.

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Appendix A - Kansas State University Livestock Auction Market Survey

Kansas State University Livestock Auction Market Survey

Economic Impact of Individual Animal Identification Systems at Livestock Markets

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USDA

Kansas State University Livestock Auction Market Survey

Economic Impact of Individual Animal Identification Systems at Livestock Markets

Thank you for taking time to participate in this study. By collecting data from your operation and others, we are quantifying the economic impact of individual animal identification scanning and recording on U.S. Livestock Auction Markets. All information you provide will be strictly confidential. The analysis and report generated from this study will be done in a manner in which no individual Livestock Auction Market is associated with specific data. Please report information as accurately as possible, if you are unsure of an answer, please provide your best estimate. We will send you a copy of our report findings after they are compiled. Your assistance is greatly appreciated!

I. Description of Livestock Market Environment

A. What is the average annual number typically sold at this location, for each of the following species?

Cattle (Dairy and Beef) ________________ head

Hogs ________________ head

Sheep ________________ head

Horses ________________ head

Goats ________________ head

Other head

B. What is the approximate breakdown of cattle typically sold? (**Enter percent for each category**)

Calves, Yearlings, and Replacement Heifers ______%

Cows and Bulls ______%

Total 100%

C. What is the current, one-time, holding pen capacity of this facility?

___________________ head of cattle

D. Do you have the ability to expand pen capacity? (**Check One**)

____ Yes ____ No

Questions E-I pertain to peak versus non-peak cattle sale days. Peak sale days refer to times of the year when you have "bigger runs" than normal (e.g. fall weaning) and non-peak sale days refer to all other times. These differences are important for identifying potential constraints or bottlenecks that might occur at certain times of the year.

E. How many cattle are typically sold on a peak volume day at this livestock market?

_____________________ head

F. What month(s) of the year would peak volume sale days occur? (**Check all that apply**)

____ January ____ April ____ July ____ October

____ February ____ May ____ August ____ November

____ March ____ June ____ September ____ December

G. On average, how long are sales during a peak day? (**Check One**)

____ Less than 2 hours
____ 2-4 hours
____ 4-8 hours
____ 8-12 hours
____ Over 12 hours

H. How many cattle are typically sold, on a non-peak sale day at this livestock market?

_________________ head

I. On average, how long are sale days during a non-peak day? (**Check One**)

____ Less than 2 hours
____ 2-4 hours
____ 4-8 hours
____ 8-12 hours
____ Over 12 hours

J. On average, how many cattle sales are conducted per year? (**Check One**)

____ Less than 25
____ 25-49
____ 50-99
____ Over 100

K. What percent of cattle currently marketed through this barn have some type of identification tag (not including market back tags) (e.g., number tag, RFID tag, etc.)? (**Check One**)

____ 0-25%
____ 26-50%
____ 51-75%
____ 76-100%

L. What is the distribution of lot sizes of the following livestock sold through the sale ring of this facility annually? (**Enter percent for each category**)

	Calves/Yearlings/ Replacement Heifers	Cows/Bulls	Swine	Goats/Sheep
	Percent of lots (rows a-d should add to 100)			
a. Single head lots				
b. 2-10 head lots				
c. 11-50 head lots				
d. Lots with more than 50 head				
Total	100%	100%	100%	100%

M. What is the approximate market value of the auction facility (e.g., land, buildings, and stationary equipment (e.g., auction arena, chutes, corrals, etc.))? (**Check One**)

____ Less than $250,000
____ $250,000-$499,999
____ $500,000-$1,499,999
____ $1,500,000-$2,499,999
____ $2,500,000-$4,999,999
____ $5,000,000-$7,499,999
____ $7,500,000 or more

N. What is the approximate market value of rolling equipment in this business (e.g., pickups, trucks, tractors, trailers)? (**Check One**)

____ Less than $75,000
____ $75,000-$149,999
____ $150,000-$249,999
____ $250,000-$499,999
____ $500,000 or more

O. What is the approximate total annual cost for each of the following at this livestock market?

A.	Salaried labor	$_________
B.	Hourly labor	$_________
C.	Fuel and hired trucking	$_________
D.	Repairs and maintenance	$_________
E.	Utilities	$_________
F.	Other ____________________	$_________

P. If you utilize a computer system, what is the name of the software used to clerk each livestock sale? (**Write "none" if no software or computer is utilized**)

____

Q. Is an internet/video auction utilized during sales? (**Check One**)

____ Yes
____ No

II. Added Services with the National Animal Identification System

A. When the National Animal Identification System becomes fully implemented will this facility provide a tagging service for customers, providing them an alternative to tagging on their farm/ranch? (**Check one**)

____ Yes
____ No, **skip to question B, in the middle of page 4**
____ I do not know, **skip to question B, in the middle of page 4**

1. Will the facility charge an added fee for this tagging service? (**Check one**)

____ Yes
____ No
____ I do not know

2. If yes, how much do you plan to charge per head, excluding the cost of the tag?

____________$/head ____ Not sure at this time

3. Would the tagging service be completed by an employee of the facility or contracted out to a third party (e.g., a local veterinarian)? (**Check one**)

____ Facility employee(s)
____ Outside third party

4. How many head of livestock do you estimate would use this service annually?

________________ head

5. Provide an estimate of additional costs the livestock market will incur from the addition of a tagging service.

$________________ Additional annual costs (i.e. labor)
$________________ One-time investment expense (i.e. squeeze chute, new pens, etc.)

B. Do you envision offering any other new service(s) to your customers when the National Animal Identification System becomes fully implemented (e.g., age/source verification, record keeping, data analysis, etc.)?

____ Yes ____ No

1. If yes, please list the type(s) of services you plan to offer your customers?

____
____
____
____

III. Knowledge and Concerns with the National Animal Identification System

A. Rate your knowledge of the National Animal Identification System (NAIS), regarding the program standards. (**Use a scale of 1-9, where 1 reflects having no knowledge of the NAIS and 9 indicates you are extremely knowledgeable of the NAIS.**)

No Knowledge — Extremely Knowledgeable

1 2 3 4 5 6 7 8 9

B. Rate your level of understanding of what this facility needs to do to comply with the National Animal Identification System. (**Use a scale of 1-9, where 1 reflects you have no understanding and 9 indicates you completely understand.**)

No Knowledge — Extremely Knowledgeable

1 2 3 4 5 6 7 8 9

C. Rate your level of understanding of costs you will incur to comply with the National Animal Identification System within this facility. (**Use a scale of 1-9, where 1 reflects you have no understanding and 9 indicates you completely understand.**)

Do Not Understand — Completely Understand

1 2 3 4 5 6 7 8 9

D. Please indicate your level of concern about each of the following as they relate to the adoption of the National Animal Identification System. (**Circle one level for each item**)

	Level of Concern Low-Moderate-High
1. Speed of sale adversely impacted	1 – 2 – 3 – 4 – 5
2. Additional technology expertise needed	1 – 2 – 3 – 4 – 5
3. Reliability of electronic animal I.D. equipment	1 – 2 – 3 – 4 – 5
4. Cost of technology (e.g., readers, computers)	1 – 2 – 3 – 4 – 5
5. Cost of operating the system (e.g., labor)	1 – 2 – 3 – 4 – 5
6. Cost of renovation/facility modification	1 – 2 – 3 – 4 – 5
7. Confidentiality of NAIS	1 – 2 – 3 – 4 – 5
8. Other (specify ________________________)	1 – 2 – 3 – 4 – 5
9. Other (specify ________________________)	1 – 2 – 3 – 4 – 5

E. Do you view the National Animal Identification System as a threat or opportunity to this business? (**Check all that apply**)

____ Threat
____ Opportunity
____ Neither a threat, nor opportunity

F. Please list any other thoughts you have relating to the adoption of the National Animal Identification System and how it will impact your business (opportunities, threats, etc.).

____
____
____
____
____

IV. Individual Animal Identification

A. Does the livestock market currently have any sales that are specifically targeted toward animals with RFID (Radio Frequency Identification) tags? (**Check One**)

____ No ____ Yes

B. Has this livestock market registered for a premise identification number? (**Check One**)

____ Yes ____ No ____ I do not know

C. Does this livestock market currently utilize an individual animal identification scanning and recording system to identify cattle, such as a RFID reader system? (**Check One**)

____ No, **please answer the questions in Section V, beginning on page 5**
____ Yes, **please skip to the questions in Section VI, beginning on page 6**

V. If you answered "No" to question C, please answer the following questions: (If you answered "Yes" to question C, answer the questions beginning in Section VI, on page 6)

A. When the National Animal Identification System is fully implemented what type of individual animal identification reader do you think would be most useful in this facility? (**Check all that apply**)

____ Hand-held reader
____ Stationary panel reader
____ Other, please specify: ____________________
____ I do not know

B. If an individual animal identification scanning system was installed in your facility would you need to buy a new computer(s) in order to utilize this new system? (**Check One**)

____ Yes ____ No ____ I do not know

C. Would the facility need to purchase new software or have the current software upgraded if an individual animal identification system was installed? (**Check one**)

____ Yes ____ No ____ I do not know

D. Where is the optimal location for an individual animal identification reader system within the facility? (**Check all that apply**)

____ Unloading area
____ Load-out area
____ Sorting area
____ Immediately before the sale ring
____ Immediately after the sale ring
____ Other, please specify: ______________________________
____ I do not know

E. If an individual animal identification system was installed in this sale barn how many new employees do you anticipate would need to be hired to manage the new system?

____________ Employees ____ I do not know

F. Would the speed of the sale change if an individual animal identification system was installed in your facility? (**Check one and fill in the blank if applicable**)

____ No
____ Yes, the speed of sale will decrease by ______% cattle per day
____ Yes, the speed of sale will increase by ______% cattle per day

Thank you for your cooperation in completing this survey!

VI. If you answered "Yes" to question C (on page 5), please answer the following: (If you answered "No" to question C (on page 5), you have completed the survey.)

A. For what reason was the individual animal identification scanning and recording system installed? (**Check all that apply**)

____ Provide an added service to customers
____ For research purposes
____ Anticipation of regulations requiring an individual animal identification system
____ Other, please indicate: ____

B. From what company were the individual animal identification readers purchased?

___________________________________(e.g., Allflex, Destron Fearing…)

C. What type of individual animal identification is being utilized? (**Check all that apply**)

____ RFID technology
____ Retinal Scan technology
____ Bar Code technology
____ Other, please specify: ____________________

D. What type of reader is being utilized? (**Check all that apply**)
____ Hand-held reader
____ Stationary panel reader
____ Other, please specify: ____________________________

E. How much did each reader cost this facility?

Type of reader	Quantity purchased	Cost of one reader
______________________	________	$________________
______________________	________	$________________
______________________	________	$________________

F. What was the total amount charged to this facility by the company that installed the electronic animal identification system? (**Please record the total cost including the cost of the above listed readers and any other charges.**)
$____________

G. How many hours of labor were required to install the reader(s) by your employees? (**Do not include hours required to modify your facility**)
__________hours

H. What was the labor cost per hour of your employees, used installing the reader(s)?
______________$/hour

I. Did a new computer(s) have to be purchased in order to utilize this new system? (**Check One**)
____ Yes ____ No

J. If yes, how much was spent on a new computer(s)? (Be sure this cost only reflects the added expense due to the new technology) (**Check One**)
____ Less than $1,000
____ $1,000-$1,999
____ $2,000-$2,999
____ $3,000-$3,999
____ $4,000-$4,999
____ $5,000 or more

K. Did the facility have to purchase new software to comply with the new technology? (**Check One**)
____ Yes ____ No

L. If yes, how much was spent on the new software? (Be sure this cost only reflects the added expense due to the new technology) (Check One)
____ Less than $5,000
____ $5,000-$9,999
____ $10,000-$14,999
____ $15,000-$19,999
____ $20,000-$24,999
____ $25,000 or more

M. Did a software company help the livestock market upgrade to using the new technology with your current software? (Check One)
____ Yes ____ No

N. If yes, how much did the upgrade in software cost? (Please include the entire cost of the software upgrade, including labor and software)

$_____________

O. Is the facility being charged additional "technology support" fees annually from the software provider because of the new technology? (**Check one**)

____ Yes, $____________ is charged additionally annually

____ No

P. Please describe, in detail, the changes made to the facility in order for the new technology to be installed (e.g., redesigning alleys, modifying chutes, constructing new pens).

____

____

____

____

____

____

Q. What material costs were incurred to modify the facility? (**Please list major items and the costs of each**)

Material	Estimated Cost
________________________	$_________________
________________________	$_________________
________________________	$_________________
________________________	$_________________
________________________	$_________________

R. What is the location of the reader system within the facility? (**Check all that apply**)

____ Unloading area

____ Load-out area

____ Sorting area

____ Immediately before the sale ring

____ Immediately after the sale ring

____ Other, please specify: ______________________________

S. Was a contractor hired to complete any of the facility modifications needed to install the reader system? (**Check One**)

____ Yes ____ No

T. If yes, what was the cost of this service in terms of materials and labor?

Materials $_________________ Labor $_________________

U. Approximately, how many hours of labor did employees spend modifying the facility to prepare it for the installment of readers? (Do not include hours required to install the reader system)

_________________ hours

V. How many new employees were hired to manage the new system?

____________ Employees

W. How many employees were no longer needed because of the new system?

____________ Employees

X. How many hours per week do employees work with the reader system (total for all employees)?
__________________hours/week

Y. What is the average cost per hour of employees working with the reader system?
________________$/hour

Z. In order for the reader system to be fully functional, were any of your employees trained? (**Check One**)
____ Yes ____ No

AA. If yes, how many employees were trained and how much did the training cost per person?
_____________ Number of employees trained
_____________ Cost of training per person ($)

AB. Has the speed of the sale changed due to the system? (**Check one and fill in the blank if applicable**)
____ No
____ Yes, the speed of sale has decreased by _____% cattle per day
____ Yes, the speed of sale has increased by ______% cattle per day

AC. What percent of livestock sold through the facility currently utilize the reader system by being scanned and recorded? (**Check one**)
____ 0-25%
____ 26-50%
____ 51-75%
____ 76-100%

Appendix B - Cover Letters

LMA
LIVESTOCK MARKETING ASSOCIATION

November, 2006

Dear Fellow Livestock Marketer:

The enclosed survey, being conducted by Kansas State University, of the potential costs of implementing an electronic national animal identification system in livestock markets **is so important that LMA has agreed to send it to you, on K-State's behalf, with our full endorsement**.

Very little is currently known of the potential costs to U.S. livestock marketing businesses of implementing the U.S. Department of Agriculture's **proposed National Animal Identification System** (NAIS). **With your participation in this survey, we hope to learn much more** about the marketing sector's cost of collecting (reading) the ID information, retrofitting market facilities to accommodate an electronic ID system, transferring the ID information to private databases, etc. and possibly even tagging animals. **Once this information is in hand,** we anticipate having the necessary information to better assess the cost/benefits of a national animal ID system, determine if cost barriers to implementation of an electronic ID system exist at livestock markets, identify needed resources to implement the NAIS requirements at livestock marketing businesses and determine market infrastructure needs to operate a fully functional national animal ID system.

Protecting your interest and concerns relative to NAIS before the U.S. Congress and State legislatures, federal and state animal health officials and with other livestock industry groups and interests **is LMA's principal consideration in supporting the enclosed cost survey.** Thus, **we urge you in the strongest possible terms** to take 20-30 minutes out of your busy schedule **to answer the survey and return it to the K-State researchers** in the enclosed self-addressed, stamped envelope **as soon as possible**. Please contact LMA Vice President Nancy Robinson at 1-800-821-2048 or K-State Graduate Research Assistant Kati Bolte at 785-532-6702 if you have any questions about the survey.

Thank you for taking part in this most important livestock auction market survey!

Sincerely,

Jim

Jim Santomaso
LMA President

P.S. **To assure the most complete survey results, please consider providing your name and contact information on the enclosed card** to allow the researchers to contact you should any questions about your individual survey responses occur. **You can be assured that your individual responses to the survey will be kept strictly confidential.**

National Livestock Producers Association

November, 2006

Dear NLPA Livestock Market Managers:

The enclosed survey, being conducted by Kansas State University, of the potential costs of implementing an electronic national animal identification system in livestock markets **is so important that NLPA has agreed to send it to you, on K-State's behalf, with our full endorsement**.

Very little is currently known of the potential costs to U. S. livestock marketing businesses of implementing the U.S. Department of Agriculture's proposed **National Animal Identification System** (NAIS). **With your participation in this survey, we hope to learn much more** about the marketing sector's cost of tagging animals, collecting (reading) the ID information, retrofitting market facilities to accommodate an electronic ID system, and transferring the ID information to private databases, etc. **Once this information is in hand,** we anticipate having the necessary information to better assess the cost/benefits of a national animal ID system, determine cost barriers to implementation of an electronic ID system at livestock markets, identify needed resources to implement the NAIS requirements at livestock marketing businesses, and determine market infrastructure needs to operate a fully functional national animal ID system.

Protecting your interest and concerns relative to NAIS before the U.S. Congress and State legislatures, federal and state animal health officials and with other livestock industry groups and interests **is NLPA's principal consideration in supporting the enclosed cost survey.** Thus, **we urge you in the strongest possible terms** to take 15-20 minutes out of your busy schedule **to answer the survey and return it to the K-State researchers** in the enclosed self-addressed, stamped envelope as soon as possible. Please contact NLPA Assistant Director of Member Services, Stacy Loutzenhiser at 1-800-237-

7293 or K-State Graduate Research Assistant Kati Bolte at 785-532-6702 if you have any questions about the survey.

Thank you for taking part in this most important livestock auction market survey!

Sincerely,

Scott Stuart
NLPA President and CEO

P.S. **To assure the most complete survey results, please consider providing your name and contact information on the enclosed card** to allow the researchers to contact you should any questions about your individual survey responses occur. **You can be assured that your individual responses to the survey will be kept strictly confidential.**

Appendix C - States Represented by Regions

Table C.1 States Represented by Regions

Region	State
Midwest	Illinois
	Indiana
	Iowa
	Kansas
	Michigan
	Minnesota
	Missouri
	Nebraska
	North Dakota
	Ohio
	South Dakota
	Wisconsin
Northeast	New York
	Pennsylvania
Northwest	California
	Colorado
	Montana
	Utah
	Wyoming
	Oregon
Southeast	Alabama
	Arkansas
	Florida
	Georgia
	Kentucky
	Louisiana
	Mississippi
	North Carolina
	South Carolina
	Tennessee
	Virginia
Southwest	New Mexico
	Oklahoma
	Texas